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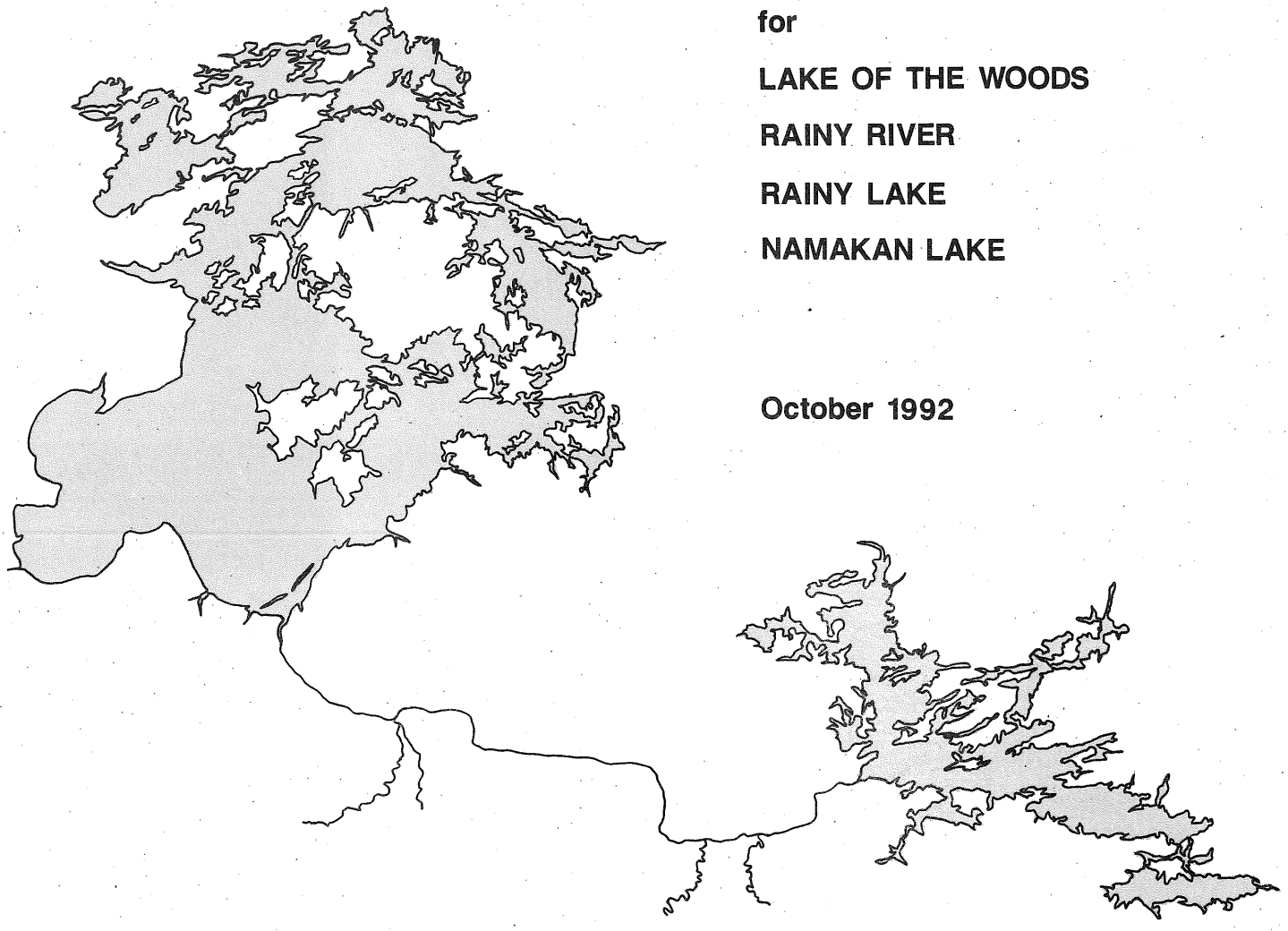
MINNESOTA – ONTARIO BOUNDARY WATERS FISHERIES ATLAS



for

LAKE OF THE WOODS

RAINY RIVER

RAINY LAKE

NAMAKAN LAKE

October 1992

Minnesota Department of Natural Resources

Ontario Ministries of Natural Resources

Tourism and Recreation

Northern Development and Mines

Ontario

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DEPARTMENT OF NATURAL RESOURCES

Ontario

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PREFACE

This document is an update of the original Minnesota-Ontario Boundary Waters Fisheries Atlas, published in July 1984, which presented fishery resource information and related socio-economic data on the common boundary waters of Lake of the Woods, Rainy Lake and the Rainy River. This latest version of the Atlas incorporates information from recent surveys within the border waters study area which has been enlarged to include Namakan Lake. It was jointly prepared by Ontario and Minnesota fisheries management and tourism professionals.

The primary purpose of this document has not changed. It continues to provide the necessary background information to allow development of options for managing the resource, which in turn will facilitate the development of long-term solutions to the management of the border waters of Lake of the Woods, Rainy River, Rainy and Namakan lakes.

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STATUS OF THE FISHERY RESOURCE

Introduction

The capability of a lake to produce a crop of fish is indicated by an index of productivity. This index (morphoedaphic index - MEI; Ryder 1965) is derived from two factors; the mean depth of the water body and the total dissolved solids in the water. Shallow lakes are more productive than deep lakes, and lakes with high levels of dissolved solids are more productive than those with low levels. Rainy Lake which is deeper, on average than Lake of the Woods, has lower levels of dissolved solids and is less productive.

Partitioning the potential fish production by species is done by using data from a series of lakes that have withstood moderate to heavy fishing pressure over time. The percentage of the total yield contributed by each species from these stable fisheries is used as a guideline to apportion the potential yield indicated by the MEI into target harvests. The apportionment of the catch may vary from lake to lake depending on the species and the type of fishery, either sport and/or commercial, present.

The current status of fish populations can be assessed by comparing the actual harvest to the potential yield. The potential yield is considered by biologists to be a "first order" estimator, and monitoring programs are employed to refine these estimates. Monitoring programs use a variety of analytical techniques such as index (test) netting, catch sampling and creel surveys which are standard for many fishery investigations.

These refinements lead to the development of target harvests. The target is the harvest objective which reflects actual conditions of the stock and ensures

maintenance of a healthy, harvestable population. In the case of Lake of the Woods, assessment indicates that the potential yield is the level at which target harvests should be set. In other lakes where potential yield has been exceeded, the refined data indicates that these stocks are overharvested and target harvest should be set below potential yield. For some species, where harvest is below potential, there are healthy stocks that can sustain greater harvest.

In fisheries where the stock of any one or more species has been seriously debilitated, such as walleye in the North Arm of Rainy Lake, it is often necessary to set target harvests below potential yield for two reasons. One is that the stock is simply not present, and the other is to assist the remaining stock to regain its former abundance so it can produce at the potential yield level. In other cases, such as northern pike in the North Arm of Rainy Lake, habitat and fisheries community conditions may favour a species to produce at levels above their theoretical potential. If stocks demonstrate this, then targets may be set at higher levels without harm to the stock.

The Ontario commercial fisheries on Lake of the Woods and Rainy Lake are regulated so that standard fishing gear (usually gill nets) are used. Changes in fishing success (catch-per-unit-of-effort or CUE) for this gear is a valuable and inexpensive means of detecting trends in population abundance.

Management agencies also survey these populations annually with standardized fishing gear i.e. index (test) nets. These surveys are useful in detecting trends, and also sample fish that are too small to be taken by commercial nets.

Changes in the age and size structures of a fish population, the mean age of fish caught, and growth rates are valuable indicators of the health of a fish population. In heavily exploited fish populations, the mean age of fish caught declines, growth rates may increase, and the age/size structure shifts from a broad range of ages and

sizes to a narrow range dominated by younger and smaller fish.

Movements of fish are usually determined by releasing tagged fish and noting the location of their reported recapture. Walleye have been tagged in large numbers in the study area. Recaptures have been reported by anglers, commercial fishermen, and by provincial and state employees during index netting operations. Movements of lake sturgeon which were surgically implanted with small radio transmitters during a recent study were monitored by aerial survey flights over the south end of Lake of the Woods and the Rainy River.

I. The Lake of the Woods Fishery Resource

A. Description of the Lake

Lake of the Woods is situated on the Canada/U.S. border between northwestern Ontario and southeastern Manitoba, and northwestern Minnesota. Its waters cover an area of 951,337 acres (385,000 hectares), two-thirds of which is in Canada. Although irregular in shape, the lake at its widest spans 65 miles (105 km) in a north-south direction and 56 miles (90 km) east-west. The lake is relatively shallow, with an average depth estimated at 26 feet (7.9 m). The maximum recorded depth is 216 feet (65.8 m) in Whitefish Bay.

Rainy River is the primary tributary to Lake of the Woods, contributing over 75 percent of the inflow. Water from the lake flows north to Hudson Bay through three outlets into the Winnipeg River at Kenora. Dams at two of the principal outlets regulate water levels and allow for the generation of electricity. Under these controlled conditions water levels fluctuate between 3 feet (0.9 m) and 4 ft (1.2 m) annually.

Water transparency is low in most areas. Mid-summer (August) secchi disc readings

(i.e. a measure of water clarity) range from a visibility of 2.0 ft (0.6 m) in the southern portion to 18 ft (5.5 m) in Whitefish Bay. The low August water transparencies are caused by dense blooms of blue-green algae.

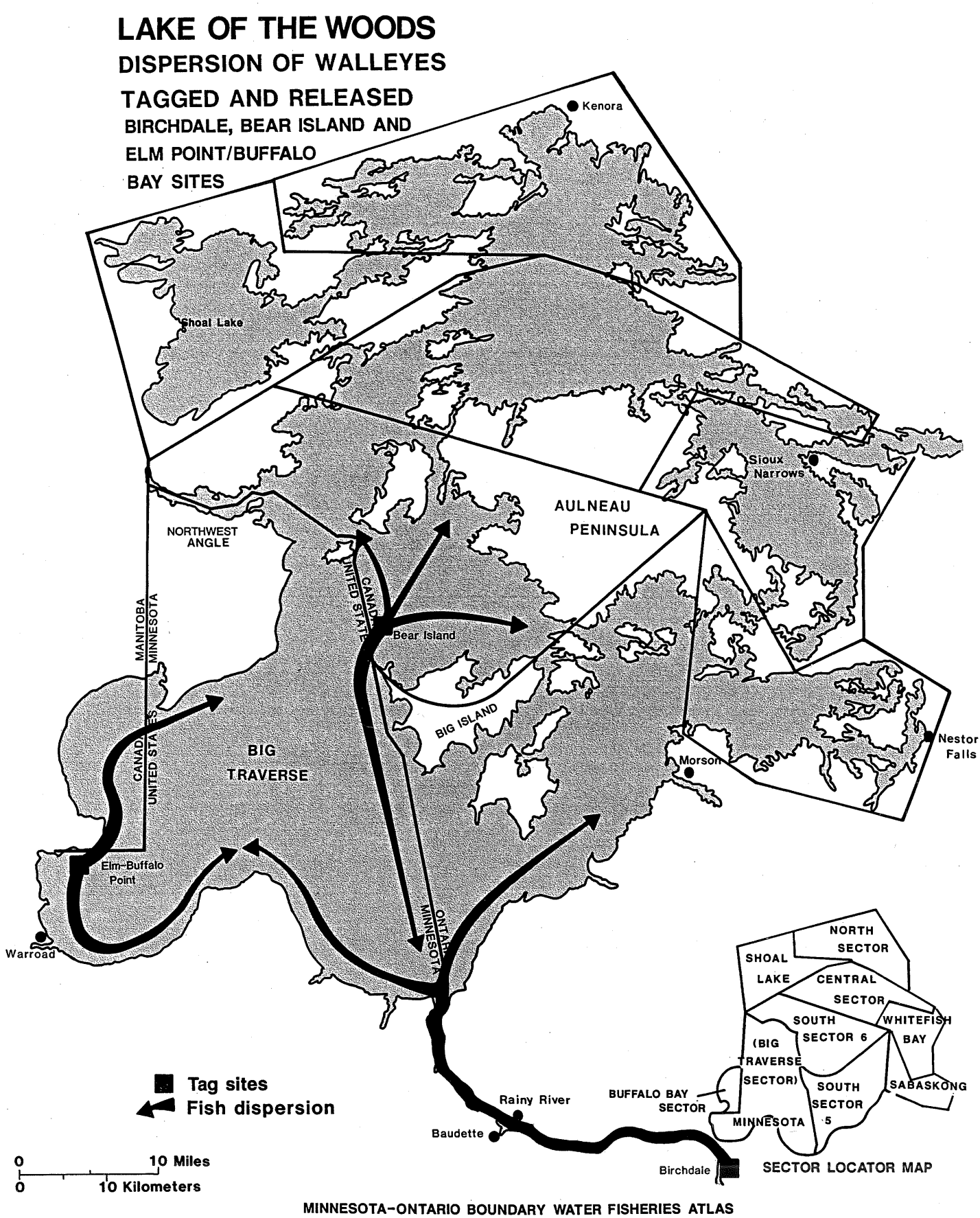
B. Walleye Tagging

Walleye stocks have been tagged at six different spawning sites along the international boundary (Fig. 1 and 2). Walleye were tagged at the following four locations in 1982: (1) Rainy River at Birchdale; (2) Four Mile Bay at the mouth of the Rainy River; (3) Elm Point, a southerly extension in Minnesota of Buffalo Point, Manitoba; and (4) Flag Island/Sugar Point area off the Northwest Angle. Walleye were also tagged at the following sites: North Island, Ontario off the southwest shore of the Aulneau Peninsula in 1974; and Bear Island, Ontario which is north of Big Island in 1965.

Precise estimates of how tagged spawning stocks disperse during the fishing season are not possible since tag returns reflect fishing activity as well as walleye movements. Individual fish may also make extreme movements, giving the impression that stocks in the lake are homogeneous when, in fact, they are not. The discreteness of fish stocks, or the lack of it, should be assessed using a substantial proportion of fish which exhibit the same behavior pattern rather than from occasional observations of extreme movement.

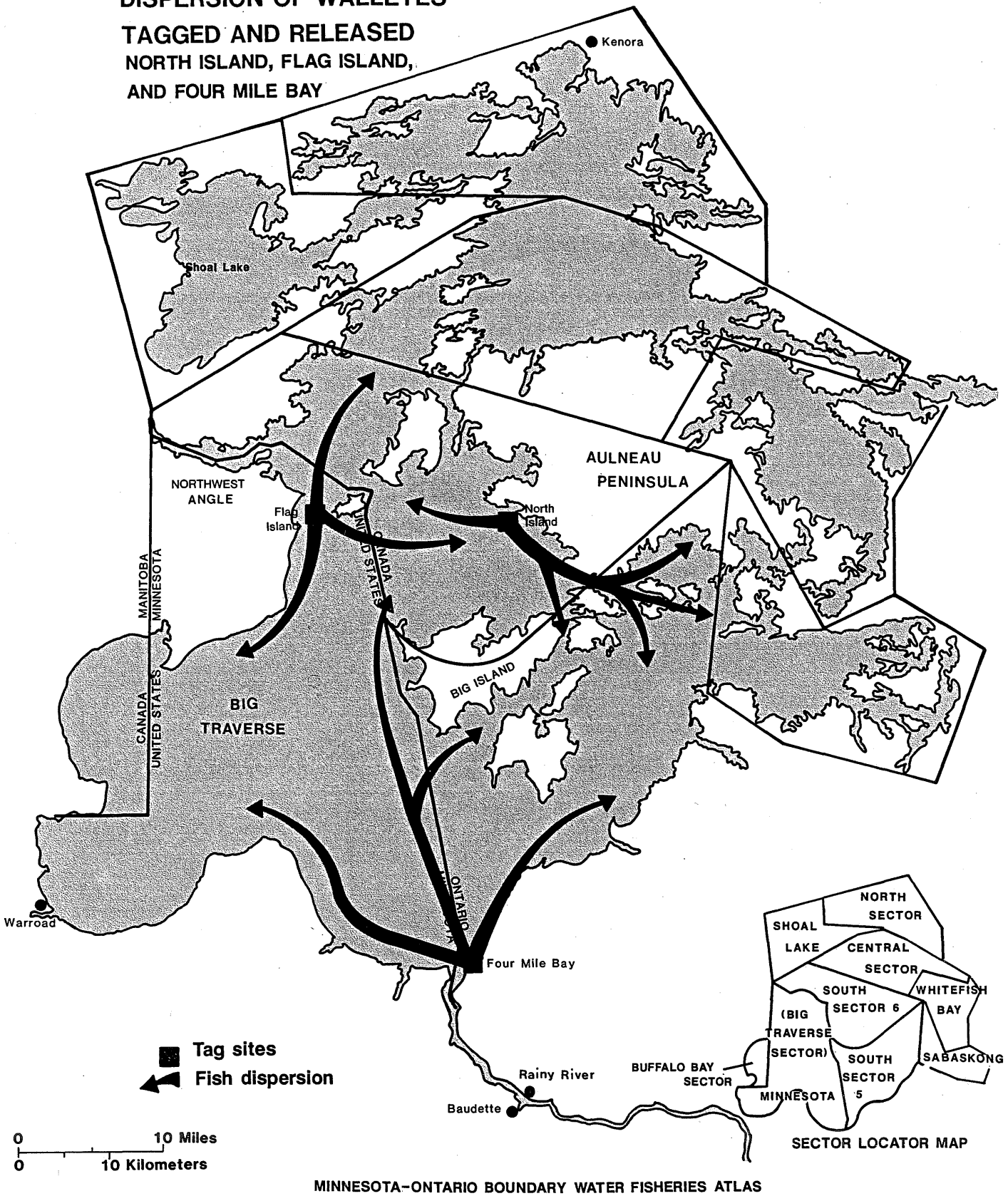
Fish tagged at Birchdale on the Rainy River and at Four Mile Bay at the mouth of the river, dispersed mainly along the south shore of the Big Traverse, out into the Big Traverse and northwards into Ontario South sectors (Fig. 1 and 2). These waters are fished by both Minnesota and Ontario-based anglers and by Ontario commercial fisherman.

Walleye tagged in Ontario near Bear and North Islands dispersed mainly through the north portion of Ontario's South sectors (Fig. 1 and 2). Minnesota-based charter



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 1



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 2

boats and pleasure craft from the Rainy River area fish in the vicinity of Big and Bigsby Islands and Basil Channel. Minnesota-based anglers from the Northwest Angle area typically fish Ontario waters. Ontario-based anglers and commercial fisherman also fish in this area.

Walleye tagged at Flag Island (Fig. 2) on the Minnesota side disperse into Ontario's Central Sector, South Sector 6 and along the shore of the Northwest Angle to the northern reaches of the Big Traverse. Walleye tagged from this site were subjected to exploitation by sport and commercial fishing on both sides of the border. Ontario's Central Sector is fished mainly by Ontario-based anglers and commercial fisherman. Minnesota-based anglers from Flag and Oak Islands also fish this area.

Walleye tagged at Elm Point (Fig. 1) dispersed north through Buffalo Bay to the south shore of the Northwest Angle and along the southwest shore of the Big Traverse. With the exception of Buffalo Bay, Manitoba, this portion of the lake is fished by Minnesota-based anglers. Buffalo Bay is closed to commercial fishing and most of the fishing there is from Minnesota and Manitoba-based anglers.

The stocks from Birchdale and Four Mile Bay were harvested mainly by Minnesota-based anglers. Anglers returned 78 and 77% of the reported tags from these sites. More than 80% of the tag returns were from Minnesota waters.

Most of the tag returns from Bear Island stocks were reported by commercial fisherman (71%), while 41% of tags from the North Island stock were reported by commercial fisherman.

Anglers reported 71% of the tag returns from Flag Island stocks. The portion of tagged fish reported from Ontario and Minnesota waters were nearly equal.

Returns from walleye tagged at Elm Point were reported nearly equally by

commercial fisherman (44%) and anglers (56%). Minnesota-based anglers reported 23% of the tag returns from Buffalo Bay. The remainder of the tag returns came from Minnesota waters.

C. Current Status of Fish Stocks

Potential yields, annual harvests, and target level harvests were compared to assess the status of walleye, northern pike, sauger, smallmouth bass, and yellow perch in Lake of the Woods (Fig. 3, 5, 7, 9 and 11). With the exception of sauger, target harvests and potential yields are the same.

The primary management goal is to maintain harvest levels at or below target levels. This is especially important for species where recent annual harvests have exceeded potential yields, and where evidence indicates that stocks are stressed from overfishing. For species where the current annual harvest is below the potential yield, the potential for increased harvest exists.

1. Ontario-North Sector

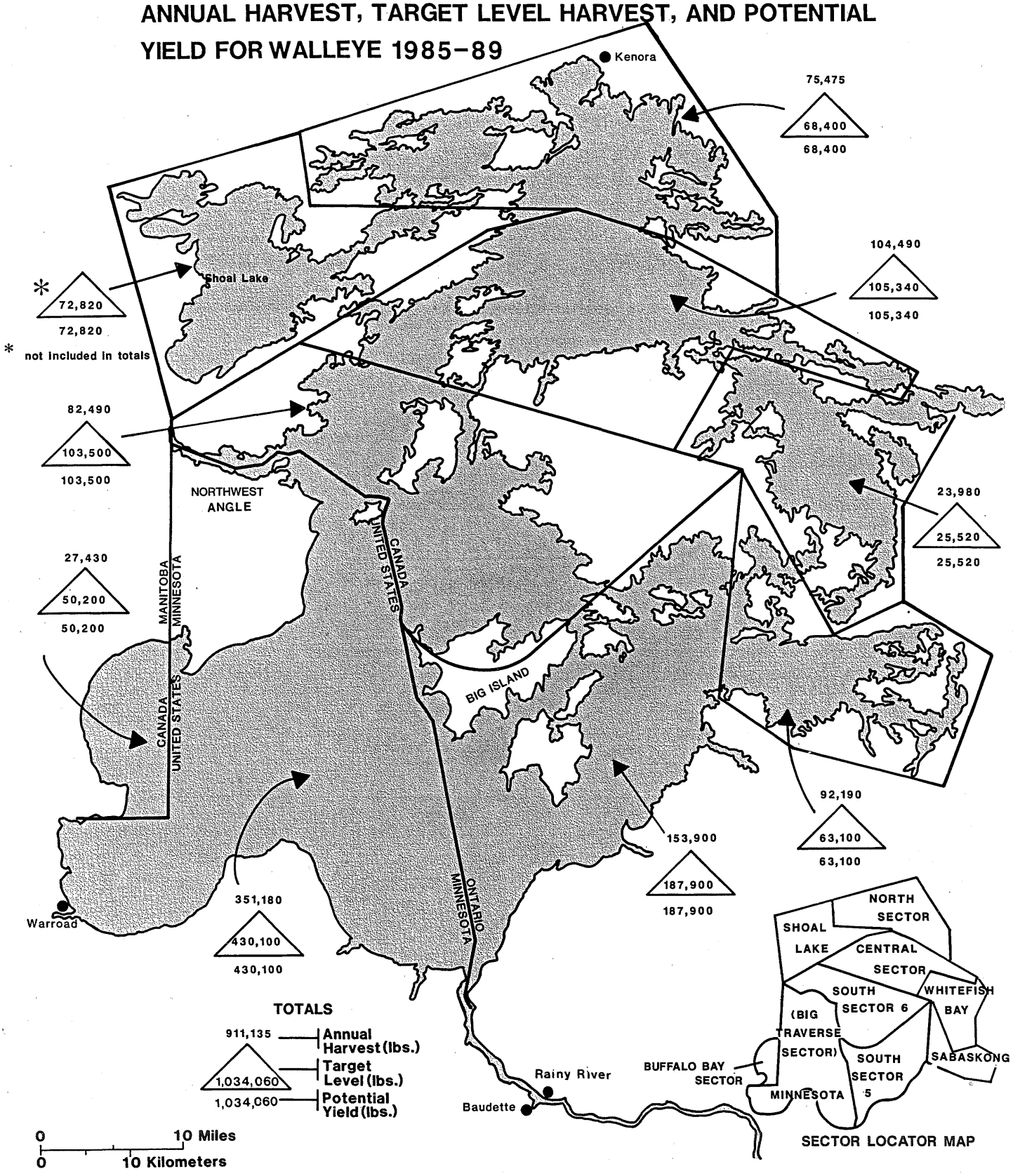
This sector which covers the northern end of Lake of the Woods has a surface area of 72,770 acres (29,450 ha), an estimated potential fish yield (Ryder 1965) of 3.36 lbs/acre/yr (3.77 kg/ha/yr) and a total target harvest of 244,260 lbs/yr (111,027 kg/yr). It currently supports three commercial licences and an active sport fishery. This area experiences a high degree of use owing to its close proximity to the Kenora-Keewatin population centre and to extensive cottage development on islands and surrounding shorelines.

a. Walleye

The annual walleye harvest from this sector is estimated at 75,475 lbs (34,310 kg), 10% above the recommended target of 68,400 lbs/yr (31,090 kg/yr) for this species

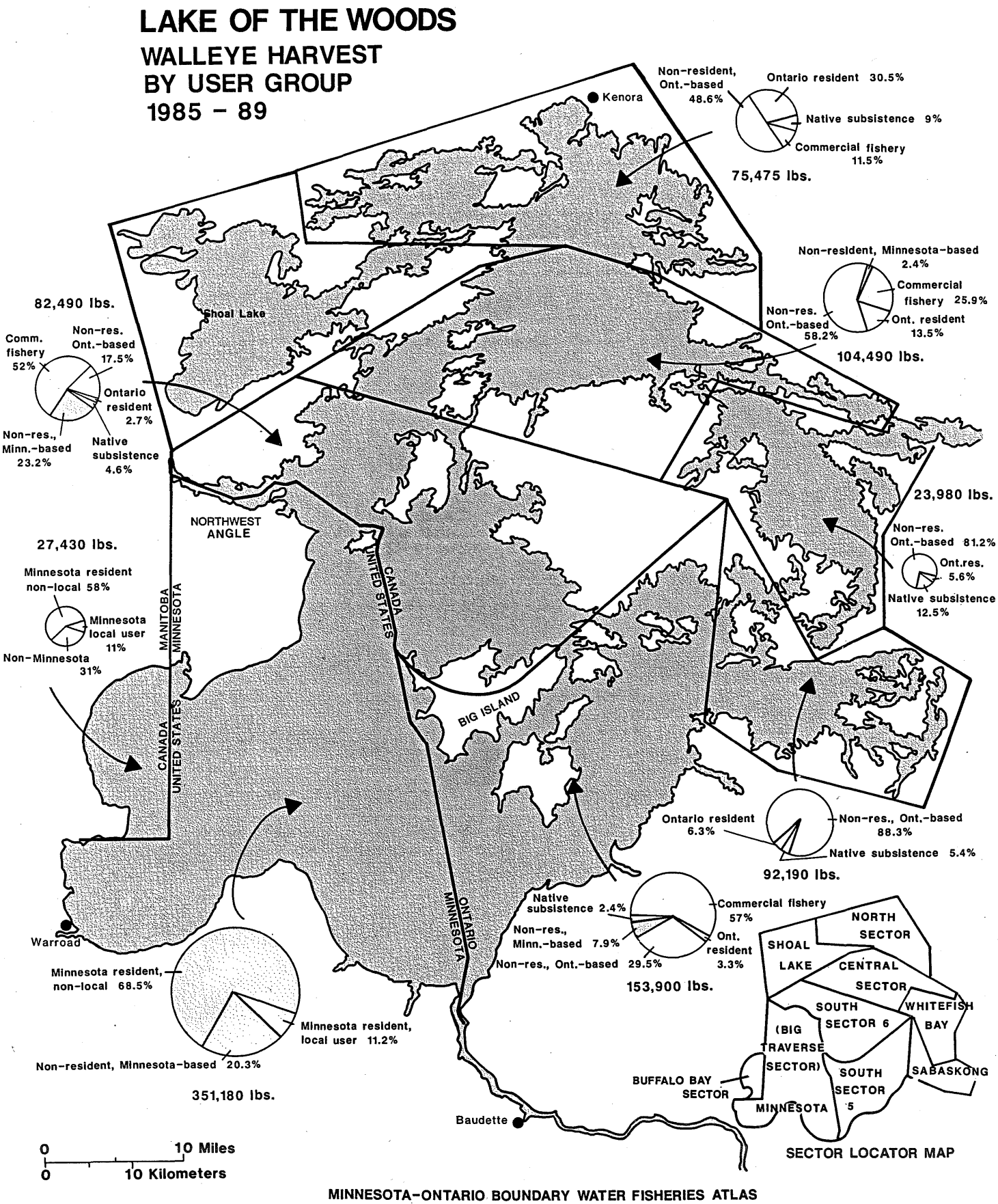
LAKE OF THE WOODS

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR WALLEYE 1985-89



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 3



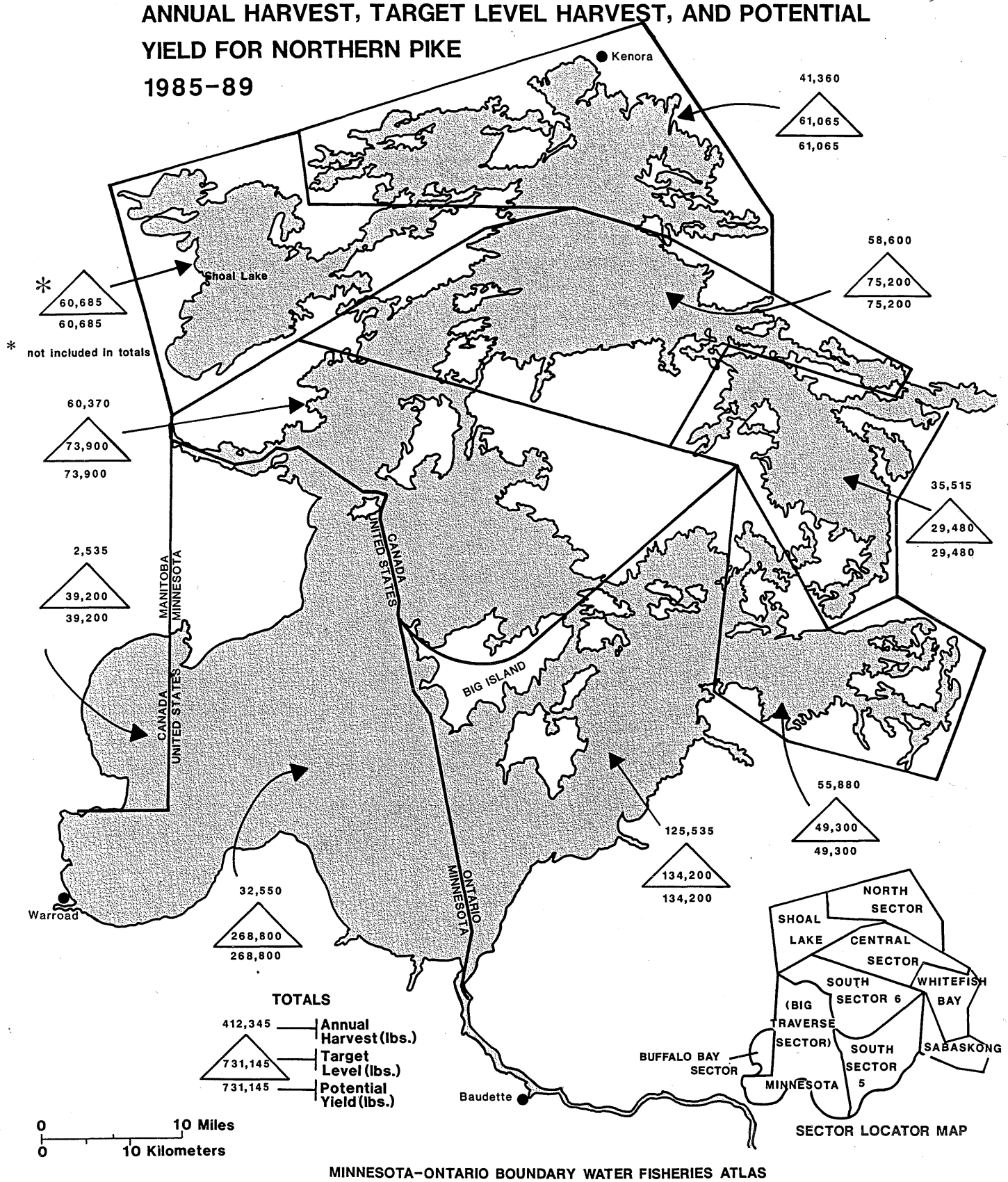
MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 4

LAKE OF THE WOODS

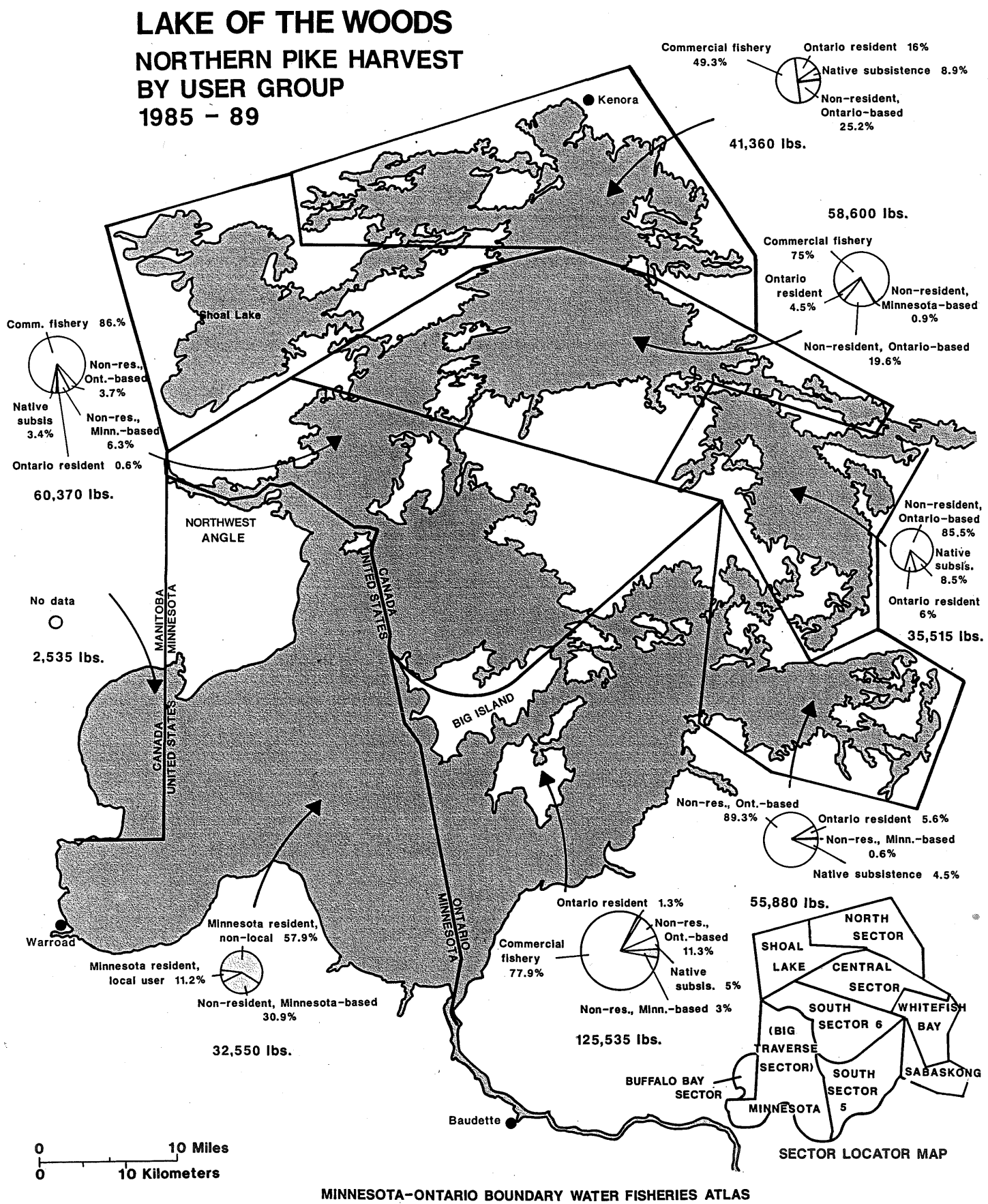
ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR NORTHERN PIKE

1985-89



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 5

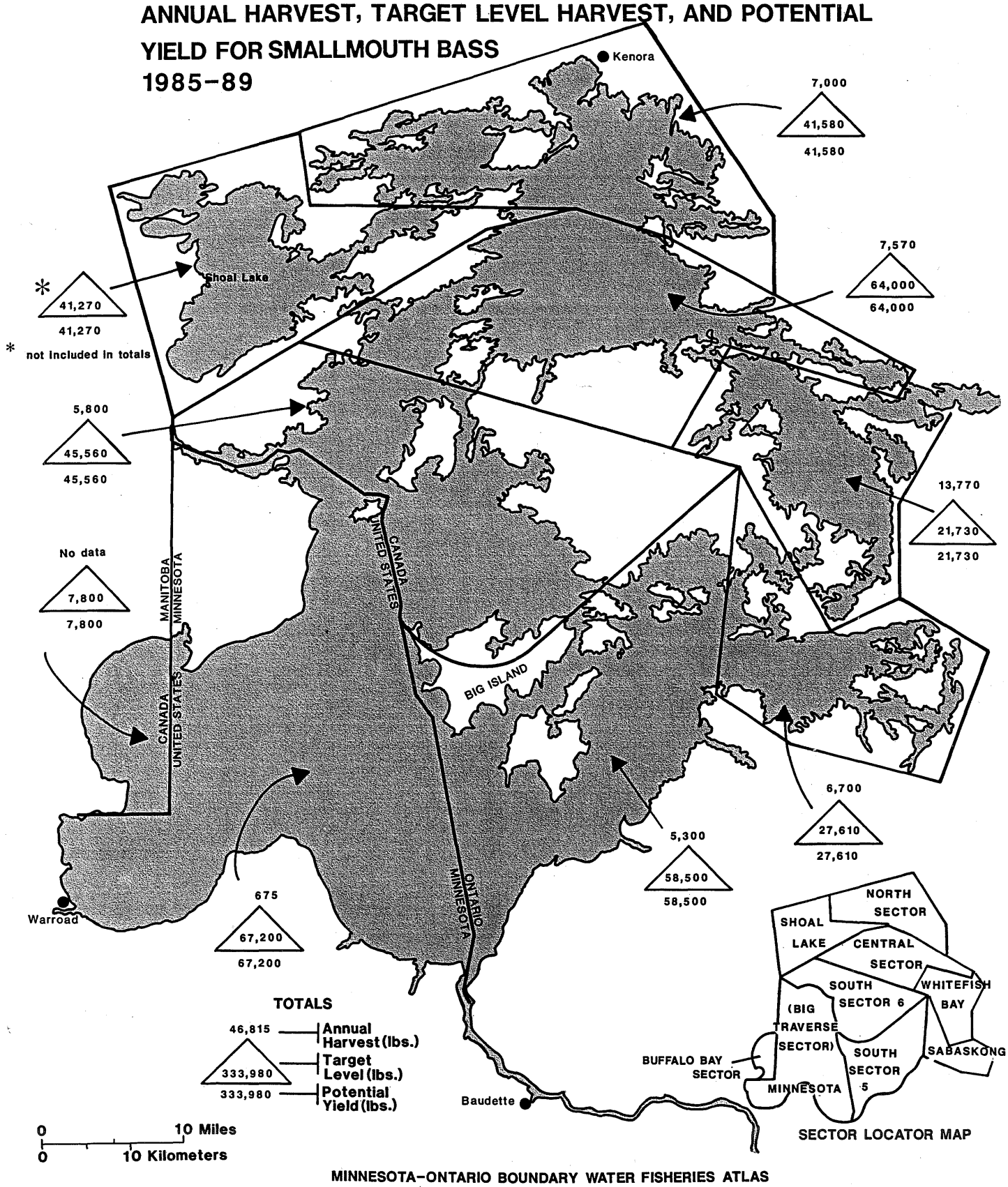


MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 6

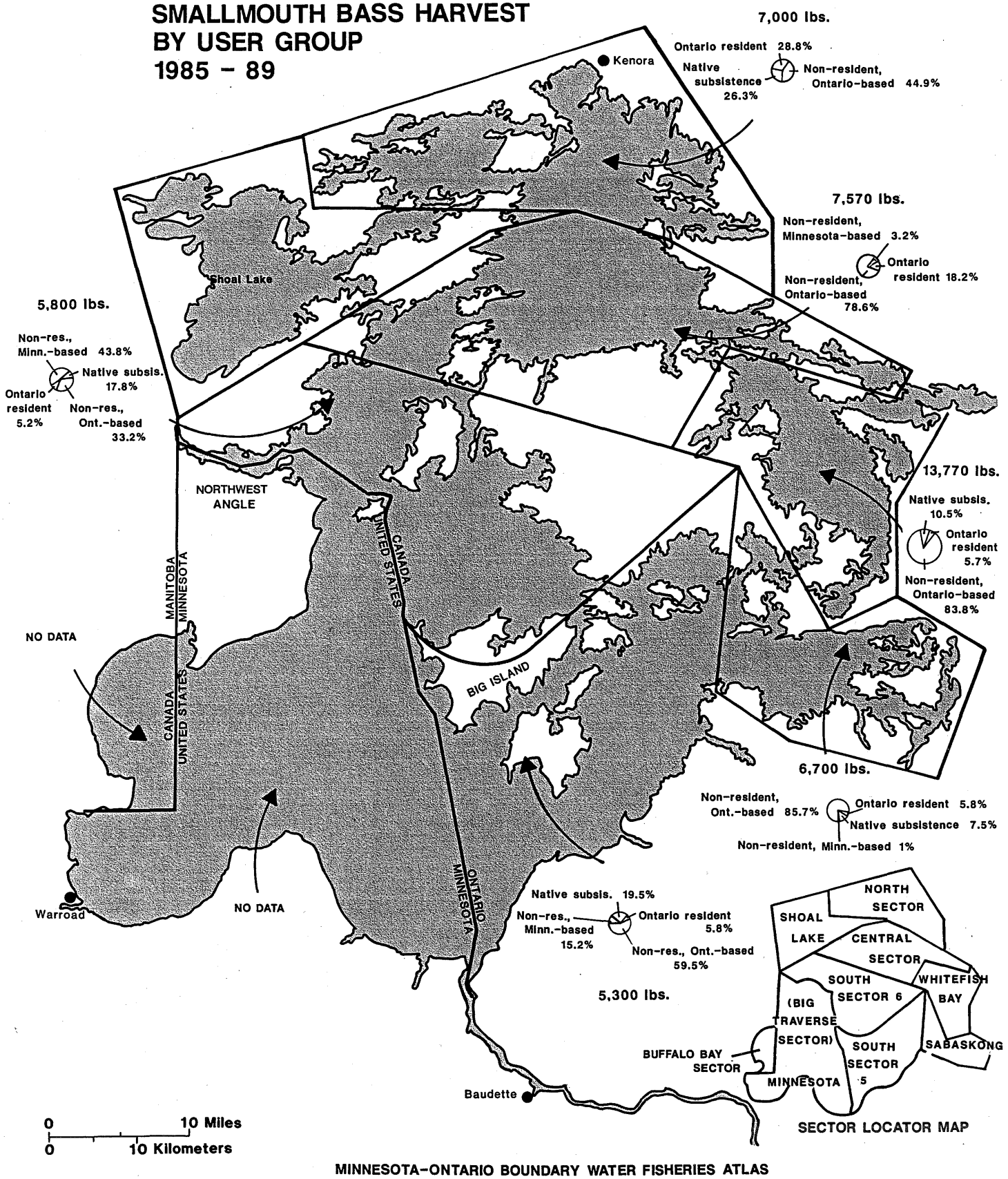
LAKE OF THE WOODS

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR SMALLMOUTH BASS 1985-89



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 7

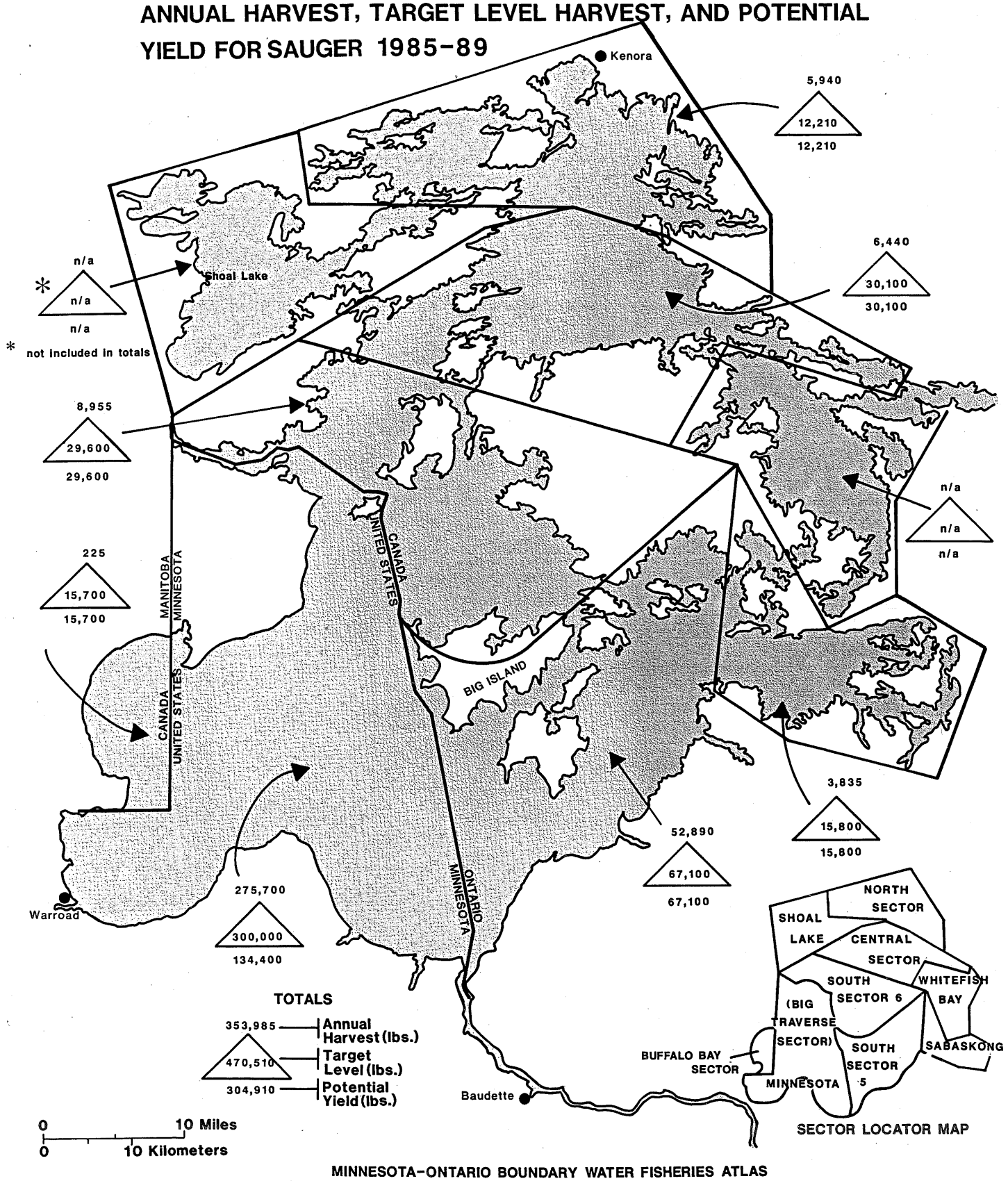


MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 8

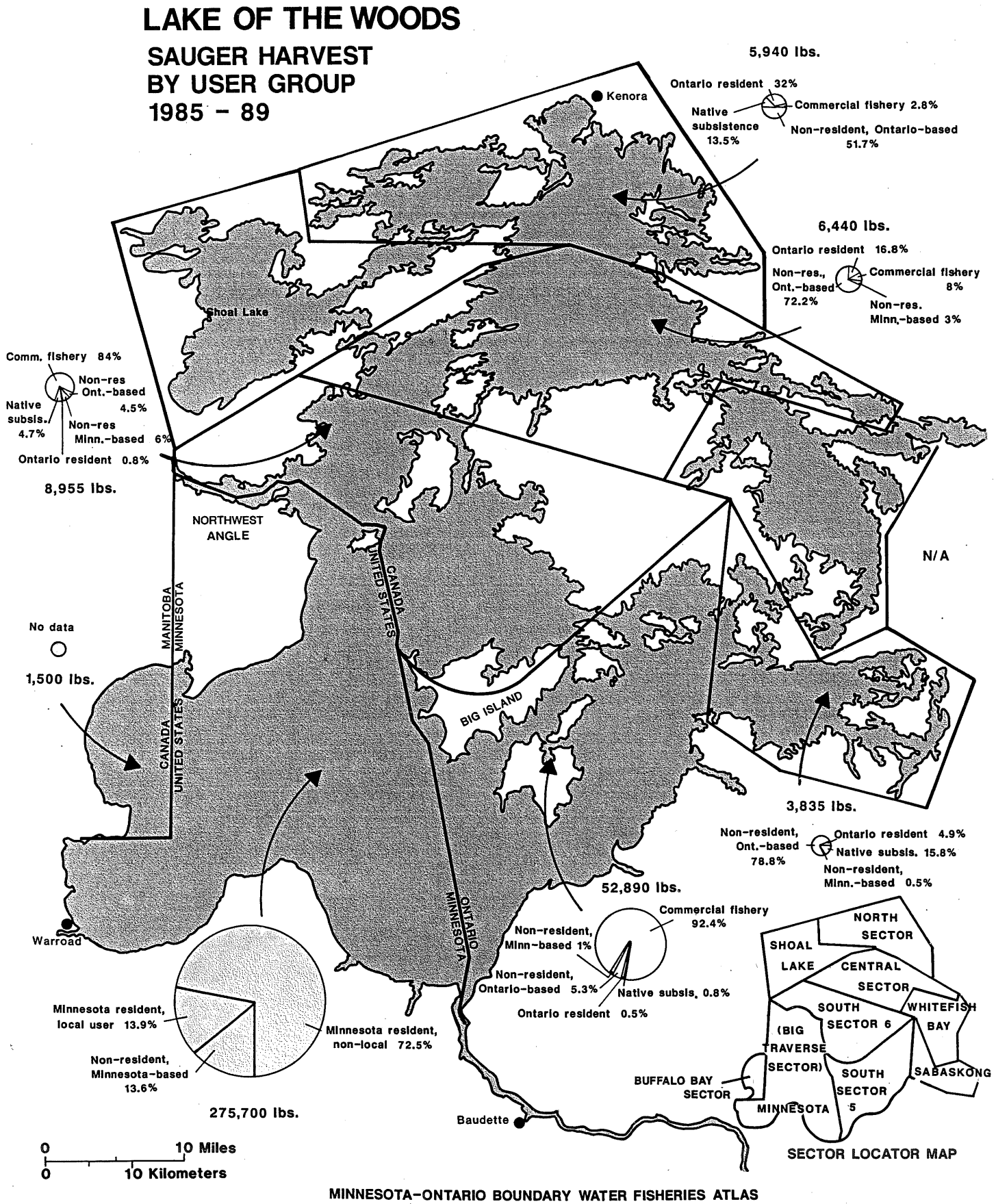
LAKE OF THE WOODS

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR SAUGER 1985-89



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 9

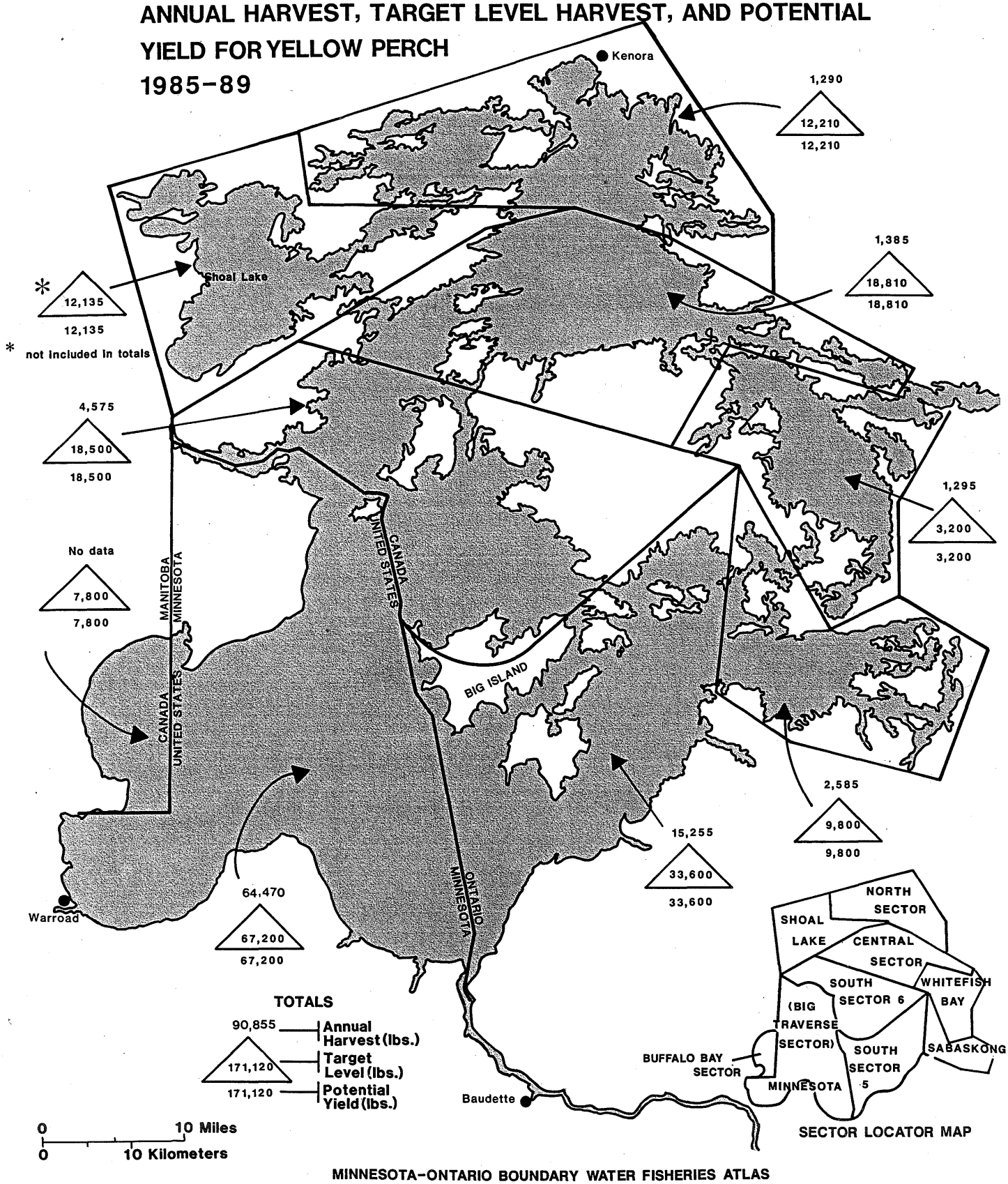


MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 10

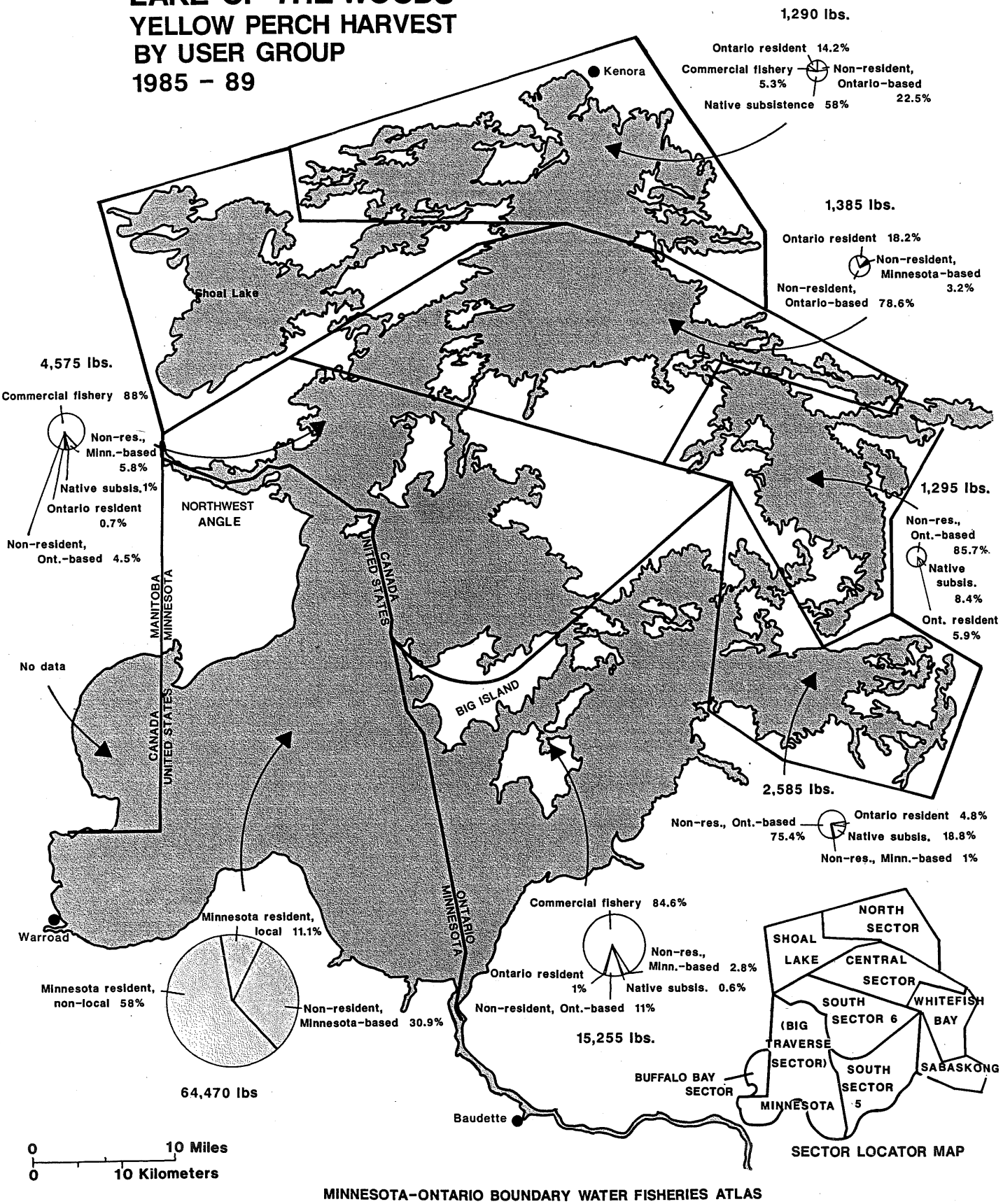
LAKE OF THE WOODS

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR YELLOW PERCH 1985-89



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 11



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 12

(Fig. 3 and 4). The establishment of commercial walleye quotas in 1978 and the government buy-out of four commercial fishing licences in this area since 1984 have reduced harvest by over 30%. Recent assessment of walleye populations in this sector have indicated a gradual increase in the number of larger fish and older age classes present. However, stocks remain heavily exploited, as indicated by more rapid growth and ages at first maturity when compared with walleye stocks in adjacent areas.

b. Northern Pike

Annual harvest of northern pike from the North Sector is currently estimated at 41,360 lbs/yr (18,800 kg/yr) which is well within the recommended target (Fig. 5 and 6) for this species of 61,065 lbs/yr (27,750 kg/yr). Overharvest has been greatly reduced by the recent buy-out of 34,400 lbs (15,640 kg) of northern pike quota from the commercial fishery. Current assessment has indicated that pike populations in this area are stable although age distributions are largely limited to fish younger than age 10. Weak year-classes in recent years appear to be directly attributable to lower than normal water levels during spring spawning.

c. Lake trout

Lake trout are resident only in the area west and north-west of the Northern Peninsula, primarily Clearwater, Cul de Sac and Echo Bays. The potential yield for this species has been estimated at 2,530 lbs/yr (1150 kg/yr), based on a maximum allowable yield of 0.5 kg/ha/yr over a total surface area of 2300 ha. Although winter angling for lake trout in this area was closed in 1988 to control overharvest, current harvests during open water still exceed the recommended target level. Losses of spawning grounds and deepwater summer habitat for lake trout have occurred, as the result of intensive shoreline development and increased nutrient input from surrounding areas. Recommendations of the Clearwater Bay Fisheries Advisory Committee that this fishery be managed under special trophy regulations (Table 11) and that steps be taken to control loss of lake trout habitat in these waters are being

implemented.

d. Smallmouth/Largemouth Bass

Both smallmouth and largemouth bass are not native to Lake of the Woods. Smallmouth bass were introduced into the north end of the lake in the 1920s and are now present throughout the North Sector. Largemouth bass have been found in several areas during recent assessments but are not as common as smallmouth bass. Bass have become a major component in the fish community but they remain secondary to other species in the total angling harvest. Current harvest estimates of 7,000 lbs/yr (3,180 kg/yr) are well within the recommended target of 41,580 lbs/yr (18,900 kg/yr) for these species combined (Fig. 7 and 8). The incidence of larval parasites (Clinostomum marginatum and Proteocephalis ambloplites) in the flesh affects their desirability as a food fish by the angling public. Selective harvest of larger, trophy sized fish by anglers does occur during spring spawning.

e. Other species

Lake whitefish were reduced from former levels of abundance in this area by overfishing and the loss of traditional spawning areas through increased water levels. Populations are gradually recovering in response to controls on harvest. Most whitefish are taken by the commercial fishery which currently lands 16,500 lbs/yr (7,500 kg/yr) from this sector.

Yellow perch, sauger, brown bullheads and rock bass are common in the North Sector but they are under-utilized by both the sport and commercial fisheries. A broad range of age and size classes are present for these species and their growth is comparable to that of lightly fished populations in nearby lakes.

Black crappie and muskellunge are also present in this sector. Their distribution is restricted to localized areas which provide suitable habitat. Recent creel surveys indicate that the combined yield of these species constitutes a small part of total fish

harvest from this area.

2. Ontario-Central Sector

The Central Sector covers 99,520 acres (40,300 ha), has a potential fish yield of 3.82 lbs/acre/yr (4.24 kg/ha/yr) and a recommended target of 376,200 lbs/yr (171,000 kg/yr). Fish populations are harvested by five commercial licences, by non-resident anglers out of resorts in Sioux Narrows, Kenora, and the Northwest Angle in Minnesota, and by local resident anglers from the Kenora-Keewatin and Sioux Narrows areas.

a. Walleye

Walleye stocks in this sector are currently harvested at about the recommended target (Fig. 3 and 4) of 105,340 lbs/yr (47,880 kg/yr). Overall harvest of this species has been substantially reduced by both the introduction of annual commercial quotas in 1978 and recent buy-outs of several commercial fisheries in this area by the Ontario government. However, population parametres continue to indicate a stressed population and recovery from overharvest has been much slower than originally anticipated. A slight trend towards a broader distribution of age and size classes has been noted although walleye, 8 years and older, are still poorly represented in commercial, sport, and index catches from this area. Observed growth rates are fairly rapid and are indicative of heavily fished populations in northern Ontario.

b. Northern pike

Annual harvests of northern pike from the Central Sector are estimated at 58,600 lbs/yr (26,640 kg/yr), well within the suggested target (Fig. 5 and 6) of 75,200 lbs/yr (34,200 kg/yr) for this species. Although total harvest has been reduced by over 30% from previous years by recent commercial buy-outs, population parametres still reflect intense exploitation of pike in this area. Age class distributions of

commercial, angling, and index (test) net samples are restricted to fish which are younger than age 9. Both growth and maturity rates which remain rapid are characteristic of heavily exploited northern Ontario populations. Low spring water levels during several years in the last decade have led to decreased spawning success by failing to flood shoreline areas and vegetation which provide pike spawning habitat.

c. Smallmouth/Largemouth Bass

Both largemouth and smallmouth bass are found in the Central Sector although smallmouth are more widely distributed. The current harvest of smallmouth and largemouth bass from this sector (7,570 lbs or 3,440 kg/yr) represents less than 12% of the recommended target (Fig. 7 and 8) for these species combined. Age groups up to 12 years are well represented in both angling and index net catches from this sector.

d. Other species

Sauger (Fig. 9 and 10) and yellow perch (Fig. 11 and 12) together comprise 25% of the biomass captured in index nets in this sector during recent assessment. Both species appear to be under-utilized by commercial and sport fisheries. Both exhibit a broad range of age and size class distributions and growth/maturity rates which are comparable to those of lightly harvested populations in nearby lakes. The desirability of yellow perch as a food species is considerably reduced by the high incidence of yellow grub (Clinostomum marginatum) in the flesh.

Lake whitefish are caught in this sector, primarily by the commercial fishery during fall, winter, and early spring. Annual harvests which average 13,000 lbs/yr (5,910 kg/yr) are thought to represent the maximum sustainable yield for this species in this area. Stocks are limited by the availability of summer habitat. Seasonal movements of whitefish into the deeper, well-oxygenated waters of nearby Whitefish Bay probably occur during late spring/early summer. The extent and regularity of these

movements are not known.

Our knowledge concerning the population dynamics of black crappie and muskellunge in this sector is limited. Both species are not widely distributed but occur in localized areas which provide suitable habitat.

3. Ontario-Whitefish Bay

Whitefish Bay covers 50,900 acres (20,600 ha) and is the least productive of all parts of Lake of the Woods, owing to its oligotrophic nature. It has a total target harvest of 127,800 lbs/yr (58,090 kg/yr) and a potential yield of 2.51 lbs/acre/yr (2.82 kg/ha/yr). Although commercial fishing is prohibited in this area, it is intensely fished by anglers, primarily non-resident guests of the numerous tourist resorts in the Sioux Narrows-Nestor Falls area.

a. Walleye

The annual walleye harvest is estimated at 23,980 lbs/yr (10,900 kg/yr) which is just within the recommended target of 25,520 lbs/yr (11,600 kg/yr). Walleye are found in greatest numbers in the shallower, more productive waters of Snake, Knickerbocker and the southern portion of Whitefish Bay. Their abundance appears to be limited by the shortage of good spawning habitat located adjacent to productive areas which are required for early rearing. Assessment of walleye spawning populations, in addition to both index (test) net and angling catches, indicate the presence of a broad distribution of age and size classes, maturity rates within the normal range for this species, and fairly rapid growth rates which probably reflect an abundant food supply. Walleye populations appear to be stable, as supported by relatively constant angling and index net CUEs over the last two decades.

b. Northern pike

Northern pike are presently harvested at about 20% over the recommended target of 29,480 lbs/yr (13,400 kg/yr). This species is heavily exploited but it would appear

to be holding its own at current levels of fishing pressure. A fairly broad range of age and size classes are still present in both index net and angling catches. However, rates of growth and maturity are rapid when compared to other populations in this part of Ontario. Abundance is probably limited by the relative shortage of shallow, marshy bays with vegetated shorelines which are required as spawning area for this species.

c. Lake trout

Lake trout are intensely fished by both the winter and open water sport fisheries in this area. Current estimates place the annual lake trout harvest at 31,810 lbs/yr (14,460 kg/yr) which is about 56% above the recommended target of 20,460 lbs/yr. Long-term monitoring of the sport fishery and spawning populations in this area have shown that older age and larger size classes of lake trout are rapidly being reduced by increasing angling pressure. Declines in the CUE, the mean size and age of trout in angler catches, and an increase in the number of immature fish being harvested have been observed. A decrease in the mean size and age of spawning populations has occurred during the same period. In an effort to stop the decline in angling quality and maintain/increase trophy lake trout fishing opportunities in this area, special lake trout regulations were introduced on Whitefish Bay in 1990 (see regulations in Table 11).

d. Smallmouth/Largemouth Bass

Both largemouth and smallmouth bass are found in Whitefish Bay although the latter are more widely distributed. Annual harvest of smallmouth and largemouth bass is estimated at 13,770 lbs/yr (6,260 kg/yr) which is well within the recommended target (Fig. 7 and 8) of 21,730 lbs/yr (9,875 kg/yr). Populations appear to be stable with a broad range of age and size classes present. Selective harvest of larger, trophy sized fish by the angling public does occur during spring spawning.

e. **Other species**

Lake whitefish are also an important component of the fish community although their abundance has been considerably reduced by overfishing in past years. It is suspected that a portion of this stock is exploited by the commercial fishery in the Central Sector during seasonal movements into that area in the fall and winter. Current harvest by the sport fishery in Whitefish Bay is minimal.

Yellow perch and sauger are present in Whitefish Bay. Sauger are not common since clear waters are not optimal for this species. Together, yellow perch and sauger comprise less than 2% of the total fish harvest from this sector.

Black crappie and muskellunge are limited to areas of favourable habitat within Whitefish Bay. At present, annual harvests are within target levels.

4. Ontario-Sabaskong Bay

This sector which includes Obabikon Lake, Sabaskong, Burrow and Obabikon bays, has a surface area of 44,970 acres (18,200 ha), a potential fish yield of 4.38 lbs/acre/yr (4.92 kg/ha/yr) and a total target harvest of 197,120 lbs/yr (89,600 kg/yr). These waters are among the most productive on Lake of the Woods and experience the heaviest sport fishing pressure by area on the lake. The majority of anglers are non-resident guests of nearby tourist resorts in the Morson, Hanson Bay and Nestor Falls area. Commercial fishing is not permitted in this area.

a. **Walleye**

Current annual walleye harvests from Sabaskong Bay, estimated at 92,190 lbs/yr (41,905 kg/yr), exceed the recommended target of 63,100 lbs/yr (28,680 kg/yr) by over 46% (Fig. 3 and 4). Population parameters indicate that walleye are heavily exploited in this area. Stocks exhibit a limited age class distribution with a general absence of fish older than age 9 and only a few age classes contributing to the

angling fishery. Both growth and maturity rates are faster than those for walleye in nearby waters of Lake of the Woods. The angling CUE for this species has shown a gradual decline during the period from 1965-88. Despite intense angling pressure, strong year-classes continue to be recruited, largely through the presence of excellent spawning and nursery habitat in this area.

b. Northern pike

Northern pike are presently harvested at 13% above the recommended target (Fig. 5 and 6) of 49,300 lbs/yr (22,410 kg/yr). Populations appear to be stable at current harvest levels. The more rapid growth and maturity rates of pike in this area have been attributed to differences in feeding behaviour and warmer water temperatures than in other sectors. The mean age of pike in both index net and angling catches along with the angling CUE have not changed appreciably over the long term.

c. Other species

Both smallmouth and largemouth bass are found in this sector but the former are more widely distributed. The total annual bass harvest, estimated at 6,700 lbs/yr (3,045 kg/yr), is well within the recommended target level (Fig. 7 and 8) of 27,610 lbs/yr (12,550 kg/yr).

Sauger (Fig. 9 and 10) and yellow perch (Fig. 11 and 12), together account for about 20% of the available fish biomass in this sector. Both species are lightly exploited by the angling fishery, as evidenced by broad distributions of age/size classes and growth rates which are comparable to those of populations in less heavily fished areas.

Both muskellunge and black crappie are more common throughout this sector than in other parts of the lake. Our present knowledge concerning the life history and population dynamics of these species in this sector is limited. Annual fluctuations in crappie abundance can be attributed to production of strong year-classes which

occur at irregular intervals. Past catches, primarily by the commercial fishery, exceeded target levels in some years. Commercial fishing is no longer permitted in this area. A substantial winter sport fishery for black crappies currently exists in the eastern half of this bay. Lake whitefish are not common to this area.

5. Ontario-South Sectors 5 and 6

Together, these sectors encompass the majority of Ontario waters south of the Aulneau Peninsula and cover 281,000 acres (113,800 ha). They have a potential fish yield of 3.71 lbs/acre/yr (4.16 kg/ha/yr), representing a total target harvest of 1,040,600 lbs/yr (473,000 kg/yr). These sectors are fished by anglers from the Rainy River/Baudette area and the Northwest Angle in Minnesota, and by non-resident and local anglers through Morson and Nestor Falls. The majority of commercial fishing on Lake of the Woods occurs in these sectors. Although six fishing licences have been recently purchased by the Ontario government, 22 commercial fisheries still remain and are spread throughout these sectors.

a. Walleye

Annual walleye harvests of 236,400 lbs/yr (107,455 kg/yr) from these sectors are within the recommended target (Fig. 3 and 4) of 291,400 lbs/yr (132,455 kg/yr). Overharvest has been significantly reduced by the government buy-out of over 40,000 lbs of walleye from six commercial fishing licences in this area since 1984. Recent assessment has indicated that walleye stocks are stable although they remain dependent on the production of strong year-classes which occur at irregular intervals. Walleye populations are intensively harvested, as evidenced by limited age class distribution (i.e a general absence of walleye older than age 10 in angling, commercial catch, and index net samples), relatively fast growth rates, and early maturity when compared to walleye stocks in nearby waters. The angling CUE for walleye which had declined from 0.78 lbs/angler-hr in 1967 to 0.40 lbs/angler-hr in 1983 has remained constant at about 0.35 - 0.40 lbs/angler-hr during recent years.

b. Northern pike

Annual harvest of northern pike from the South sectors which is currently estimated at 185,900 lbs/yr (84,500 kg/yr) has been reduced to within the recommended target level (Fig. 5 and 6) of 208,100 lbs/yr (94,590 kg/yr) by recent government purchases of commercial fisheries in this area. Previous to the buy-out, pike harvest by both commercial and sport fishermen in these sectors had been increasing. Populations remain heavily exploited, as evidenced by limited age/size class distributions, rapid growth and early maturity rates when compared with stocks in nearby areas. Lower than normal water levels during spring spawning have produced several weak year-classes in recent years.

c. Sauger

Sauger are an important component of the fish community in the South sectors. Annual harvest which has been estimated at 61,840 lbs/yr (28,110 kg/yr) is within the recommended target (Fig. 9 and 10) of 96,700 lbs/yr (43,955 kg/yr). Commercial harvest which currently accounts for over 90% of the total harvest has increased substantially since 1985 when fishermen first began to fish for sauger and yellow perch with smaller mesh gill nets under experimental permit. Recent assessment has indicated that sauger populations are stable, with a wide distribution of age classes present and growth/maturity rates which are comparable to those of less exploited stocks.

d. Yellow perch

Annual harvest of yellow perch from these sectors, especially by the commercial fishery, has increased during recent years but overall harvest (19,835 lbs/yr or 9,015 kg/yr) still remains well below the recommended target (Fig. 11 and 12) of 52,100 lbs/yr (23,680 kg/yr). Perch are considered a more desirable sport and commercial species in the South sectors than in other areas of the lake, due to the much lower incidence of yellow grub.

e. **Smallmouth bass**

Smallmouth bass also appear to be under-utilized in these sectors. Current harvest averages 11,100 lbs/yr (5,045 kg/yr) which is well within the revised target (Fig. 7 and 8) of 47,300 kg/yr (104,060 lbs/yr). This species has been assigned a lower partitioned yield (i.e. 10% of the total potential yield estimate) than in the previous Atlas (1984), since recent assessment has indicated that large portions of these sectors lack preferred spawning and rearing habitat for bass. A broad distribution of age classes was present in recent samples of fish taken from index net and angling catches. Largemouth bass are not common to these sectors.

f. **Lake sturgeon**

Lake sturgeon (Acipenser fulvescens) were an important component of the original fish community in the south end of Lake of the Woods and the Rainy River. Populations collapsed at the turn of the century, primarily due to overfishing, although loss of spawning habitat in the Rainy River from paper mill pollution was likely a contributing factor. Recently, populations appear to be making a recovery in response to improvements in water quality in the Rainy River since the early 1970s. A commercial fishery for sturgeon is located in Ontario waters and is restricted by quota to an annual harvest of 12,800 lbs/yr (5,820 kg/yr). Current harvests by the sport fishery are minimal although interest in the lake sturgeon as a sport species is increasing.

A recent study examined various aspects of lake sturgeon biology in Lake of the Woods and the Rainy River, including identification of spawning areas and seasonal movement patterns, maturity regimes, food habits and the current impact of exploitation on this species.

The results suggest that two distinct groups of lake sturgeon inhabit this area: a river population and a lake population. Those classed as 'river' fish spend the winter within certain stretches of the Rainy River and appear to spawn earlier in the spring

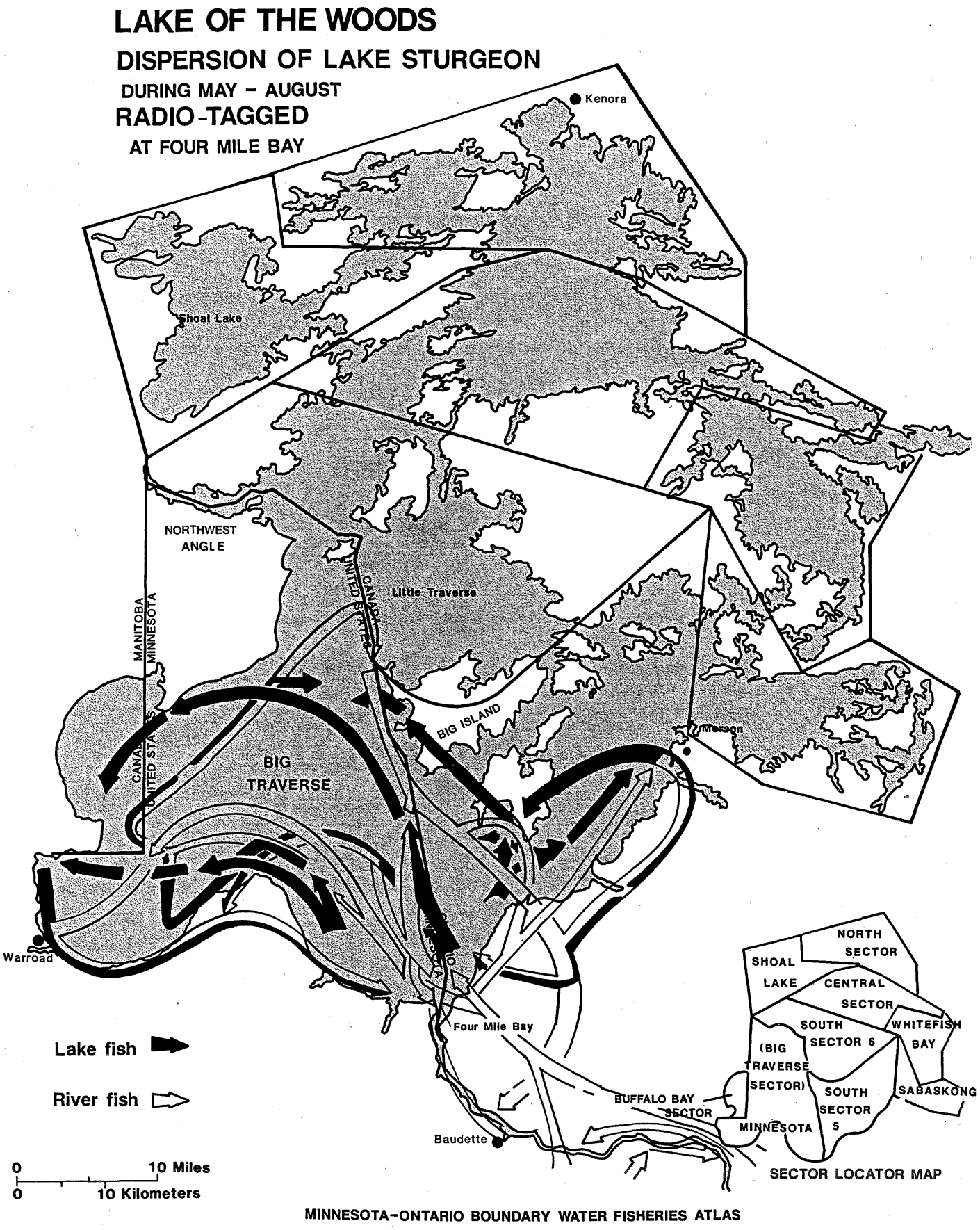
than the lake population. Both populations use the same spawning grounds at Long Sault, Manitou Rapids, and just below International Falls on the Rainy River, in addition to a number of sites upstream on major tributaries such as the Big Fork and Little Fork Rivers (Fig. 13). Although fish from both populations can be found around the mouth of the Rainy River and throughout the Big Traverse during the late spring, summer and early fall, it is the lake population that overwinters in Lake of the Woods.

Lake sturgeon in this area are mature as males at 17 years old and as females at age 26. Males spawn every 2 to 3 years while females have a periodicity in spawning of 4 to 9 years. These maturity rates fall within the normal range for this species. Growth rates were found to be extremely rapid and were comparable to those for more southern populations. Increased growth can be attributed to an abundance of food, especially crayfish which are the primary forage of lake sturgeon in this area.

Annual harvest appears to be sustainable at current levels of exploitation and has not affected recovery by these populations. The mean age and size of fish in the commercial harvest have not changed significantly over the past decade. Both the commercial catch-per-unit-effort (CUE) of legal and sub-legal fish have continued to increase. Successful reproduction occurs on a regular basis.

g. Other species

The distribution of black crappie and muskellunge in the South sectors are limited to small pockets of suitable habitat in Miles, Monument and Sabaskosing bays. Combined commercial and sport harvest of black crappie has averaged 15,000 lbs/yr (6,820 kg/yr) for the period 1964-83. Past catch data has revealed wide fluctuations in annual harvest of this species which might indicate 'fishing up' of local populations or a natural cyclical pattern of population abundance. Although lake whitefish are caught occasionally by the commercial fishery, this species is not common in these sectors.



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 13

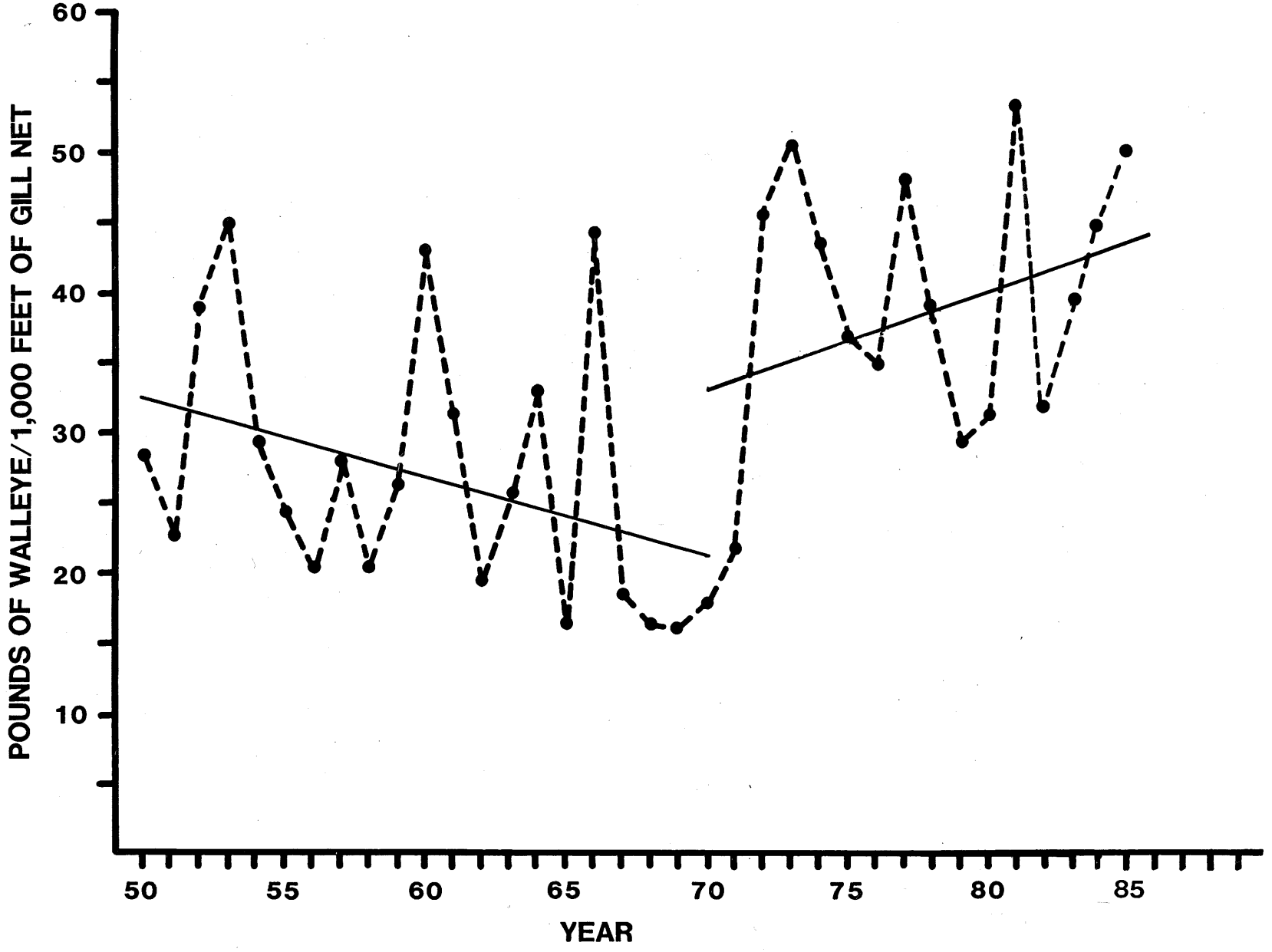


FIGURE 14 Walleye Catch Per Unit of Effort by Commercial Gill Nets Lake of the Woods, Minnesota 1950 – 85

6. Shoal Lake

This sector which encompasses all of Shoal Lake is considered to be part of Lake of the Woods for management purposes. It covers 64,000 acres (25,900 ha) and has a potential fish yield of 3.79 lbs/acre/yr (4.26 kg/ha/yr). In the past, Shoal Lake was intensely fished by five commercial operations and a sport fishery composed of non-resident cottagers, non-resident guests at nearby resorts, and local residents of the Kenora-Keewatin area. Fish populations, especially walleye, were overexploited to the point of collapse. This prompted the closure of the walleye fishery to both commercial and sport fishing, along with restrictions on the use of gill nets. Since these measures were imposed in May 1983, both commercial and sport fishing activity on this lake has been minimal. With the purchase of three commercial fishing licences on the lake since 1982, two licences which are currently held by the Shoal Lake First Nations remain. Fish populations continue to be monitored annually by the Lake of the Woods Fisheries Assessment Unit, with the recent participation of Aboriginal commercial fishermen representing each of the Shoal Lake Bands.

a. Walleye

This sector is one of the most productive for walleye, as evidenced by the extent of past harvest levels. Between 1960 and 1983, commercial catches alone exceeded the recommended target of 72,800 lbs/yr (33,100 kg/yr) in 17 of 24 years and by up to 650% in a single year (1977). Sport harvest was estimated at about 40,000 lbs/yr (18,200 kg/yr) during this period. By 1982, numbers of mature fish had been greatly reduced and walleye stocks were primarily composed of a single year-class (1979). In an effort to protect these last potential spawners, both the commercial and sport fisheries for walleye were closed in May 1983.

Recent monitoring has indicated that the walleye population is slowly rebuilding, although the spawning population remains largely dependent on the continued survival of the 1979 year-class. Reproduction has been intermittent and only two

successful year-classes (i.e. 1983 and 1987) have been produced since 1979. Major spawning grounds at the mouth of the Falcon River have been rehabilitated and improvements at several other locations are planned. The closure of walleye fishing and the ban on the use of gill nets will remain in effect until the spawning population has achieved a sufficient number of age classes to withstand exploitation.

b. Northern pike

Northern pike were also stressed by overfishing in this area but populations have rebounded since the closure of the walleye fishery in 1983. The CUE for northern pike in index (test) nets has more than doubled during the period from 1980-90. The number of older age and larger size classes in index net samples have also increased. Growth and maturity rates which had increased dramatically in response to exploitation stress have decreased in recent years, indicating a return to greater stability within this population. Annual harvest has remained less than 10% of the recommended target of 60,685 lbs/yr (27,585 kg/yr) since 1983.

c. Smallmouth/Largemouth bass

Smallmouth are the dominant species of bass although largemouth have recently moved into this sector. Smallmouth bass are an important but under-utilized component of the fish community. Since the closure of the walleye fishery, more interest has been directed towards bass by anglers. However, annual harvests currently represent less than 10% of the target (Fig. 7 and 8) for these species, i.e. 41,270 lbs/yr (18,760 kg/yr). Selective harvest of larger trophy sized fish occurs during spawning season.

d. Other species

Lake whitefish along with other commercial species were overfished in Shoal Lake, prior to 1983. Commercial catch records indicate a significant decline in annual harvest during the period from 1958-83. Shoal Lake contains some of the best lake whitefish habitat in Lake of the Woods with a recommended target of 43,700 lbs/yr

(19,865 kg/yr). The ban on the use of gill nets by the commercial fishery reduced pressure on this species and has allowed stocks to increase. An experimental gill net fishery, in co-operation with Aboriginal fishermen from the Shoal Lake bands, has selectively harvested about 20,000 lbs/yr during fall spawning in 1989 and 1990.

Sauger are not found in Shoal Lake but yellow perch are abundant. Owing to the high incidence of yellow grub in their flesh, perch remain a secondary species in the angling and commercial catch.

As in other parts of Lake of the Woods, both muskellunge and black crappie have a localized distribution in Shoal Lake. Current harvests remain within target levels for both species.

7. Minnesota-Big Traverse Bay

Minnesota's portion of Lake of the Woods, Big Traverse Bay, covers 317,000 acres (128,340 ha) and has an estimated annual yield for both game and nongame species of 4.32 lbs/acre (4.79 kg/ha). The total target harvest for game fish is 1,132,500 lbs/yr (515,000 kg). Game fish populations are harvested exclusively by sport fishing.

a. Walleye

The status of the walleye stocks has improved markedly during the last 20 years. The commercial catch-per-unit effort (CUE) declined from 28.3 lb/1,000 ft. of gill net in 1950 to an all time low of 16.0 lb/1,000 ft. in 1969 (Fig. 14). From 1969 through 1984, the CUE has steadily increased and exceeded the highest CUE recorded prior to 1970, five times between 1970 and 1985. Minnesota's commercial harvest of game fish was eliminated through the purchase of the last remaining walleye quota in 1986. The average CUE for all years between 1972 and 1985 (41.2 lbs.) was exceeded only three times in the preceding 22 years and was 53.7% higher than the 1950-71 average. The average CUE from 1950-71 (26.8) was lower than the poorest CUE

recorded from 1972-85. Commercial catch data indicated that walleye, 16 inches (40.6 cm) or larger, were 2.3 times more abundant during 1980-85 than the period 1968-70.

Index (test) netting by the Minnesota DNR showed the same general trend as the commercial fishery information. The proportion of walleye, 16 inches and larger, in the index catch has increased over the last decade (1980-89). The proportion of walleye, 16 inches and larger, was 2.2 times greater during 1980-1983 and 3.5 times greater during 1984-89 than in similar netting during the years 1968-70. The abundance of walleye has remained quite stable in recent years, due to good recruitment into the population and harvests below the target level.

Recently, walleye harvest (i.e. based on 1984-1989 creel estimates, and the 1989 Rainy River creel) has averaged 81.7% of the target level of 430,100 lbs/yr (195,500 kg). Recruitment into the population has been consistent with 14 year-classes being represented in index net catches. The present sport fishery is supported by five strong year-classes ('87, '85, '83, '82, '79).

Only in recent years have anglers been able to benefit from the increased abundance of walleye larger than 16 inches. Anglers on bigger boats, often equipped with downriggers, have been successful in catching walleye from offshore locations of the Big Traverse. This has resulted in more anglers fishing offshore fish concentrations during July through September. Walleye caught from offshore areas average two inches larger than those creeled by from nearshore waters. The fall and spring open water fisheries on the Rainy River have also contributed to the harvest of walleye, primarily male fish.

Overall, the average size of harvested walleye on Lake of the Woods has increased slightly over the last decade from 1.1 to 1.5 lbs (0.5-0.7 kg). The increase in average size of walleye harvested reflects the increased abundance of 4-7 year old (15-21" or

38-53 cm) fish. Computer modeling indicates that the average size of walleye caught will not continue to increase appreciably. However, anglers will be more likely to catch an occasional big fish (>2-3 lbs.). The number of big walleye in the creel is expected to increase as offshore fishing increases in popularity.

The present atlas is based on data obtained during the period from 1985-89. Data collected during the 1990 season became available too late to be included, however, some of the 1990 data warrants discussion.

The estimated walleye harvest for 1990 was 623,643 lbs (283,475 kg) which exceeds the target level (Fig. 3 and 4) of 430,100 lbs (195,500 kg) by 45%. This is the first time that the annual walleye harvest has exceeded the target level for Minnesota waters. This large harvest increase can be attributed to: 1) the very strong 1987 year-class recruiting to the fishery along with an abundance of other strong year-classes; 2) generally good weather; and 3) good fishing success which attracted anglers throughout the summer.

Results of the annual Large Lake Sampling Program (Wingate and Schupp 1983) have indicated no signs of stress in the walleye population. Recruitment has been stable. Growth rates have not changed. Sport fishing harvests of this magnitude can likely be absorbed by this population in the short-term. The walleye population will continue to be monitored through annual assessment netting, electrofishing and creel surveys.

b. Northern pike

Northern pike are lightly harvested in Minnesota waters since the removal of the commercial fishery. The 1984-89 harvest averaged 12.1% of the target harvest (Fig. 5 and 6) of 268,000 lbs (122,200 kg). Angler interest in northern pike is low. Presently, only 3% of open water anglers fishing in Minnesota waters target northern pike. Fishing pressure for pike is increasing as anglers become more aware of the

potential for trophy fish.

Index netting indicates that northern pike numbers are relatively stable, with average size increasing. Northern pike represent 18% of the gill net biomass.

c. **Sauger**

Sauger make up the second largest portion of the total harvest on the Minnesota side of Lake of the Woods. The average harvest for 1984-89 was 92% of the target harvest of 300,000 lbs (136,365 kg). This target (Fig. 9 and 10) has been revised upwards from 134,000 lbs (61,010 kg). The sauger population is currently supporting 250,000 lbs (113,635 kg) of harvest and shows no signs of stress. Growth rates and age at maturity have not changed.

Historically, sauger harvests of this magnitude were observed only during the 1930s when small mesh gill nets were used in the commercial fishery. Recently, ice fishing has become increasingly popular on the Minnesota portion of Lake of the Woods. Winter angling pressure is now equal to summer angling pressure. Sauger are the mainstay of the winter fishery and harvests have increased accordingly (i.e. a nine fold increase from early 1980s). Sauger comprise an average of 58% of the total winter harvest by weight. The winter fishery for sauger accounted for 81.6% of the total sauger harvest in 1989. The summer harvest of sauger is also increasing, due to the greater use of downriggers by anglers.

Sauger represent 12% of the index netting biomass with 12 age classes represented. The strong 1983 year-class which accounted for 28.7% of the index netting catch in 1989 will likely support the sport harvest until the 1987 and 1989 year-classes recruit to the fishery. Growth rates and age at maturity for sauger have not changed since 1940. The condition factor of sauger has increased in recent years, coinciding with a greatly increased harvest.

d. Yellow perch

The 1984-89 yellow perch harvest averaged 64,468 lbs (29,223 kg). Target (Fig. 11 and 12) and potential yields of 67,200 lbs (30,600 kg) may be conservative for this species. The present harvest is 96% of the target level. Yellow perch have become an important component of the winter fishery in the west end of the Big Traverse. In past years, perch were not acceptable to many anglers because they were considered "wormy" (yellow grub). Anglers are now realizing that perch from the Big Traverse tend to have a low incidence of yellow grubs and harvests have increased.

Yellow perch represent 9.7% of the index netting biomass. Nine year-classes were present in the index netting catch in 1989.

e. Smallmouth bass

Smallmouth bass habitat is limited in the open expanse of the Big Traverse. Smallmouth bass are not likely to become a significant part of the fish community in this area.

8. Manitoba-Buffalo Bay

Buffalo Bay encompasses an area of 36,300 acres (14,700 ha) on the northwest part of the Big Traverse. Its potential yield is 156,900 lbs/yr (71,300 kg). The status of the more important fish species is similar to that of Minnesota waters. Much of the fish harvest from Buffalo Bay is taken by Minnesota-based anglers from the Warroad area. Sport fishing by Manitoba-based anglers has increased with the construction of a marina at Buffalo Point. The new marina is shifting a significant portion of the Minnesota-based boats to Manitoba.

Walleye in Buffalo Bay and the western portion of Minnesota waters are from the same stock. The walleye harvest by Minnesota-based users has averaged 27,429 lbs (12,468 kg), based on 1984-89 open water creel estimates. This represents 54.6% of

the potential walleye yield for this area. Information is not available on the harvest by Manitoba anglers but it is believed that the combined harvest by Minnesota and Manitoba anglers is near potential yield.

The combined harvest of sauger, yellow perch and northern pike by Minnesota-based anglers represents less than 10% of the potential yield (Fig. 2 to 12) for these species from Manitoba waters.

II. The Rainy Lake Fishery Resource

A. Description of the Lake

Rainy Lake is located on the Canada-United States border between northwestern Ontario and north-central Minnesota. The lake covers an area of 212,010 acres (85,800 hectares) of which 75 percent is in Ontario. Three geographically distinct basins form Rainy Lake. Both the North Arm and Redgut Bay lie entirely in Ontario and the South Arm is divided by the International border. The lake is irregular in shape and has a shoreline of 929 miles (1,495 km) with an additional 635 miles (1,068 km) of shoreline associated with approximately 1,600 islands. Rainy Lake has a mean depth of 32 ft (9.2 m) and a maximum depth of 161 ft (49 m).

A hydroelectric dam which controls lake water levels is located on the Rainy River outlet at Fort Frances-International Falls. Annual water level regulation usually involves a spring build-up, followed by stable water levels during the summer open water period. The water level during the fall and winter is drawn down for hydro power production.

B. Walleye Tagging

Walleye spawning stocks have been tagged at seven sites in Rainy Lake: (1) North Arm at Northwest Bay; (2) North Arm at Stanjikoming Bay; (3) Redgut Bay at Spawn Inlet; (4) South Arm at Rat River, Ontario; (5) South Arm at Stokes Bay, Ontario; (6) South Arm at Berry Island, Ontario; (7) South Arm at Black Bay, Minnesota (Fig. 15).

Walleye tagged during the spawning period in the Ontario North Arm remained in that basin and generally dispersed east and north. Walleye tagged at Spawn Inlet on Redgut Bay remained within this bay, moving west and south. Fish tagged in the

South Arm moved freely across the International border between Minnesota and Ontario. Movement was in all directions but remained within the South Arm, suggesting that South Arm fish are shared walleye stocks.

C. Current Fish Stock Status

1. Ontario-North Arm

The North Arm covers approximately 85,000 acres (34,590 ha) with an estimated annual fish yield of 2.77 lbs/acre (3.10 kg/ha) for a total potential harvest of 235,800 lbs (107,200 kg) per year.

Fish populations in this sector are harvested by commercial fishermen, Ontario resident anglers, non-resident anglers based in both Ontario and Minnesota, and by Aboriginals for domestic (subsistence) use.

a. Walleye

The potential harvest of walleye from the North Arm of Rainy Lake (Fig. 16 and 17) is approximately 47,000 lbs (21,400 kg) per year. This level of production, however, has not been consistently achieved since the 1950s. The angling fishery for walleye has witnessed a dramatic decline in fishing success rates or CUEs from 1.21 walleye per angler-hour in 1956 to an historic low of 0.06 walleye per angler-hour in 1979. The growing angling population in this area is now targeting other sport fish species.

It would appear that walleye abundance has reached a new equilibrium at depressed levels. The incidental angling catch rate, which includes anglers fishing for other species, has remained relatively stable from a CUE of 0.03 walleye per angler-hour in 1983 to 0.06 walleye per angler-hour in 1986, the most recent estimate of open water angling success. Similarly, MNR index (test) netting data indicate depressed stock abundance. The number of walleye caught per net set remained unchanged

between 1979 and 1983 at 1.9 fish per lift. The lowest index netting CUE value ever recorded was 0.8 walleye per net obtained in 1988, followed by the highest CUE value of 5.3 in 1989. Two year old fish represented more than 74% of the 1989 walleye catch.

The walleye angling harvest has increased from 2,700 lbs (1,224 kg) in 1983 to 10,500 lbs (4,800 kg) in 1986. Annual harvest by anglers averaged 7,200 lbs (3,300 kg) during this period. Commercial walleye harvest which was approximately 14,500 lbs (6,600 kg) in 1986 was reduced 68% by 1991 through quota buy-outs by MNR. Aboriginal subsistence harvest of walleye is estimated at 13,800 lbs (6,300 kg) per year and growing. The total annual walleye harvest from the North Arm of Rainy Lake has averaged 29,500 lbs (13,400 kg) over the past eight year period. A target harvest of 16,500 lbs (7,500 kg) was recommended in the 1984 Atlas to allow for rehabilitation of the walleye population and expansion of the brood stock component. This target has not yet been achieved and there are indications that brood stock abundance has continued to decline.

The number of spawning walleye caught at the Wasaw Creek assessment site between 1966 and 1975 averaged 1,454 fish per year. The catch of mature walleye from this site during 1985-88 averaged only 166 fish per year. Since the North Arm walleye population had dramatically declined prior to 1966, current brood stock abundance would appear depressed.

Recent attempts to rehabilitate walleye in the North Arm have included: a fry/fingerling stocking program to supplement the natural population (1985-88); a reduction in commercial fishing quotas for walleye by 68% percent through MNR licence purchases; the establishment of sanctuaries from April 1 to June 14 at four sites, currently or historically known as walleye spawning areas in Stanjikoming Bay, Halfway Inlet, Big and Little Canoe Rivers; and size regulations to limit the daily catch and possession limit of walleye greater than 19.5 in (50.0 cm) to one fish.

Male and female walleye began to mature in 1989 at age two and an average fork length of 14.9" (37.8 cm). This suggests that the new size regulation will offer little protection to individual walleye, as they recruit to the mature segment of the population. Depressed brood stock abundance increases the importance of each individual fish which is able to spawn.

The 1987 year-class which dominated as two year olds in 1989 represents the strongest year-class observed in 28 years of study on the North Arm. If current harvest strategies remain unchanged, total mortality, estimated for previous strong year-classes, would remain at 55 percent. The 1987 year-class would have only four opportunities to spawn at this rate before they would disappear from the population in 1994. In an effort to maximize survival of remaining walleye in the North Arm, an annual harvest target of zero is required.

b. Northern Pike

Changes have occurred in the northern pike population in the North Arm. Both angling and MNR index netting CUEs for northern pike have consistently decreased through the 1980s. Fish size, on average, has increased over the past ten year period and the largest mean size in index net catches was observed in 1989.

Total angling harvest which averaged 30,750 lbs (13,980 kg) per year has decreased slightly between 1983 and 1986. In combination with commercial food fishing quotas of 20,800 lbs (9,460 kg) and native subsistence harvest of approximately 13,900 lbs (6,300 kg) per year, total northern pike harvest has averaged 65,450 lbs (29,750 kg) annually (Fig. 18 and 19).

Although mean annual harvest currently exceeds the potential yield of 47,000 lbs (21,400 kg) per year, it is believed that the northern pike population has expanded over the past 30 years, probably in response to depressed walleye stocks.

RAINY LAKE

DISPERSION OF WALLEYES TAGGED AND RELEASED

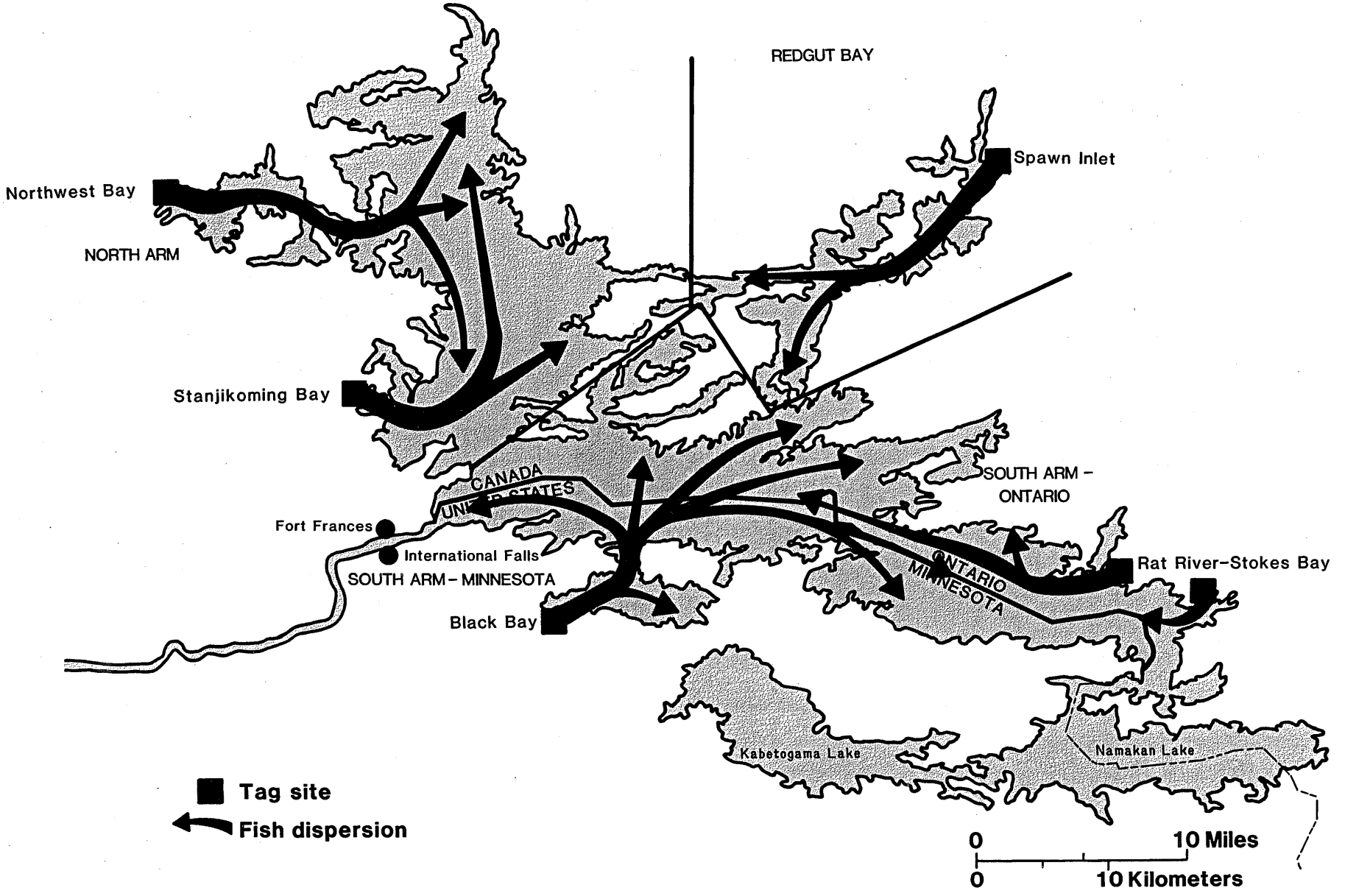


FIGURE 15

RAINY LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR WALLEYE

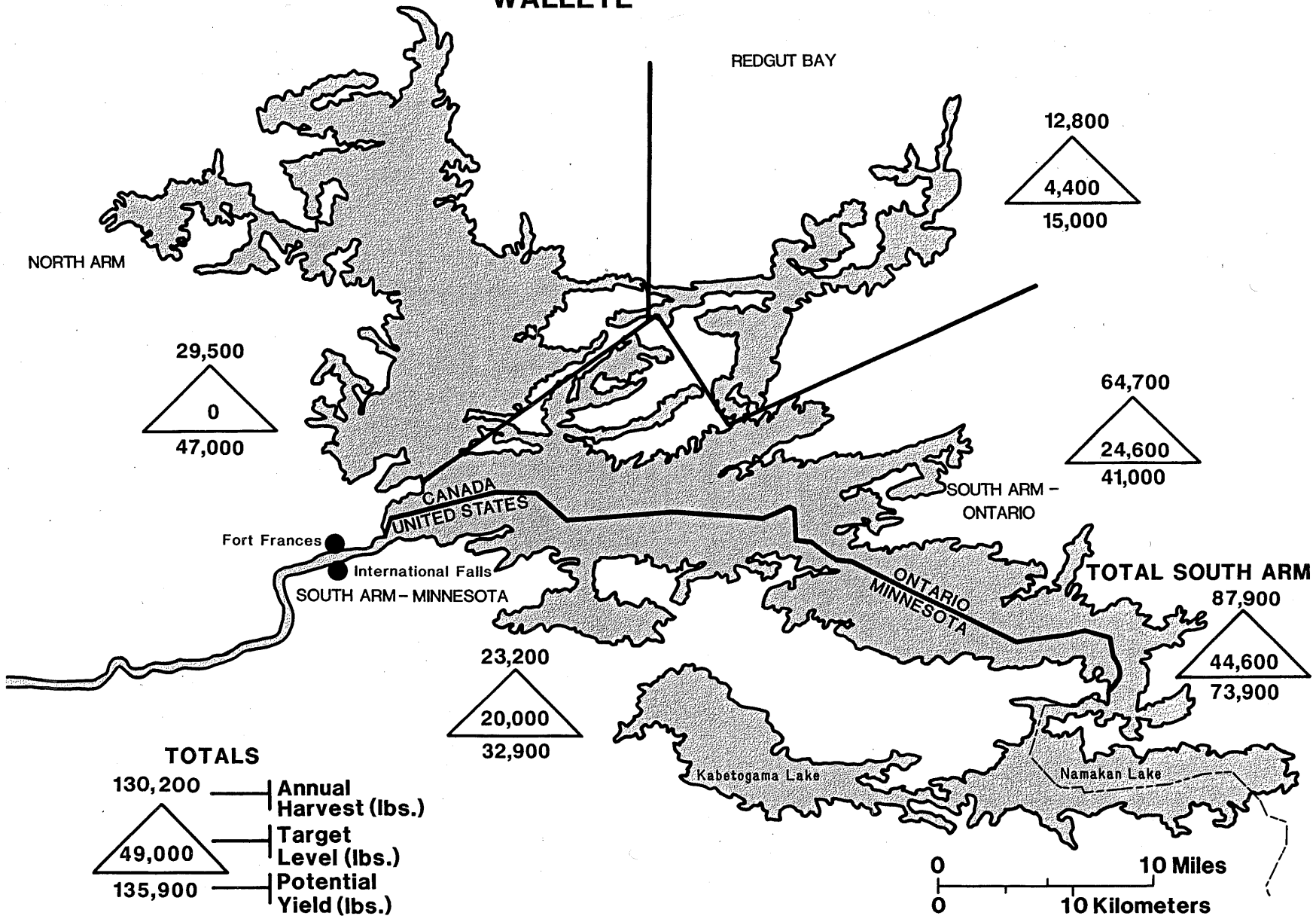


FIGURE 16

RAINY LAKE

WALLEYE HARVEST BY USER GROUP

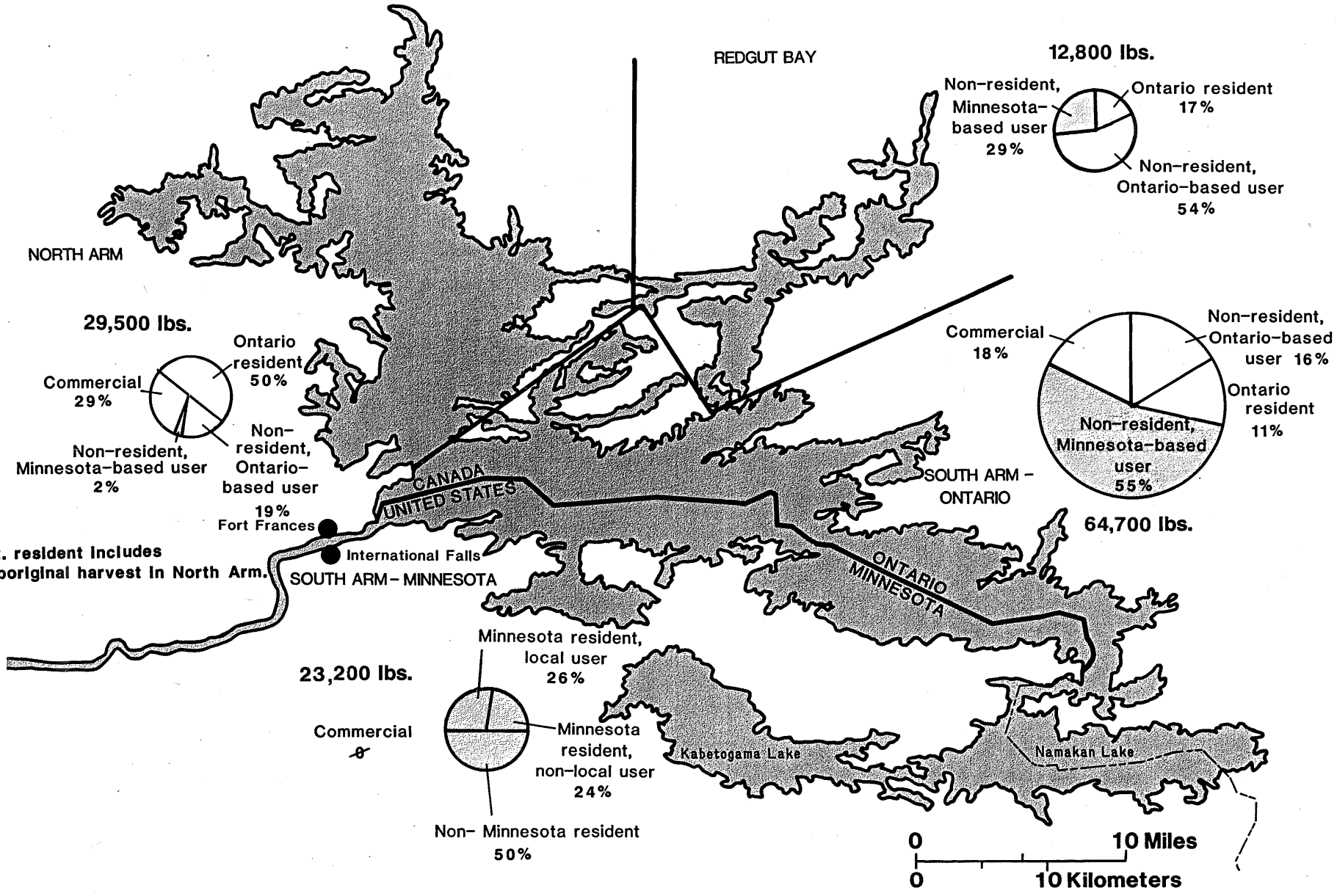


FIGURE 17

RAINY LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR NORTHERN PIKE

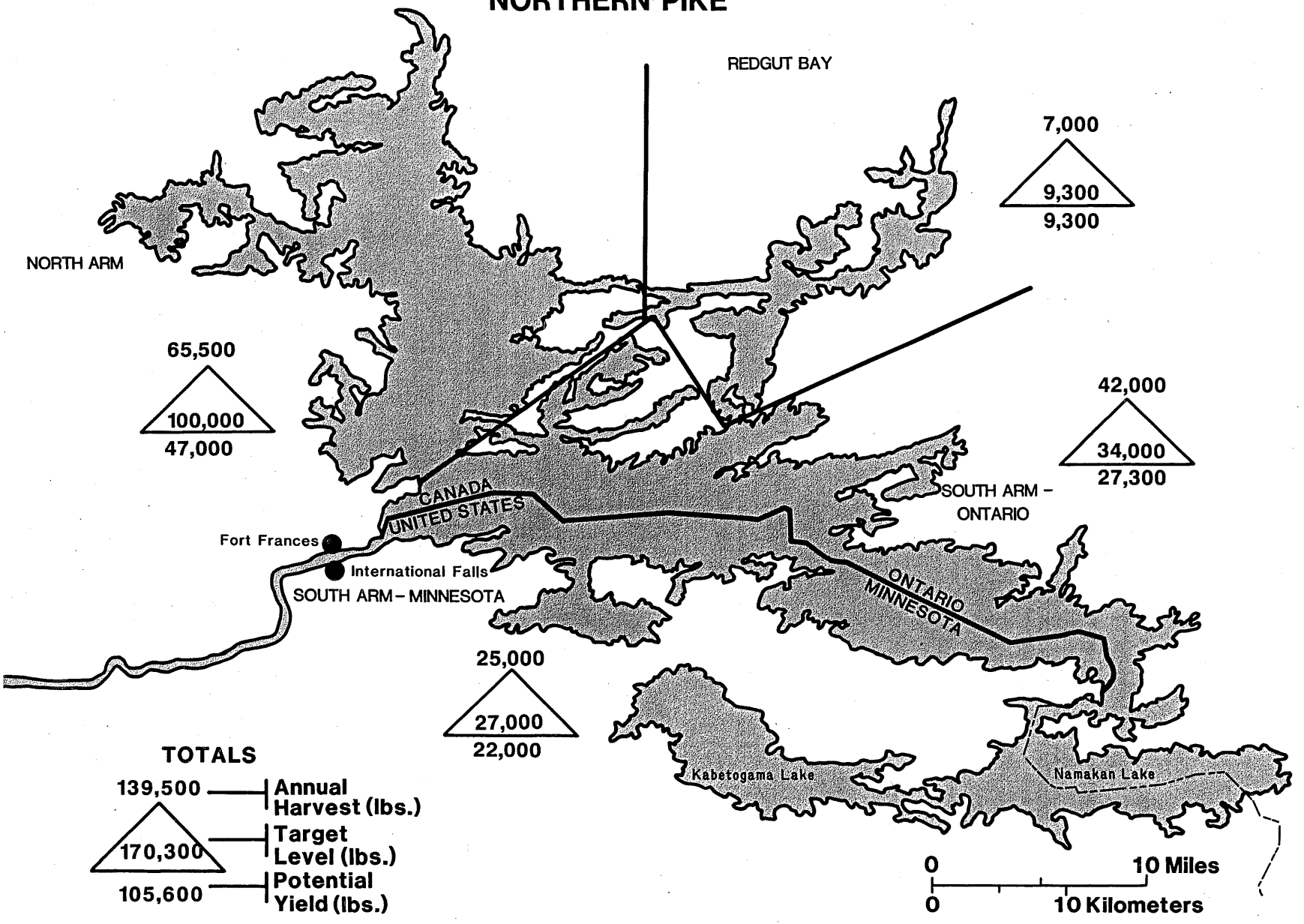


FIGURE 18

RAINY LAKE

NORTHERN PIKE HARVEST BY USER GROUP

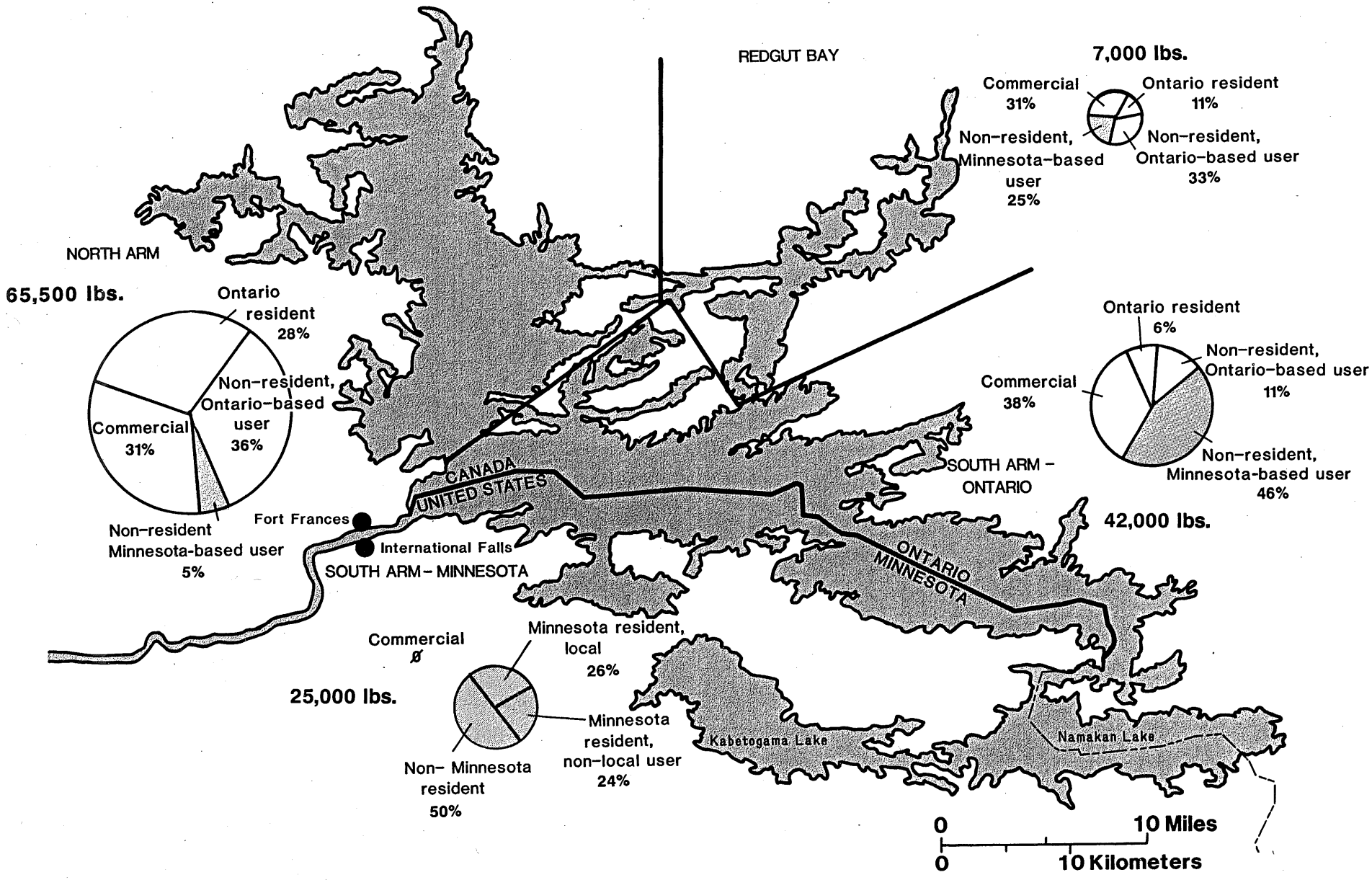


FIGURE 19

RAINY LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR SMALLMOUTH BASS/CRAPPIES

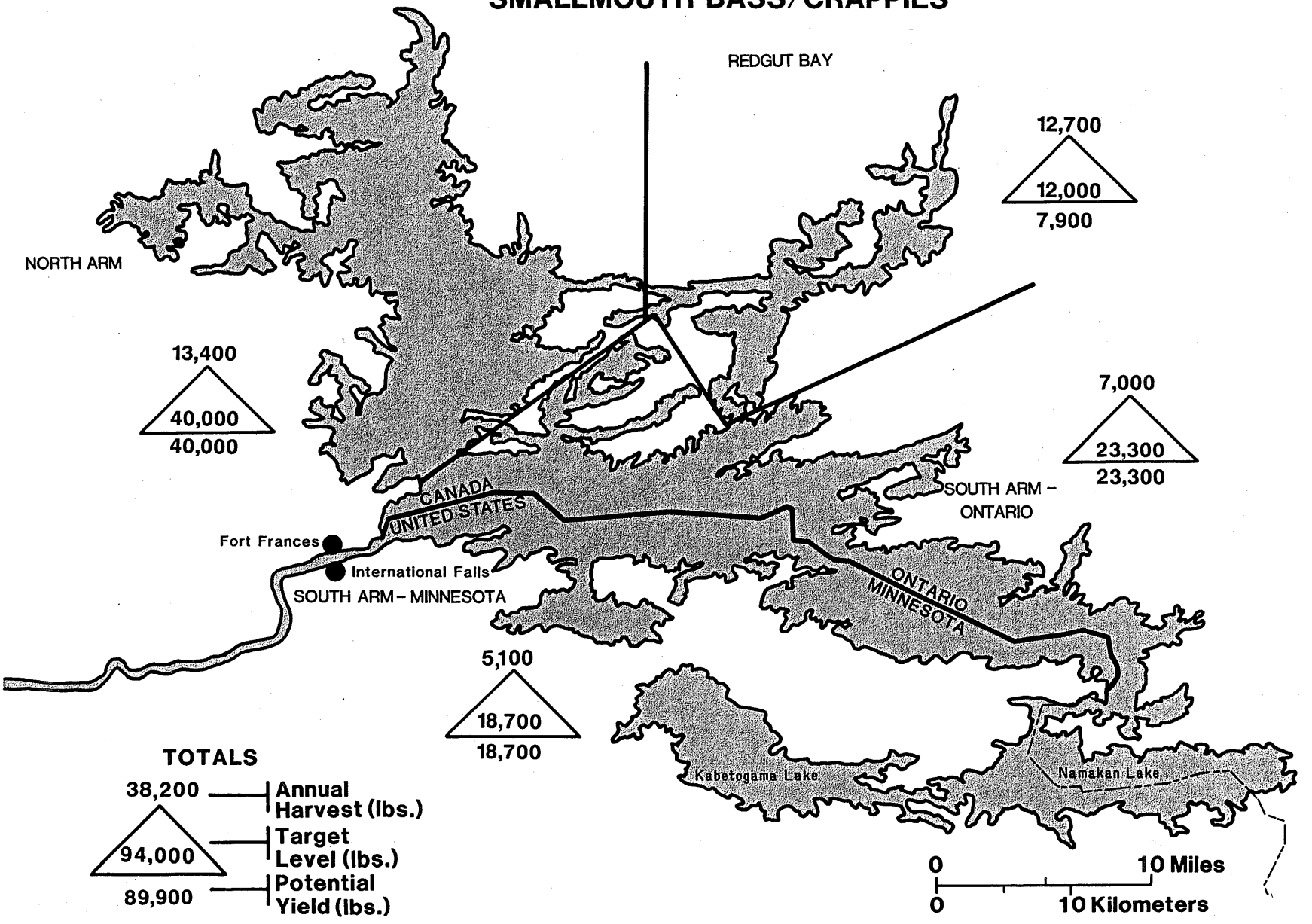


FIGURE 20

RAINY LAKE

SMALLMOUTH BASS/CRAPPIES HARVEST BY USER GROUP

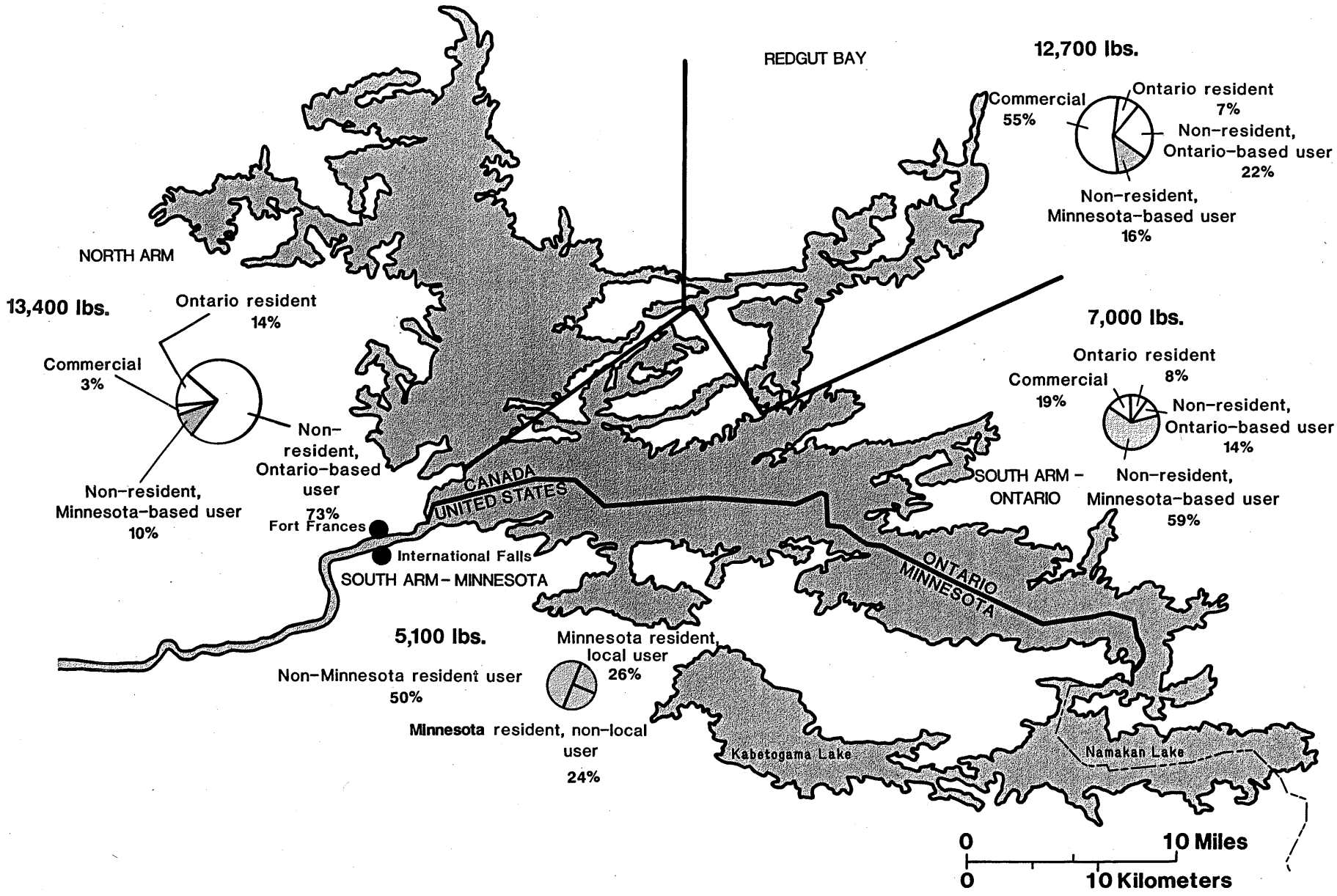


FIGURE 21

RAINY LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR SMALLMOUTH BASS

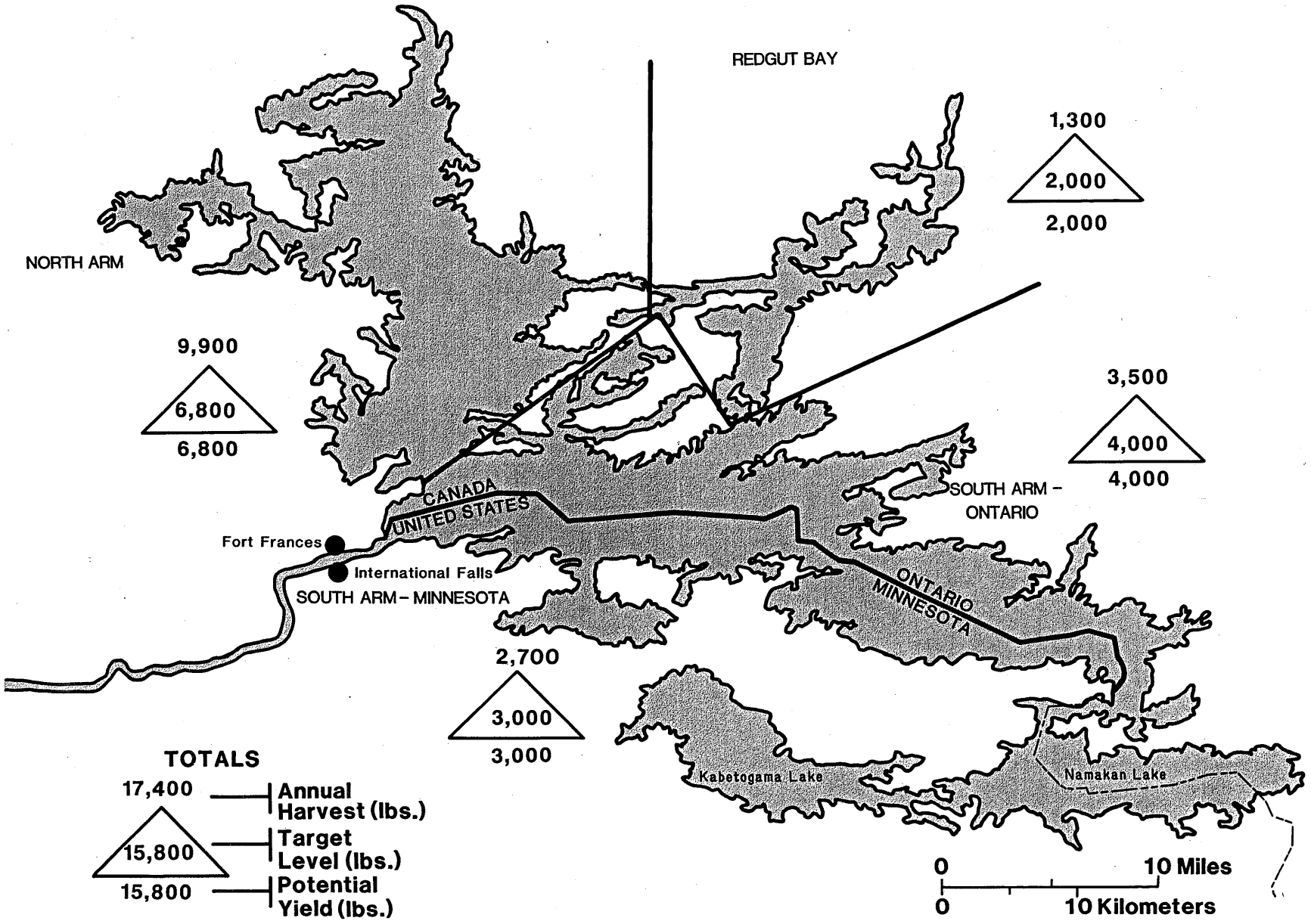


FIGURE 22

RAINY LAKE

SMALLMOUTH BASS HARVEST BY USER GROUP

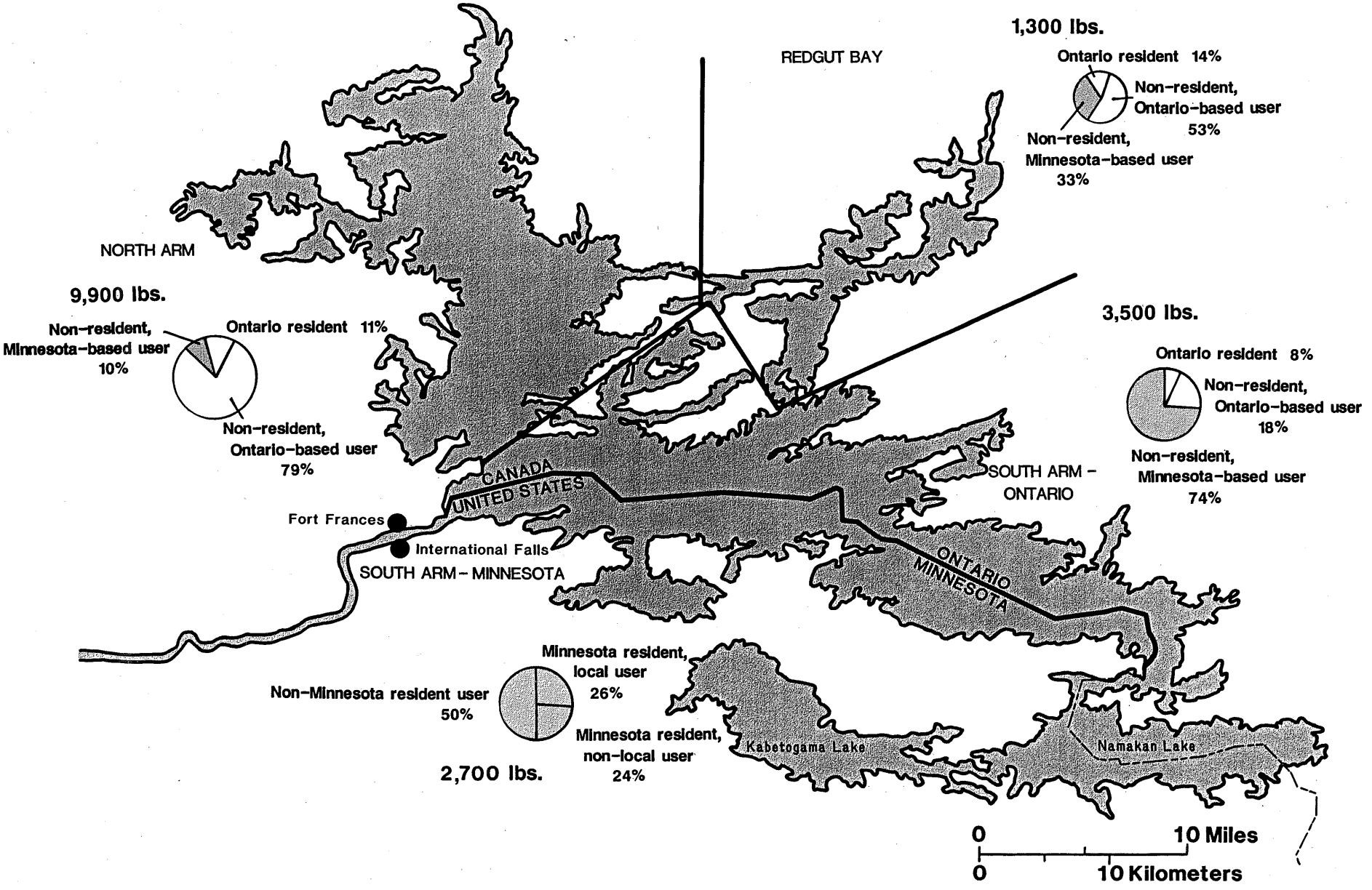


FIGURE 23

RAINY LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, AND POTENTIAL YIELD FOR WHITEFISH

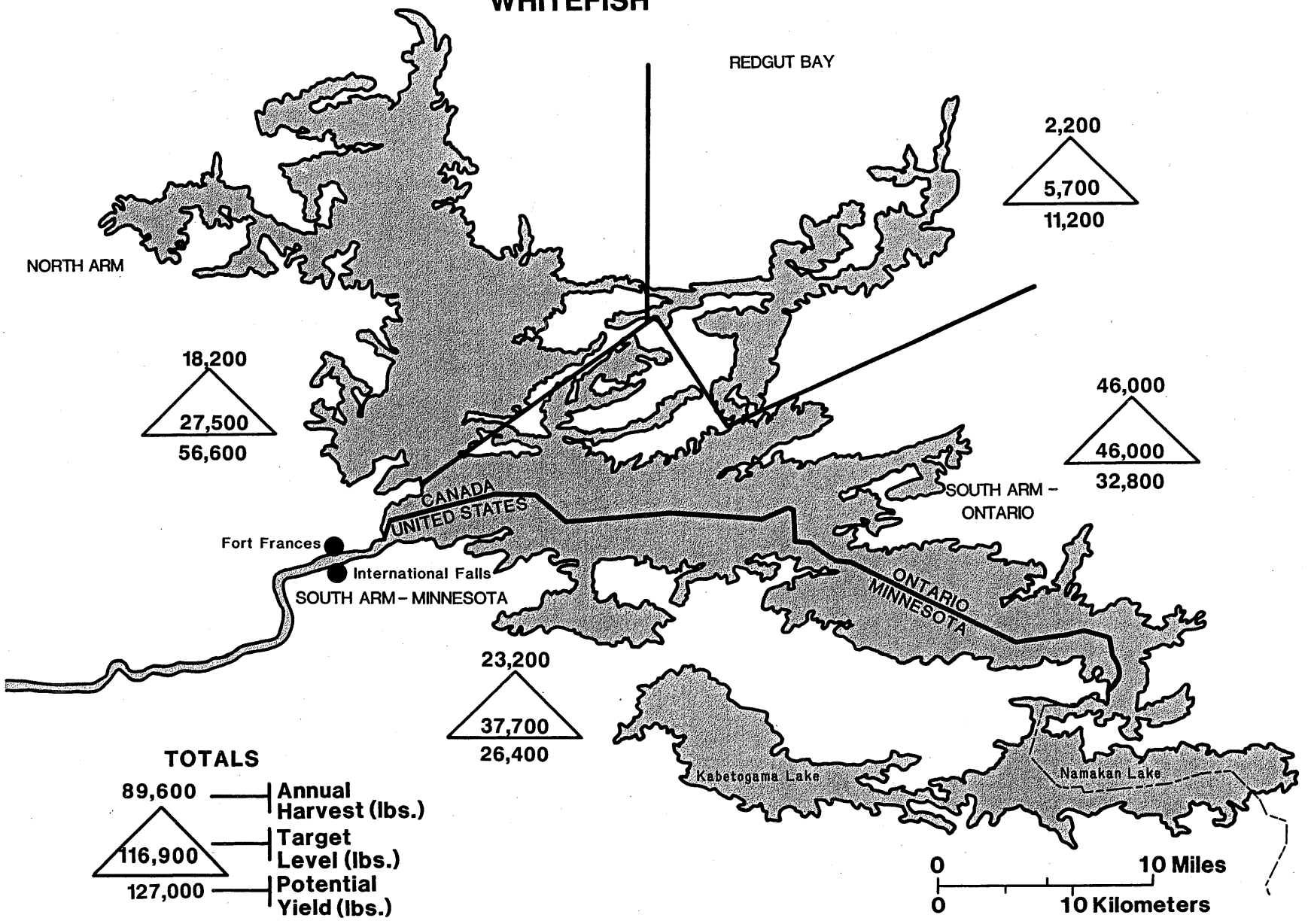


FIGURE 24

There is no immediate concern regarding northern pike stock status in the North Arm. Fish sanctuaries, along with the size regulation which permits only one pike greater than 27.5" (70.0 cm) in the daily catch and possession limit, may improve survival of older age classes. The current target of 100,000 lbs (45,500 kg) per year will be maintained until further assessment can monitor the impacts of current regulations.

c. Centrarchids (Smallmouth Bass/Black Crappie)

Smallmouth bass and black crappie which are relatively recent additions to the North Arm fish community were introduced in the late 1920s but can now be described as naturalized sport fish species. It is estimated that, in combination, 40,000 lbs (18,200 kg) can be taken from the North Arm annually (Fig. 20 and 21). Open water angling harvest averaged 13,000 lbs (5,900 kg) per year from 1983-86. Commercial quotas for black crappie have been recently reduced to 370 lbs (170 kg) per year.

Largemouth bass which have only recently been identified in Rainy Lake are currently a minor component in the fish community and in angling catches.

Centrarchids, as underutilized sport fish species, have recently been promoted as alternatives to walleye and northern pike. The angling public has been very receptive, given poor angling success for traditional species. However, it is recommended that the annual bass harvest not exceed 17% of the total centrarchid potential yield (Fig. 20, 22, and 23), or 6,800 lbs (3,100 kg), in order to maintain the quality of the current angling fishery. The recommended target for black crappie is 33,200 lbs (15,100 kg).

d. Other species

The potential harvest of whitefish from the North Arm is estimated to be 56,500 lbs (25,700 kg) per year (Fig. 24). Commercial production has averaged 12,300 lbs (5,600 kg) annually over the last ten year period. Quotas in 1989 represented 18,200

lbs (8,300 kg) but recent observations suggest that the target harvest level should be adjusted to 27,500 lbs (12,500 kg) per year for the following reasons: the yield estimate based on surface area is too high since whitefish habitat is not uniform throughout the North Arm; improved commercial catches and a wider age class distribution in catches indicate that whitefish stocks are recovering from historic low levels of abundance. The adjusted target harvest should permit more use while ensuring continued recovery.

Bullheads were caught in the North Arm for the first time in MNR index nets in 1989. Previously, bullheads had only been identified in the South Arm of Rainy Lake. The consequences of an additional fish species in the North Arm fish community will be monitored closely.

Sauger, yellow perch and other species contribute less than one percent to the annual sport fish catch and are of minor importance in the commercial fishery.

2. Ontario-Redgut Bay

Redgut Bay which is the smallest of the three basins forming Rainy Lake covers 20,560 acres (8,320 ha). The estimated annual fish yield is 2.27 lbs/acre (2.54 kg/ha) for a total potential yield of 46,700 lbs (21,100 kg) per year. Fish in this area are harvested by commercial fishermen, by Ontario resident anglers, by both Ontario and Minnesota-based non-residents and by local Aboriginals for domestic use.

a. Walleye

The potential yield of walleye from Redgut Bay is approximately 15,000 lbs (6,800 kg) per year (Fig. 16 and 17). No commercial fishing quotas exist in this area and recreational angling accounts for the majority of harvest, although an unspecified amount of native subsistence use occurs.

Walleye harvest from Redgut Bay has decreased by roughly 50% from a mean annual harvest of 19,300 lbs (8,760 kg) between 1970 and 1984 to an average of 9,900 lbs (4,500 kg) per year during 1985-86. Angling success or CUE has declined from a 1970 high of 0.58 walleye per angler-hour to an historic low of 0.16 walleye per angler-hour in 1986. The number of walleye caught in MNR index nets showed a similar trend during the last seven year period, suggesting that walleye abundance has declined.

The angling catch is comprised primarily of age two, three and four year old fish. These three age groups represented more than 60% of the total catch during 1983-86. Walleye in Redgut Bay start to mature at age two and are fully mature at age five. The mean age in MNR index net catches has not surpassed four years old during the 1980s. It would appear that an insufficient number of walleye currently survive to maturity to maintain past abundance levels.

Recent management initiatives to provide protection to the remaining brood stock include the establishment of fish sanctuaries from April 1 to June 14 at Porter Inlet and from Crooked Narrows to Sand Island Falls. In addition, only one walleye greater than 19.5 in (50 cm) total length is allowed in the daily catch and possession limit.

In the short-term, there is a need to increase the number of fish in older age groups. A reduction in harvest would permit more individuals to reach maturity and contribute to stock rehabilitation. The target harvest level has been reduced to 4,400 lbs (2,000 kg) per year to reflect this need (Fig. 16). The new target represents 30% of the old target and a 50% reduction in current use.

b. Northern pike

The potential yield of northern pike (Fig. 18) is 9,300 lbs (4,200 kg). Total

commercial quota is 2,200 lbs (1,000 kg) and fish are taken by means of live entrapment gear. Sport fishing harvest has averaged 4,800 lbs (2,200 kg) annually from 1983-86. Total annual harvest (Fig. 19) is approximately 7,000 lbs (3,200 kg).

Angling CUEs for northern pike have remained relatively stable throughout the 1980s while MNR index netting CUEs have fluctuated but showed no discernable trend. Both mean weight and size of pike caught in index nets have declined slightly over time. The target harvest of northern pike from Redgut Bay remains equal to the potential yield of 9,300 lbs (4,200 kg).

c. Centrarchids (Smallmouth Bass/Black Crappie)

Smallmouth bass and black crappie which were introduced into Rainy Lake in the late 1920s are now firmly established in Redgut Bay. The potential harvest (Fig. 20) of both species is estimated at 7,900 lbs (3,600 kg). Total commercial crappie quota is 7,000 lbs (3,180 kg) while the sport fishing catch of bass and crappie together averaged 5,700 lbs (2,600 kg) per year between 1983 and 1986 (Fig. 21). In combination, black crappie and smallmouth bass harvest is currently estimated at 12,700 lbs (5,800 kg) per year. Largemouth bass comprise a minor component of the resident fish community and of the angling catch.

The angling catch of smallmouth bass has averaged less than 1,300 lbs (600 kg) per year between 1983-86 (Fig. 22 and 23). This sport fish has recently been promoted as an alternate species for traditional walleye anglers. Bass angling is a quality experience, due to light harvest pressure in the past. Therefore, it is recommended that the current harvest level, approximately 17 percent of the centrarchid harvest target of 12,000 lbs (5,500 kg) be maintained. A smallmouth bass target harvest level of 2,000 lbs (900 kg) would ensure that angling quality for this sport species is not eroded.

The target harvest level for black crappie is the remaining portion of the centrarchid

target or 10,000 lbs (4,600 kg). Although this target exceeds the potential yield estimate, current stock status appears to be stable and abundance has increased in MNR index net samples.

d. Other species

Although the potential yield for whitefish from Redgut Bay is approximately 11,200 lbs (5,100 kg), based on water surface area, the entire bay does not provide uniform whitefish habitat. Since only the south half of this basin has adequate depth to maintain whitefish during warm water periods, the target harvest has been adjusted to 5,700 lbs (2,600 kg) to reflect habitat limitations (Fig. 24). Currently, whitefish are harvested by commercial food fishermen with a total annual quota of 2,200 lbs (1,000 kg).

Bullheads have expanded their range into Redgut Bay in 1988. Although they have not yet appeared in MNR index nets or commercial gear, several sightings in Baseline Bay by anglers and cottagers have been confirmed by MNR.

Sauger, muskellunge, yellow perch and other species not discussed are of minor importance in the angling and/or commercial fisheries. Sauger are becoming more common in the angling creel, as a result of changes in fish community structure or declines in walleye angling success.

3. Ontario and Minnesota-South Arm

The South Arm is divided approximately in half by the Canada-U.S. International border. Ontario's portion is roughly 67,000 acres (27,260 ha) of a total surface area of 121,000 acres (49,200 ha). The total potential fish yield for all species is estimated to be 2.04 lbs/acre (2.28 kg/ha) or 246,600 lbs (112,100 kg) per year; 136,800 lbs (62,200 kg) to Ontario and 109,800 lbs (49,900 kg) to Minnesota.

Fish populations are harvested commercially on both sides of the border, but only whitefish can be taken on the Minnesota side. Commercial sport fish harvest on the Minnesota side was gradually reduced by gear restrictions and eliminated with a legislated buy-out in 1985. The majority of recreational angling activity on the South Arm is from Minnesota but some Ontario-based anglers, both local and non-resident, fish Ontario waters.

a. Walleye

The walleye potential yield of 74,000 lbs (33,600 kg) per year for the South Arm was divided between Ontario and Minnesota based on surface area (Fig. 16 and 17). Ontario, with 55% of the South Arm, has a potential walleye yield of 41,000 lbs (18,600 kg) while Minnesota's portion is 32,900 lbs (15,000 kg).

Ontario

Total walleye harvest from the Ontario portion of the South Arm has averaged 64,700 lbs (29,400 kg) per year from 1982-86. The annual angling harvest over this period has been estimated at 46,400 lbs (21,100 kg) and the annual commercial catch has averaged 18,300 lbs (8,300 kg). The native subsistence harvest of walleye from this area is not known.

Walleye populations in the Ontario South Arm were considered to be recovering throughout the 1970s from historic low abundance in the late 1960s. However, harvest levels in the 1980s have exceeded potential yield and the population, once again, is showing signs of stress from overexploitation.

Although angling effort has steadily increased, walleye harvest has continued to decline between 1982-86. Angling CUEs have shifted from an historic high of 0.60 walleye per angler-hour in 1964 to an historic low of 0.25 walleye per angler-hour in 1985. Catch composition is dependant on strong year-classes but mean age of the catch, roughly 4.4 years, has remained relatively consistent throughout the 1980s.

Fish normally appear in the angling creel at age two and few individuals older than age seven are caught. MNR index netting studies demonstrate an absence of prime brood stock in the eight to 10 year old category.

Recent management initiatives to reduce harvest and provide additional protection to the remaining brood stock have included the following: the establishment of sanctuaries from April 1 to June 14 at Squirrel Falls, Stokes Bay and Rat River where mature fish tend to concentrate; elimination of the commercial walleye harvest in 1991 through the purchase of commercial fish licences from fishermen willing to retire from the industry; and changes to walleye angling regulations which allow only one fish greater than 19.5 in (50 cm) in the daily catch and possession limit.

The target harvest level for walleye from the Ontario portion of the South Arm has been regularly exceeded and there are now indications that harvest must be reduced. The target (Fig. 16) has been reduced by 40% to 24,600 lbs (11,200 kg) to allow more young fish to survive to maturity, thereby resulting in a wider range of age groups in the spawning populations and greater long-term stability.

Minnesota

Minnesota's commercial walleye harvest declined to 11,000 lbs (5,000 kg) in 1984 and was eliminated in 1985. The angling harvest has averaged about 23,200 lbs (10,500 kg) per year from 1984-90. Total harvest is about 70% of the estimated potential yield for the Minnesota South Arm (Fig. 16 and 17).

A trend towards increased walleye abundance which was reported in the 1984 Atlas did not continue throughout the 1980s. Abundance, as demonstrated by index netting data, was generally low in the early and mid-1980s but increased slightly in 1989. However, both the percentage of walleye greater than 16.0" (41.0 cm) and average age have increased over the long-term from 1963-89. Recently, average length,

weight, growth and catch rates for walleye in Minnesota index nets and in the sport fishery have all fluctuated, showing no distinct short-term trends. The average age of walleye from creel surveys was 4.5 years for the period 1984-89.

The walleye fishery which is dependent on two or three year-classes is considered to be a recovering fishery. Minnesota walleye stocks have shown high variability in abundance from index net catches, in year-class strength and angling harvest. Changes in community composition, especially increased abundance of black crappie and bullheads, may contribute to instability in this fishery. The previous target harvest of 33,000 lbs (15,000 kg) has been reduced by 40% to 20,000 lbs (9,100 kg) which is less than the average angling harvest between 1984 and 1989. The target harvest was reduced in order to spread harvest over more age groups, promote long-term harvest stability and to aid in the recovery of this fishery (Fig. 16). Regulations that reduce harvest may be necessary. Angler support for a reduced harvest seems to exist, with the acceptance and participation in catch and release fishing.

b. Northern pike

The potential yield for northern pike is estimated at 27,300 lbs (12,400 kg) for the Ontario side and 22,000 lbs (10,000 kg) for the Minnesota portion of the South Arm (Fig. 18 and 19).

Ontario

Total northern pike harvest from the Ontario South Arm has averaged 42,000 lbs (19,100 kg) annually between 1983 and 1986. Commercial fishing quotas accounted for 15,800 lbs (7,200 kg) per year and recreational anglers harvested 26,200 lbs (11,900 kg) yearly. No estimate of native subsistence harvest levels are available.

MNR index (test) netting catches over time have shown a slight decline in the number of pike caught. Age and size distributions of the catch appear to be increasing which may suggest that annual recruitment has not been optimal. Angling

catch rates have improved marginally, but these probably reflect changes in angler preference rather than increased abundance.

Recent reductions in total northern pike harvest have been achieved through MNR purchase of commercial fish quotas, the establishment of fish sanctuaries in prime pike spawning habitat and the introduction of a size regulation which restricts daily catch and possession of fish greater than 27.5 in (70 cm) to one fish. Total harvest has been reduced to a level more representative of the potential yield, with an annual harvest target of 34,000 lbs (15,500 kg).

Minnesota

The commercial harvest of northern pike in Minnesota waters declined to 4,200 lbs (1,900 kg) in 1984 and was eliminated in 1985. The sport fishing harvest has averaged about 25,000 lbs (11,300 kg) per year from 1984-89 which exceeds potential yield by 14 percent. Northern pike abundance has remained stable although average length, weight, and age have increased and the size distribution has shifted upwards. These data provide evidence of a fairly stable northern pike population, however, recruitment may not be ideal. A target harvest level of 27,000 lbs (12,300 kg) will be maintained (Fig. 19).

c. Centrarchids (Smallmouth Bass/Black Crappie)

The potential yield of centrarchids for the Ontario and Minnesota portions of the South Arm is 23,300 lbs (10,600 kg) and 18,700 lbs (8,500 kg) per year (Fig. 20 and 21).

Ontario

Annual commercial fish quotas for black crappie total 1,300 lbs (600 kg) and fish are caught by live entrapment gear. The angling catch of crappie has averaged 2,200 lbs (1,000 kg) per year between 1984-86 while the annual smallmouth bass harvest has averaged 3,500 lbs (1,600 kg) for the same time period (Fig. 23).

Centrarchids in the South Arm have been promoted as an alternative sport fish, due to limited use by anglers in the past. The quality of smallmouth bass angling in this area can be maintained by limiting harvest to within 17% of the total centrarchid potential yield (Fig. 20). This level of harvest would represent 4,000 lbs (1,800 kg) per year or roughly the amount of current use (Fig. 23). The annual target harvest for black crappie has been set at 19,300 lbs (8,800 kg) which is the remainder of the centrarchid potential yield.

Minnesota

No commercial harvest of black crappie or smallmouth bass exists. The annual sport fishing harvest of bass and crappie averaged about 5,100 lbs (2,300 kg) during 1984-90 creel surveys.

Crappie abundance is probably increasing, based on seine net samples and angling harvest. There is some concern that an increasing crappie population may inhibit walleye recovery. Smallmouth bass harvest was higher than black crappie harvest in 1984 and 1985 but more crappie were harvested than bass during 1986-90. However, the harvested weight of smallmouth bass remained higher.

Better sampling techniques are required to set a target harvest for smallmouth bass. However, the existing target of 3,000 lbs (1,400 kg) per year can probably be maintained in the interim (Fig. 22). The new combined target for bass and crappie has been increased from 8,800 lbs (4,000 kg) to a potential harvest of 18,700 lbs (8,500 kg), provided that the bass component remains at about 3,000 lbs (1,400 kg) and any harvest increase is directed toward black crappie.

d. Other species

The potential yield for whitefish is 32,800 lbs (14,900 kg) for the Ontario side and 26,400 lbs (12,000 kg) per year for the Minnesota portion of the South Arm, for a combined total of 59,200 lbs (26,900 kg) per year (Fig.24).

Ontario

The 1990 commercial quota for whitefish was 46,000 lbs (20,900 kg). This level of harvest exceeds the potential yield but it would appear that the target can be defined by recent harvest levels since deep water habitat is available throughout the South Arm. Long-term monitoring of the commercial catch has shown normal growth, maturity, age and size distributions which strongly suggest harvest at this level has caused little change in the whitefish population. The recent (1989) smelt invasion of the South Arm from waters upstream may have a negative impact on whitefish recruitment and will require monitoring to ensure continued harvest opportunities Since 1991, whitefish quotas have been reduced by over 50% through MNR buy-outs of commercial licences in the South Arm.

Sauger and yellow perch are of minor importance in the sport and commercial fisheries. Sturgeon, however, are caught by the commercial fishery and quotas total 1,200 lbs (550 kg) annually. There are no plans to increase quota levels. Aboriginal people regularly harvest sturgeon for domestic use, but amount of harvest not known.

Minnesota

The commercial whitefish harvest declined to an average catch of 23,200 lbs (10,500 kg) dressed weight during 1985-89. This decline was due to the elimination of gill netting for game fish and an overall reduction in commercial fishing pressure. The current target harvest of 37,700 lbs (17,100 kg) round weight (32,000 lbs or 14,500 kg dressed weight) was based on past harvest. This level exceeds the estimated potential yield by 21 percent (Fig. 24). Analysis of whitefish growth rates and age distributions are required before any adjustments to the current target can be made.

No commercial harvest of sauger or yellow perch exists in Minnesota waters. Sauger and perch comprised five and six percent of the biomass sampled in index nets during 1984-89. The average angling harvest of sauger and perch combined was estimated at 1,700 lbs (775 kg) from 1984-90 creel surveys.

III. The Namakan Lake Fishery Resource

A. Description of the Lake

Namakan Lake is located on the U.S.-Canadian border and encompasses an area of 24,964 acres (10,102 ha), 49 percent of which is in the United States. This mesotrophic lake lies within the southern range of boreal forests in North America. Namakan Lake is typical of lakes within the Canadian Shield. The waters are soft and submergent vegetation is sparse. Namakan Lake has the following characteristics: 20% of the lake consists of littoral area; mean depth of 44.5 ft (13.6 m); greatest length of 19.5 miles (31.4 km); shoreline length of 146 miles (235 km); island shoreline of 105 miles (169 km); maximum recorded depth of 150 ft (45.7 m); mean summer secchi disk of 8.48 ft (2.6 m); and a mean total alkalinity of 14.26 mg/l.

Namakan Lake is part of Namakan Reservoir which also includes Kabetogama, Crane, Sand Point and Little Vermilion lakes. Namakan Reservoir with a drainage basin area of 7,452 sq. miles (19,300 sq. km) is part of the headwaters of the Winnipeg-Nelson River system. Two regulatory dams in operation since 1914 are located at the outlet of Namakan Lake. Water levels were originally controlled by natural rock sills at Kettle and Squirrel Falls at the outlet of Namakan Lake. These natural rock sills supported the integrity of the lakes at slightly lower levels. The water level in Namakan Lake is regulated by the International Joint Commission. Regulation of lake level by the commission is based upon a "rule curve" (i.e. the supplemental order of 1970 is presently in effect). The rule curve requires that water levels be maintained within a defined band of lake elevations during normal operations at any particular time of the year. Namakan Lake differs from the natural or estimated pre-dam condition in the following ways: a greater magnitude of annual fluctuation, 8.9 ft versus 5.9 ft (2.7 m versus 1.8 m); higher summer and fall water

levels and a significantly greater overwinter drawdown; and the timing of peak water levels occurs approximately one month later (i.e. the lake reaches peak level in late June or early July rather than late May or early June). The present water level management system has been shown to adversely affect the aquatic ecosystem.

The fishery has been investigated numerous times. A 1941 Minnesota DNR study was the first to investigate the effects of the water management regime. The first fisheries survey was conducted jointly by Ontario and Minnesota in 1962 and 1963. This investigation documented a high walleye population dominated by young fish. Numerous population assessments have since been completed.

Commercial fishing on Namakan Lake began in 1916-17. However, with the growth of the tourist trade, commercial fishing for walleye and northern pike was eliminated on Minnesota waters in 1946. Two licensed commercial fishermen have been active since the 1950s on the Minnesota side of the lake where they fish for lake whitefish. Ontario currently licenses one commercial fisherman for Namakan Lake. In recent years, the commercial harvest under this license has approached established quotas for walleye, northern pike, lake whitefish and sturgeon.

Namakan Lake has recently been made accessible by road from Ontario. Access is also obtained via water from Kabetogama and Sand Point lakes. Nearly all sport fishing in Namakan Lake is Minnesota-based. The American side of the lake lies within Voyageurs National Park. There is little development on the lake, consisting of only a few scattered cabins and National Park campsites.

B. Current Status of Fish Stocks

Namakan Lake is divided approximately in half by the Canada-U.S. border. Ontario's portion is about 12,700 acres (5,150 ha), while Minnesota has approximately 12,200 acres (4,950 ha). Potential yields, as determined using the

morphoedaphic index (MEI), recent annual harvests, and target harvests are cited for comparison purposes. However, the primary management goal for Namakan Lake is to achieve or maintain the target harvest. The target harvest is that level of harvest believed necessary to produce or maintain a quality fishing experience by: (1) preventing overharvest and depletion of the fish stocks; (2) creating a favorable size distribution in the catch; or (3) maintaining favorable fish population dynamics. The MEI provides first-order approximations of the productive capacities of large freshwater lakes, and its application beyond the ranges of the underlying data has shown variation from the original relationship. The MEI derived potential yields appeared to underestimate the productive capacity of Namakan Lake. Factors such as water residence time, morphology of lake basins which comprise Namakan Reservoir, and the distribution of oxygen and heat could allow greater productivity than that predicted by the relationship between the ratio of total dissolved solids to mean depth. Therefore, target harvest levels were established using optimal thermal habitat (Christie and Regier 1988) and yield-per-recruit (Ricker 1975) models.

The productive capacity for a given species in a lake is dependent on the amount of lake bottom or volume in the optimal temperature range for growth of that species and lake water productivity, as measured by total dissolved solids. Average annual time-integrated measures of lake bottom area within a species's fundamental thermal habitat volume (THV) were derived from extensive data of the stratification period for Namakan Lake during 1981 through 1989. Potential yields were calculated, using developed relationships between the sustained yield of various species to these thermal habitat (THV) measures. Potential yields derived from THVs for walleye and northern pike were significantly higher than those determined by partitioning yields estimated from the MEI. This knowledge suggested that target harvest levels could be determined from annual harvest. Therefore, target harvest levels for walleye and northern pike were calculated by simulating harvest based on various proportions of the annual harvest using the yield-per-recruit model. Those proportions which appeared to best improve population size structure were chosen

NAMAKAN LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, POTENTIAL YIELD, AND HARVEST BY USER GROUP FOR WALLEYE

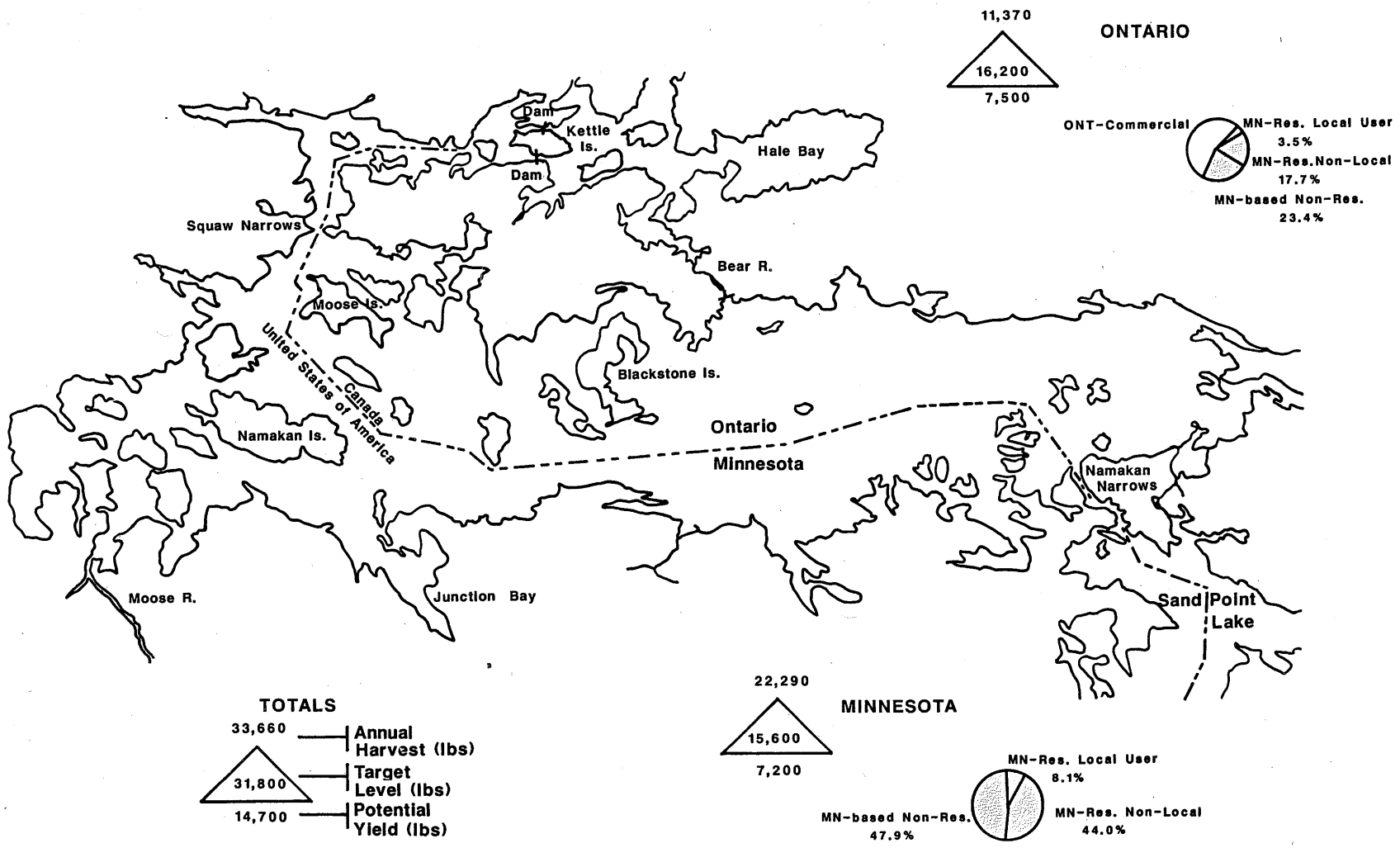


FIGURE 25 MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

NAMAKAN LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, POTENTIAL YIELD, AND HARVEST BY USER GROUP FOR NORTHERN PIKE

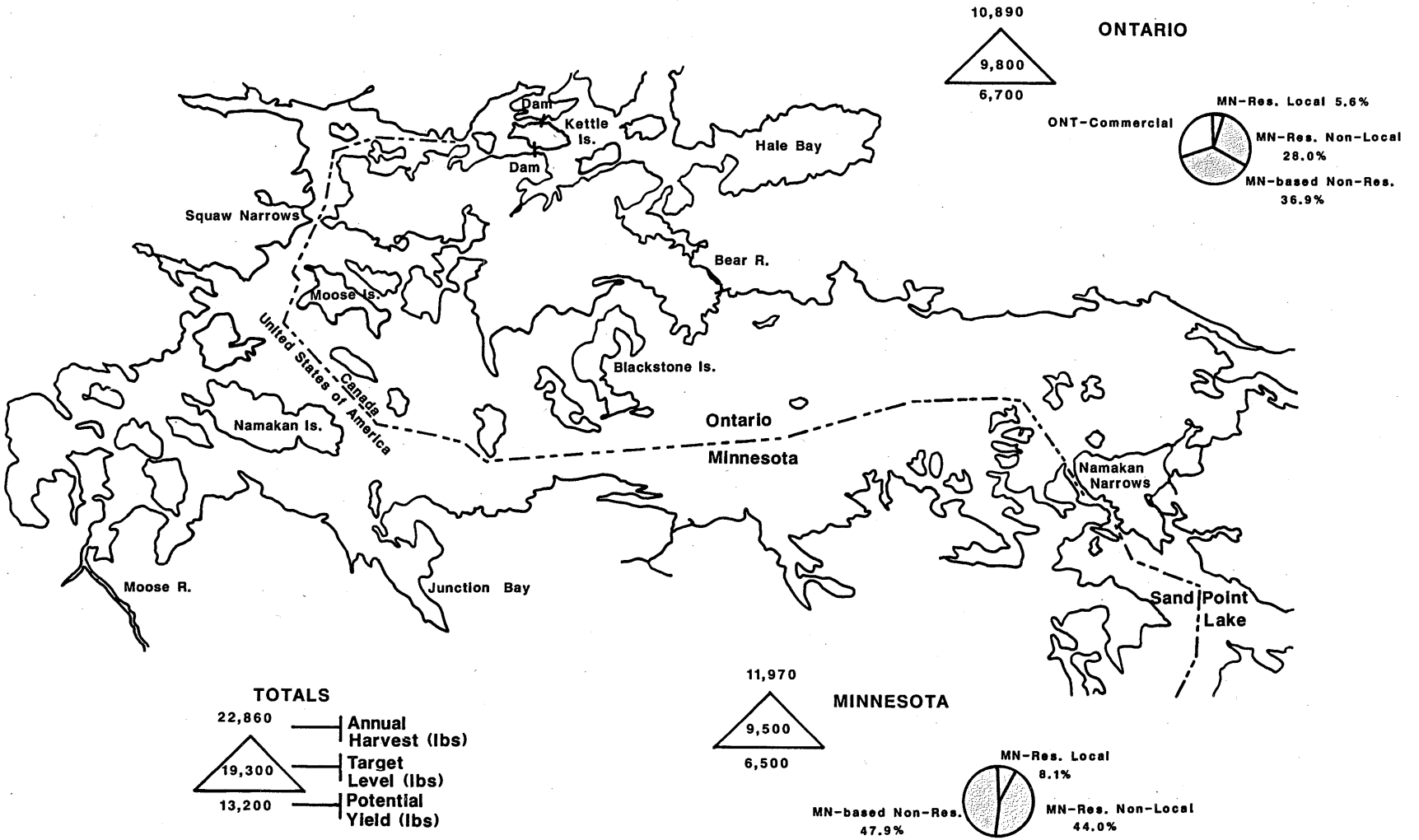


FIGURE 26 MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

NAMAKAN LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, POTENTIAL YIELD, AND HARVEST BY USER GROUP FOR SMALLMOUTH BASS/CRAPPIES

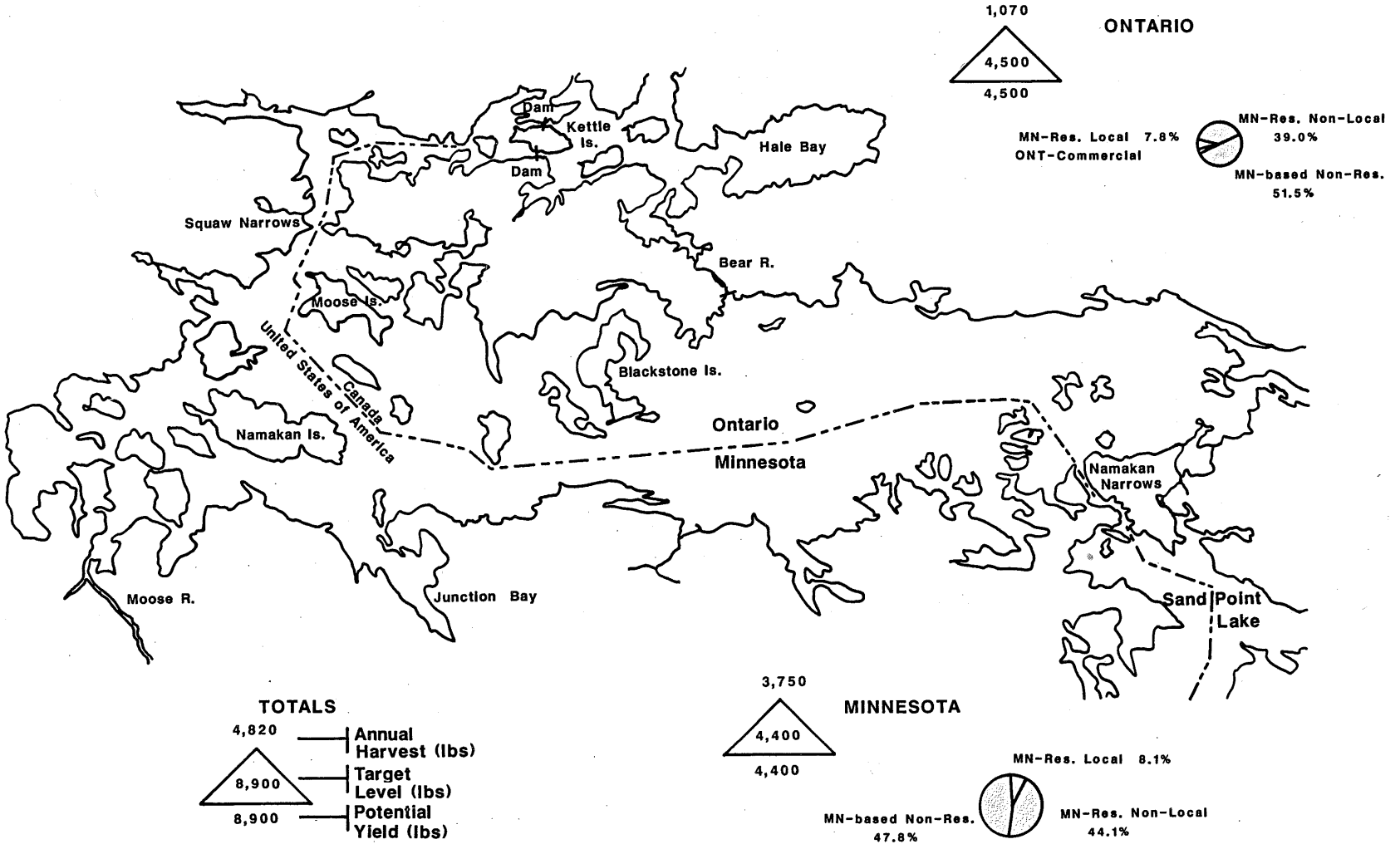


FIGURE 27 MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

NAMAKAN LAKE

ANNUAL HARVEST, TARGET LEVEL HARVEST, POTENTIAL YIELD, AND HARVEST BY USER GROUP FOR LAKE WHITEFISH

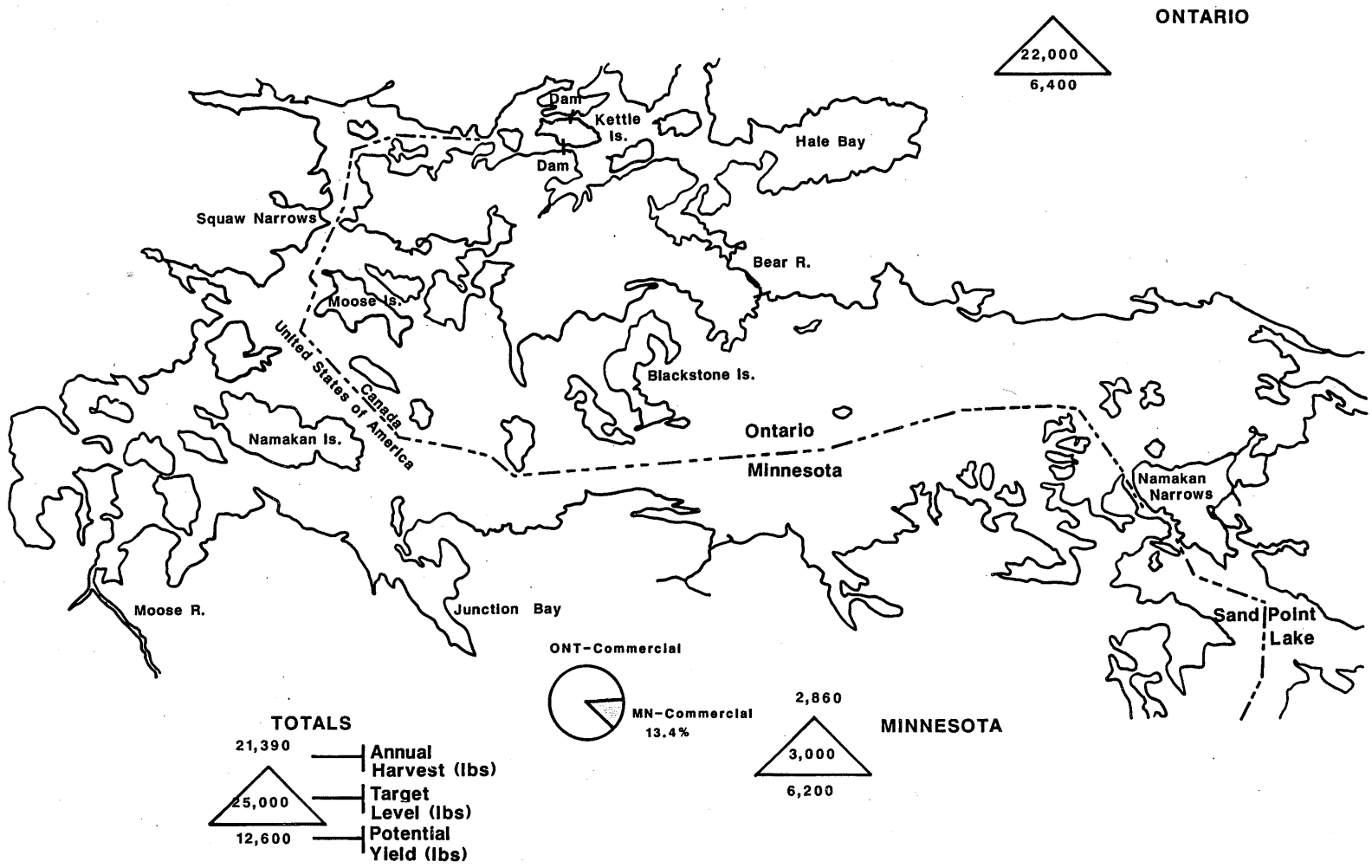


FIGURE 28 MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

as the target harvest level.

The potential annual fish yield, estimated from the MEI model, for all species of fish is 2.11 lbs/acre (2.36 kg/ha). The current annual harvest for all species is estimated at 4.22 lbs/acre (4.73 kg/ha), and the total annual target harvest is 4.28 lbs/acre (4.80 kg/ha). A total annual harvest of 106,800 lbs (48,400 kg) could be sustained; 54,500 lbs (24,700 kg) from Ontario and 52,300 lbs (23,700 kg) from Minnesota waters. Current information suggests that the Namakan Lake fishery is moderately developed. At this stage of development, there is sufficient fishing activity to produce changes in the size or age structure of the stocks, but not enough to threaten recruitment.

a. Walleye

The current walleye stock size appears typical for this lake type, with most recent population changes attributable to a strong year-class moving through the fishery. The walleye harvest in recent years has been estimated at 106% of the target harvest of 31,800 lbs (14,400 kg). The walleye target harvest for Namakan Lake was divided between Ontario and Minnesota based on surface area (Fig. 25). Ontario, with 51% of the surface area, has a target harvest at 16,200 lbs (7,300 kg), while Minnesota, with 49% of the area, has a target harvest of 15,600 lbs (7,100 kg). The Minnesota harvest has exceeded the target harvest by 43% (Fig. 25).

b. Northern pike

The northern pike population has declined in recent years, with large fish dominating the size structure. This condition is usually symptomatic of a recruitment problem linked to environmental conditions, and is probably related to low spring water levels which reduce the amount of preferred spawning substrate. The harvest in recent years (Fig. 26) has been 118% of the target level of 19,300 lbs (8,800 kg). The target harvest is 9,800 lbs (4,400 kg) for Ontario, and 9,500 lbs (4,300 kg) for Minnesota. The Ontario harvest has exceeded the target harvest by 11% while the Minnesota

harvest has exceeded the target harvest by 26%.

c. **Other species**

Harvest levels for smallmouth bass and black crappie (Fig. 27) suggest that these species are under utilized. Estimates of annual harvest represent only 54% of the potential and target harvest of 8,900 lbs/yr (4,000 kg/yr) for bass and crappie combined.

The potential annual harvest for whitefish is 12,600 lbs. (5,700 kg) for Namakan Lake (Fig. 28). The existing commercial harvest, based on Ontario's quota and average annual harvest for Minnesota commercial fishermen, is 21,390 lbs (9,700 kg) per year. Based on past harvest, a target harvest of 25,000 lbs (11,400 kg) per year is appropriate. Assessment of whitefish growth rates and mean ages are needed before a refined level of harvest can be established.

There is insufficient knowledge on the population status of lake sturgeon to warrant any increase in commercial exploitation.

SECTION 2
SOCIO-ECONOMIC EVALUATION

I. Lake of the Woods

A. Socio-Economic Infrastructure

1. History of Use

The use of the Lake of the Woods fishery for domestic consumption by local Aboriginal people dates back thousands of years. The non-aboriginal commercial fishery developed during the late 1880s on both U.S. and Canadian sides of the lake. The recreational fishery has become known internationally during the last 50 years.

2. Local Communities and Population

Over 28,000 people live around Lake of the Woods and most have varying degrees of interest in or dependence on the fishery. Three-fourths of the local population reside in Ontario. Residents live in organized municipalities, rural townships, in First Nations communities (Indian Reserves) and in unorganized areas. Seventy-two percent of the Ontario population live in Kenora, Keewatin, Jaffray-Melick, 12% in other organized areas, 9% in unorganized areas and 7% in First Nations communities (Table 1). In Minnesota, 41% of local residents live in municipalities, 28% in unorganized territories, while another 31% of the local population reside in rural townships (Table 2). The population on the Ontario side has remained relatively stable while Minnesota has experienced a 33.3% growth in population within the study area in recent years. The largest expansion has been in Warroad with a more moderate increase in the Baudette area.

3. Economic Base

The economy of the Lake of the Woods area is heavily oriented to forest products,

tourism, fishing, transportation, public and commercial services. The only major industrial employers are Boise-Cascade, Canadian Pacific Railway (Kenora), Canadian National Railway (Rainy River), Solvay Pharmaceuticals (Baudette), Marvin Windows and Christian Brothers Hockey Sticks (Warroad).

In Ontario, commercial and sport fishing on Lake of the Woods make an important contribution to a local economy which is not growing significantly but offers a limited range of employment opportunities for local residents. The fishery is of particular economic and social importance to people who live outside of the larger centres. Employment and income opportunities other than those based on the lake's fishery are often very limited in the small municipalities and in the First Nation communities. The fishery also provides food for people with limited incomes. For many other local residents of Ontario, angling provides a recreational opportunity not readily available in comparable quality in most other localities and makes a significant contribution to the quality of life in the Lake of the Woods area.

In Minnesota, sport fishing (tourism) generates the largest economic return to Lake of the Woods County and is a major contributor to the economy in Roseau County. Sport fishing is presently providing a steadily increasing job base. The fishery provides significant economic and social contributions to the residents that live along the south shore of Lake of the Woods. Angling is the number one recreational activity for residents of this area and contributes to the quality of life.

4. Users of the Fishery

a. Commercial Fishermen

The following two groups are recognized under this category:

i) **Aboriginal Fishermen:** includes Treaty Indians living in Ontario on reserves who fish for commercial and domestic purposes under the authority of a commercial

Table 1. Ontario population in the Lake of the Woods study area.

Organized Municipalities (1986 Census)	Population
Kenora, Keewatin, Jaffray & Melick	15,265
Sioux Narrows	373
Nestor Falls	200
Morson	209
Rainy River	941
Atwood Twp.	293
McCrosson and Tovell Twp.	222
Sub Total	17,503
First Nation Communities (1986 Census - on reserve residents)	
Big Grassy	134
Big Island	63
Northwest Angle 33	77
Northwest Angle 37	63
Rat Portage	115
Sabaskong	253
Shoal Lake 39	247
Shoal Lake 40	138
Washagamis Bay	78
Whitefish Bay	177
Sub Total	1,569
Unorganized Areas (1986 Census) (approx.)	1,800
Total	20,872

Table 2. Minnesota population in the Lake of the Woods study area. Data are from the 1990 U.S. census.

Lake of the Woods and Roseau Counties	Population
Municipalities	
Baudette	1,150
Roosevelt	152
Warroad	1,981
Williams	236
Sub Total	3,519
Rural Townships	
Lake	1,511
Loana	330
Moranville	551
Sub Total	2,391
Unorganized Territories	
Northwest Angle	71
Rainy River	2,616
Sub Total	2,687
Total	8,598

fishing license.

ii) **Non-Aboriginal Fishermen:** all other commercial fishermen.

b. **Anglers**

The following groups are included within this category:

i) **Resident (local) Anglers:** Minnesota and Ontario residents living in the immediate study area and fishing in their own jurisdiction. (All Ontario resident anglers are considered locals).

ii) **Resident (non-local) Anglers:** Minnesota residents from outside the study area fishing in their own jurisdiction.

iii) **Non-Resident/Non-Local Resort Guests:** anglers using local commercial tourist accommodation operations including lodges, campgrounds and houseboats.

iv) **Non-Resident Property Owners:** anglers based at cottages owned by non-residents of the local area.

v) **Non-Resident (Non-Local) Campers:** includes Lake of the Woods anglers who live outside the jurisdiction being fished and who camp on public or Crown land, including the two Ontario Provincial Parks (Lake of the Woods and Sioux Narrows Parks).

vi) **Manitoba-Based Anglers:** includes fishermen, primarily residents of Manitoba, based in Manitoba and fishing in Ontario or Minnesota waters on a day-use basis.

vii) **Minnesota-Based Anglers:** includes fishermen based in Minnesota and fishing in Ontario waters on a day-use basis.

5. User Profiles

a. Commercial Fishermen

i) Aboriginal Commercial Fishermen

Table 3. Tourism accommodation by sector for Ontario and Minnesota resorts, Lake of the Woods.

Sector	Total No of Operations	Total guest capacity	Average Season Occupancy
(1) North	13	1,384 (168 campsites)* 8 houseboats	50% (1987)
(2) Central	13	852 (52 campsites)* 10 houseboats	56% (1987)
(3) Whitefish Bay	21	1,599 (114 campsites)* 11 houseboats	50% (1987)
(4) Sabaskong Bay	27	2,229 (170 campsites)* 15 houseboats	60% (1988)
(5) South Sector	11	709 (49 campsites)* 8 houseboats	63% (1988)
(6) South Sector	8	232 (3 campsites)*	50% (1988)
Minnesota	39	3,214 (112 campsites) 8 houseboats	65% (1989) year round
TOTAL	132	10,219	

* Maximum capacity of 6 guests per campsite (R. Paterick MNR Kenora, pers. comm.)

The Aboriginal commercial fishery in Ontario has grown substantially in the last 40 years. All bands on Lake of the Woods fish commercially, with the exception of Washagamis Bay. Most of the Aboriginal fisheries are recognized as band fisheries. Licenses are usually fished by many families with a full range of age and experience. Aboriginal commercial fisheries currently operate on 16 of the 33 active commercial fishing lots on Lake of the Woods, Ontario: 2 in the Regina - Long Bay area of the Central Sector; 1 in the North Sector; 11 on the South Sectors; and 2 on Shoal Lake.

While most effort is expended on fishing for commercial sale, rather than for domestic purposes, fishing for personal consumption also occurs through a commercial fishing license. Fishing for sustenance has a traditional significance in the social organization for Aboriginal people which is still valid today.

The economic value of the domestic harvest has been included along with commercial fishing, while harvest data from this source has been reported as part of the resident fishery.

ii) Non-Aboriginal Commercial Fishermen

Of the 33 commercial fishing lots on the Ontario portion of Lake of the Woods, 17 are licensed to non-Aboriginal commercial operators: 4 in the Central Sector; 2 in the North Sector; and 11 in the South Sector. Shoal Lake has no non-Aboriginal commercial fisheries left. Most non-Aboriginal fishing operations are carried out by an individual or family group, with assistance from friends, relatives or from hired fishermen. Fishing activity which was mainly concentrated in the fall and to a lesser extent in May/June in the past, also occurs during the winter in many fisheries. Fishermen receive premium prices for their catch during this season. Most commercial fishing in Ontario waters is done by gill netting.

In Minnesota, three commercial fishing operations are licenced to fish Lake of the Woods. Since commercial harvest of game fish was eliminated in Minnesota waters

of the lake in 1986, commercial activity is currently centred around a winter burbot fishery with pound and trap nets.

b. Anglers

i) Resident Anglers

Angling is a very important recreational activity for local residents. In about three-quarters of local households in Ontario, at least one person fishes on Lake of the Woods once or more per year (Hough et al. 1982).

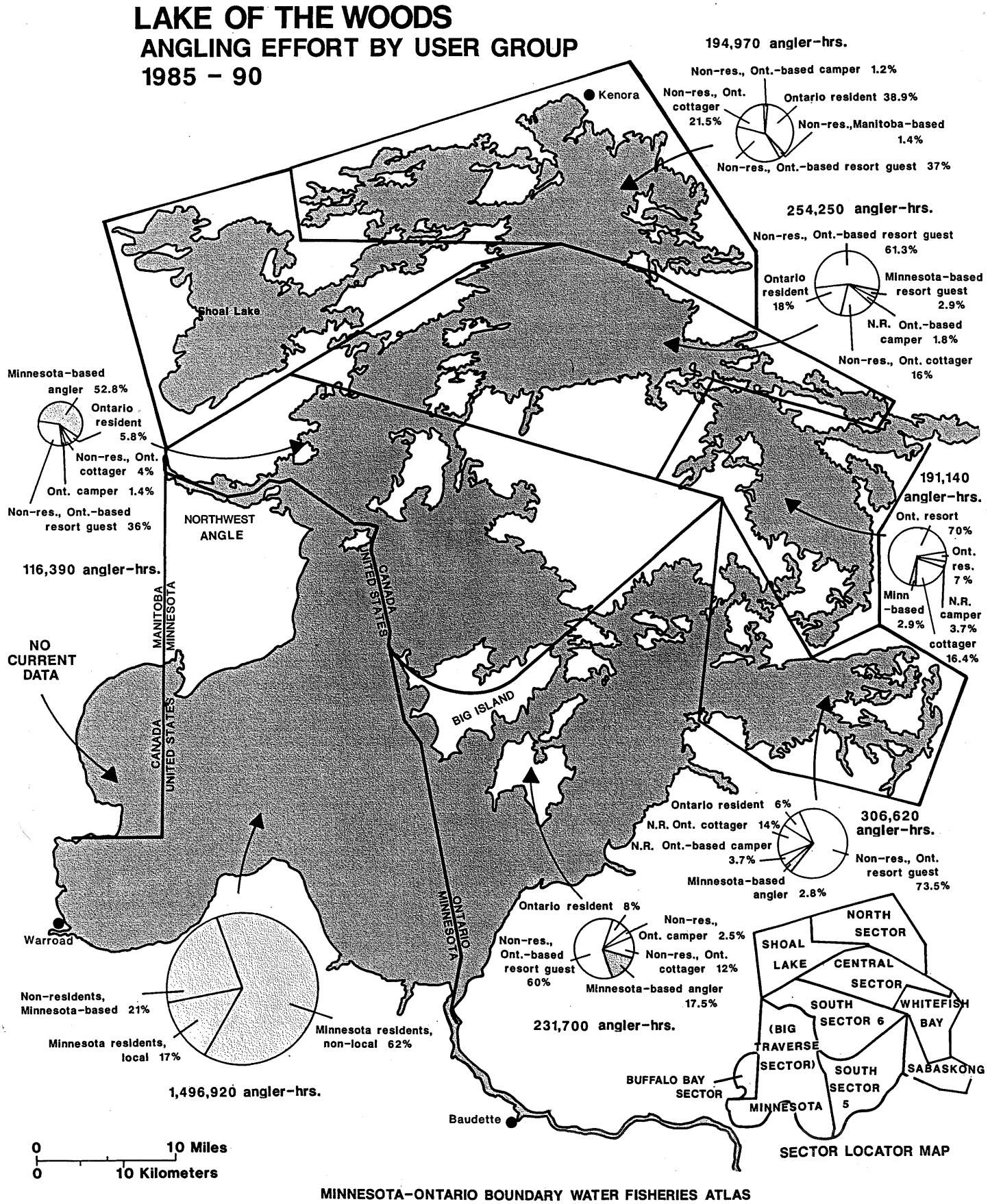
The North Sector which is closest to the Kenora-Keewatin population centre is the most heavily fished area by local Ontario residents (i.e. 39% of total effort for this sector; Fig. 29). The Central Sector is the second most frequently fished area on Lake of the Woods by this group (i.e. 18% of total). Comparatively little local angling activity occurs on the South Sector (8%), Whitefish (6.8%) and Sabaskong Bays (6.0%) by residents of Ontario.

Local residents of Lake of the Woods in Minnesota account for approximately 17% of the total recreational fishery in Minnesota waters during the open water season. Non-local Minnesota residents were responsible for 62% of this activity (Fig. 29).

ii) Non-Resident/Non-Local Resort Guests

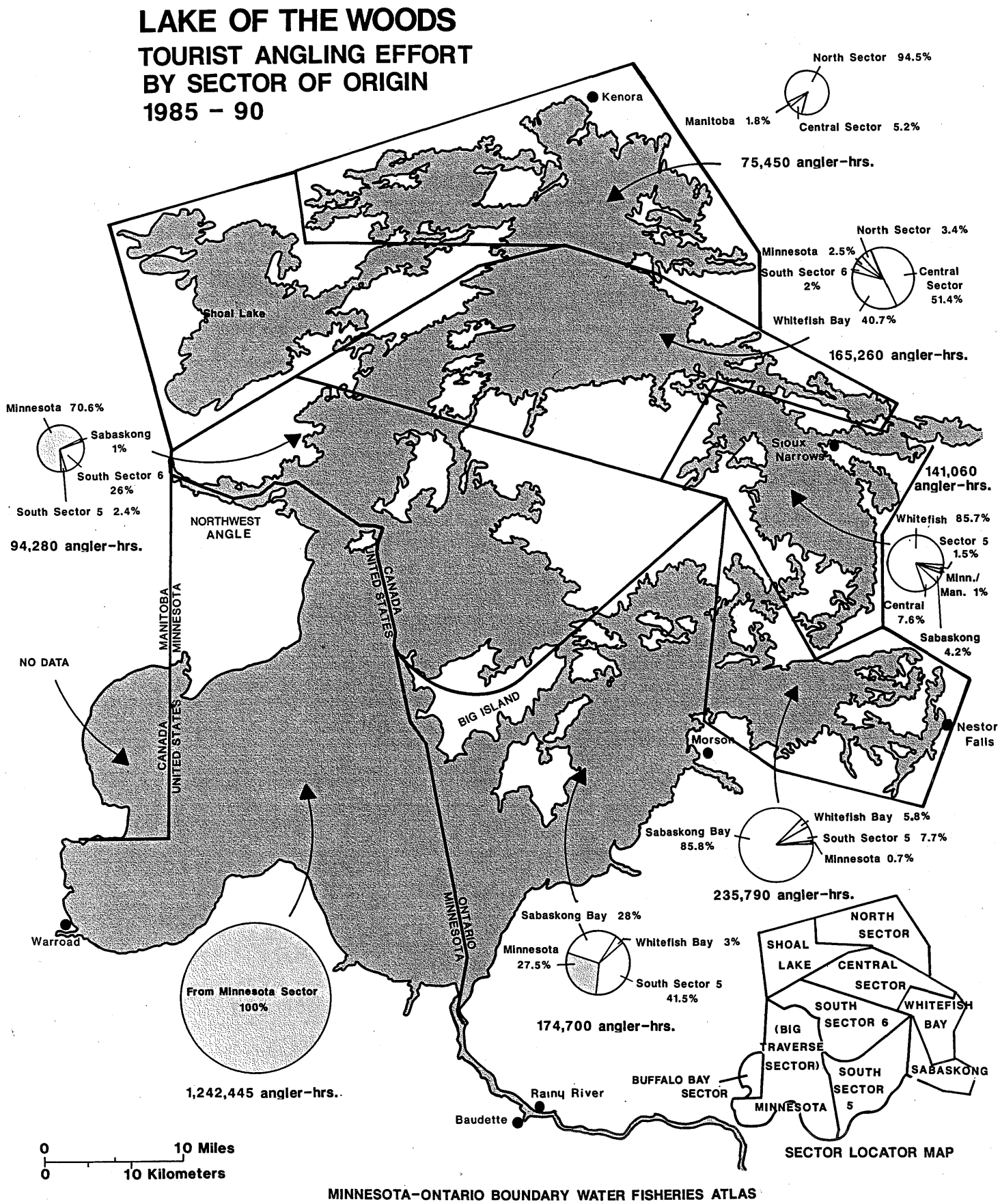
Within the immediate study area are 132 tourist operations, 39 of which are in Minnesota (Table 3). Estimates of occupancy rates for these establishments range from 45% - 63% (seasonal) in Ontario and 65% (year-round) in Minnesota.

There are 93 tourist accommodation operations in Ontario, dependent on fishing Lake of the Woods. These operations obtain more than 25% of their gross revenue from angling activity on the lake and include main base, outpost camp, campground and houseboat accommodations. Approximately 80% of all guests are anglers who fish primarily on Lake of the Woods. About 90% of these are from the United



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 29



MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 30

States, especially the mid-West. Most of the rest are from Manitoba, other parts of Ontario, or other countries (e.g. Germany).

American visitors are more predominant in the southern and eastern parts of the lake while Canadian non-residents of Ontario (e.g. Manitoba) tend to stay in the northern sectors and Whitefish Bay.

The North Sector tourist fishery receives most of its use (94.5%) from guests staying at resorts within this area or located nearby, off of the lake (Fig. 30). Anglers from resorts in the Central Sector and from Manitoba bases of operation accounted for 5.2% and 1.8% of non-resident anglers in this area during recent creel surveys (1985-88).

The Central sector tourist fishery receives 51.4% of its use from tourist guests based within the Central Sector itself, 40.7% from Whitefish Bay, 3.4% from the North, 2.0% from South Sector 6, and 2.5% from Minnesota (Fig. 30).

Over 85% of tourist anglers fishing in Whitefish and Sabaskong bays are based in each of these respective sectors (Fig. 30). Non-residents angling in Whitefish Bay were also based at resorts in the Central Sector (7.6%), Sabaskong Bay (4.2%) and South Sector 5 (1.5%). A few anglers in this sector (1.0%) also used U.S. and Manitoba bases of operation during the open water season. Non-resident anglers fishing in Sabaskong Bay also stayed at resorts in Whitefish Bay (5.8%), South Sector 5 (7.7%) and the U.S. (<1.0%).

The southern portion of Lake of the Woods, Ontario, has been divided into two sectors, Sector 5 and Sector 6, for fisheries assessment purposes. Tourist-guest composition within these sectors differs significantly (Fig. 30). The largest group of tourist anglers in Sector 5 are based at resorts in this sector (41.5%), followed by tourist anglers based in Sector 4 (Sabaskong Bay 28%), Minnesota (27.5%) and

Whitefish Bay (3.0%). The majority of tourist anglers who fish in South Sector 6 are based at Minnesota resorts (70.6%) while the remainder stay at tourist operations in Sector 6 itself (26%) and other nearby sectors.

The Minnesota portion of the lake receives all of its use from anglers based at operations within the state.

The Manitoba-Buffalo Bay portion of the lake receives the majority of its use from Minnesota-based anglers out of Warroad. Since the recent contruction of a marina/resort in Manitoba, sport fishing by Manitoba-based anglers in this area has increased.

iii) **Non-Resident Property Owners**

Cottage-based angling is an important component of the recreational fishery on Lake of the Woods. Of the estimated 6,000 cottage lots on Lake of the Woods in Ontario, some 1,200 are owned by local residents, 2,100 are owned by residents of the United States and remaining 2,700 are owned by residents of Manitoba. Manitobans account for the majority of non-resident property owners, especially on Shoal Lake and the North Sector. A total of 327 cottages are located on Lake of the Woods in Minnesota.

The majority (91%) of local cottagers fish at least once a year in Ontario; the same is true in Minnesota. Non-resident property owners accounted for 22.5% of the total angling effort in the North Sector, 16% in the Central, 17% in Whitefish Bay, 14% in Sabaskong, and approximately 12% and 4% of the total angling effort in South Sectors 5 and 6, respectively during recent creel surveys (Fig. 29).

iv) **Non-resident Campers**

Currently, about 2% of the total angling effort in the Central Sector is attributable to non-resident campers based in Ontario. This group also accounts for 4% of the

effort in Whitefish Bay, 3.7% of the effort in Sabaskong Bay and approximately 2.4% and 1.5% of the effort in the South Sectors 5 and 6 (Fig. 29).

v) **Manitoba-Based Anglers**

Although a trend to increased use of Kenora district waters by Manitoba-based anglers has been noted, this group was present only in the North Sector and Whitefish Bay fisheries during recent surveys, representing less than 2% of total angling activity in these areas.

(vi) **Minnesota-Based Boater Anglers**

The use of Ontario's portion of Lake of the Woods by U.S.-based charter boats, houseboats and smaller boats owned by both local area residents and tourist resort guests is an important component of the recreational fishery. The relative use of Minnesota and Manitoba waters by Ontario residents is small.

Minnesota-based anglers accounted for a substantial portion of total angling effort in the South sectors, representing 17.5% and 52.7% of total effort in Sectors 5 and 6, respectively. Angling in Ontario waters from Minnesota bases of accommodation accounted for 2.9% of the total angling effort in the Central sector during recent surveys (1985-88). Minnesota-based angling effort in Whitefish and Sabaskong Bays was minimal, representing less than 3% of total effort within these sectors during open water surveys (Fig. 29).

B. Estimate of Socio-Economic Benefits

1. Economic Analysis

The measure of revenue in this analysis was restricted to "gross operation revenue" which refers to the total revenues accruing to operations before any costs are considered. Estimates of revenues are limited to direct revenues and no attempt was

made to reflect secondary activity or multipliers. All economic data were estimated on an annual basis and standardized to 1990 Canadian dollars where possible.

Approximately 54.3 million dollars in gross operation revenues are generated annually by the Lake of the Woods fishery. This fishery produced about $21.4 million in gross operation revenues in the local area of Ontario and $32.9 million in Minnesota. Angling by non-resident Ontario resort guests accounts for some 86% of the gross economic return from the Lake of the Woods fishery in Ontario, commercial fishing 5% and other uses 9%. In Minnesota, the recreational fishery generates almost all of the economic return.

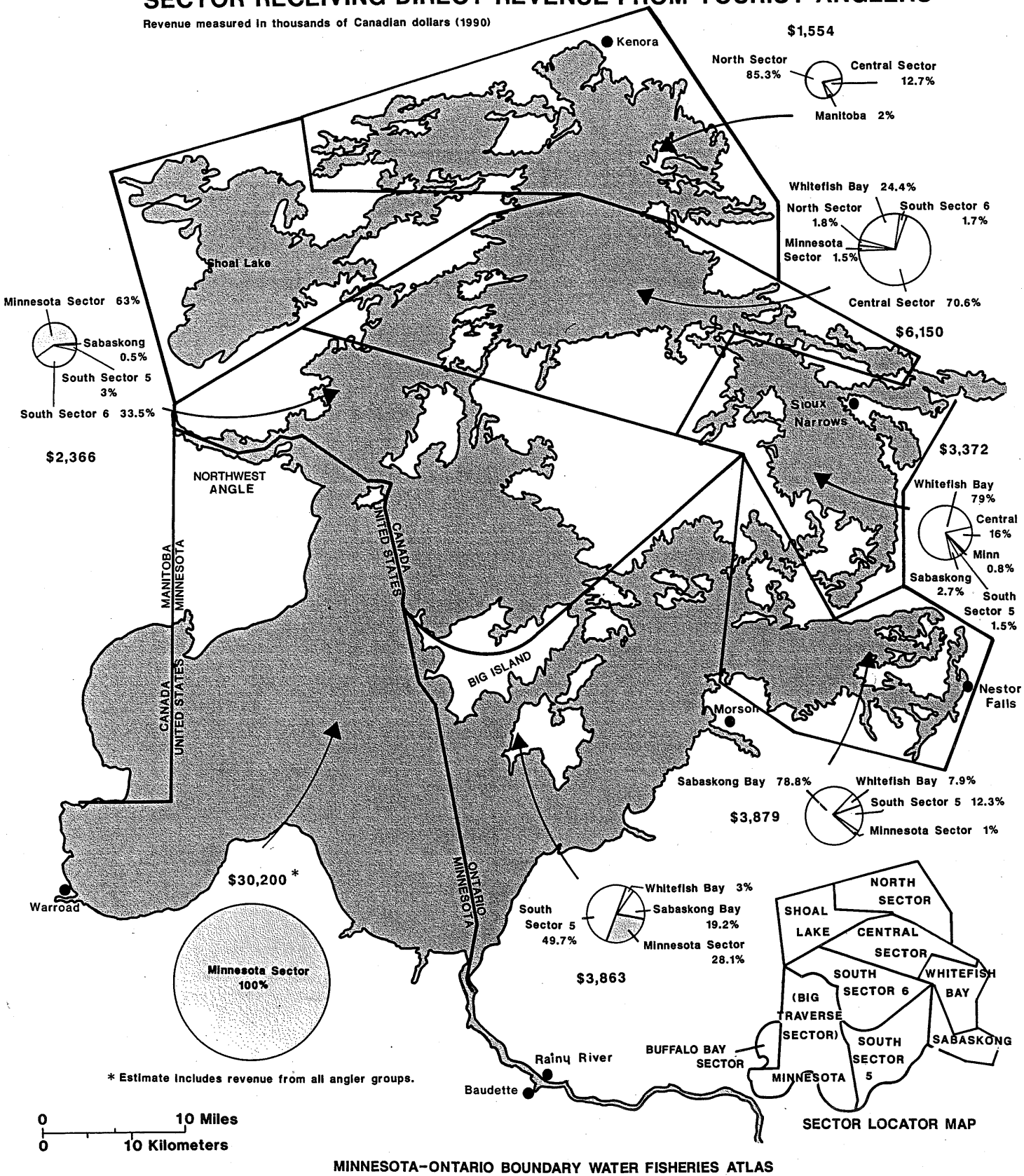
The 1990 Lake of the Woods commercial fish harvest in Ontario had an estimated dockside value of $857,220 based on 1990 quotas for walleye, northern pike, crappie, whitefish and sturgeon, and reported catches of non-quota species (e.g. sauger, yellow perch, etc.) in 1990 (Table 4). In addition, the fish taken by Aboriginal people under commercial fish licenses for domestic use is estimated to have a value of $140,585. The South sector commercial fishery accounted for almost 79% of the total value of the Ontario Lake of the Woods commercial fishery. The North, Central and Shoal Lake fisheries accounted for the remaining 21% of the estimated value in 1990. Commercial fishing in Minnesota waters generate a gross revenue of $16,000/yr.

The non-resident resort guest fishery on the Ontario portion of Lake of the Woods generated an estimated $21.184 million in 1990. Ontario receives 98% of the economic benefits from tourist angling in the North and Central sectors, and almost all of the economic benefits from tourists angling in the Shoal Lake, Whitefish and Sabaskong Bays (Fig. 31). Ontario receives 72% of the economic benefits from tourist angling in South Sector 5 but only 37% of the economic benefits from the tourist angling fishery in South Sector 6. Minnesota received 28% and 63% of the economic benefits from tourist angling in South Sector 5 and 6 (Fig. 31). It is estimated that Minnesota receives virtually all benefits from tourist angling in

LAKE OF THE WOODS

SECTOR RECEIVING DIRECT REVENUE FROM TOURIST ANGLERS

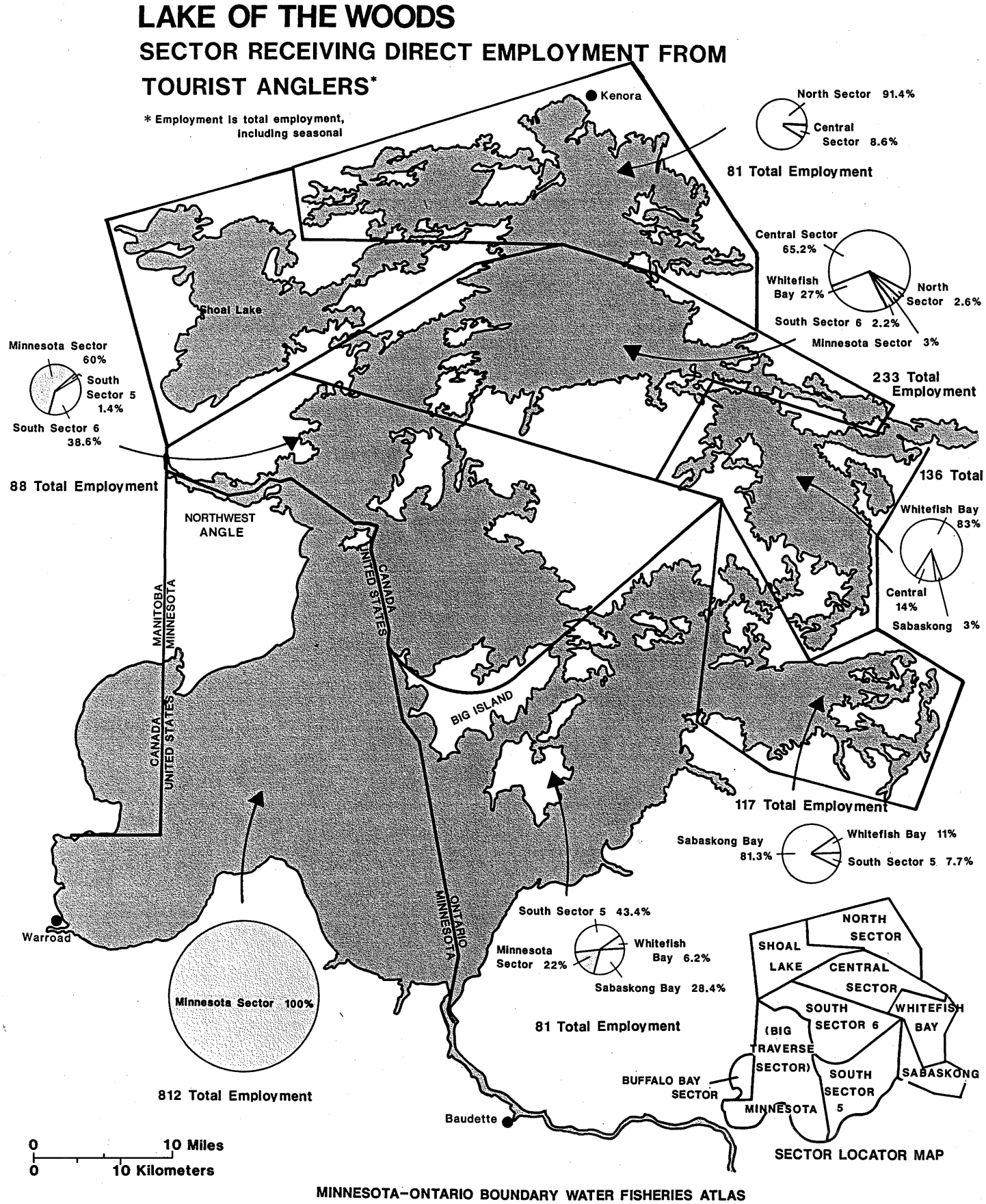
Revenue measured in thousands of Canadian dollars (1990)



* Estimate includes revenue from all angler groups.

MINNESOTA–ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 31



MINNESOTA–ONTARIO BOUNDARY WATER FISHERIES ATLAS

FIGURE 32

Table 4. Gross operation revenues generated locally by user group from the Lake of the Woods fishery (in thousands of 1990 Canadian dollars).

User Group	Jurisdiction		
	Ontario	Minnesota	Combined
1. Commercial Fishermen	$ 998(a)	$ 16	$ 1,014
2. Local Anglers	$ 961(b)		$ 961
3. Non-Resident Resort Guests: tourist accommodation operations	$ 18,412(c)	$32,941(d)	$51,353
4. Non-Resident Campers	$ 141(b)		$ 141
5. Non-Resident Property Owners	$ 867(b)		$ 867
TOTAL	$ 21,379	$32,957	$ 54,3363

(a) value based on 1990 quotas and reported catch; includes Aboriginal domestic harvest valued at $140,585.

(b) estimates based on 1983 figures, inflated to 1990 value based on average 1990 Consumer Price Index (CPI) for Ontario and 1985-88 creel surveys.

(c) estimates based on 1987/88 data (Ministry of Tourism and Recreation), inflated to 1990 value based on average 1990 CPI for Ontario (Statistics Canada).

(d) estimate includes revenues from all other angler groups.

Table 5. Local residents receiving employment directly from the Lake of the Woods fishery, 1989.

User Group	Ontario	Minnesota
Commercial fishermen	88	7
Tourist accommodation operations	658	890

Minnesota waters.

No attempt to identify direct economic returns by sector for the remaining users of the fishery in Ontario or Minnesota has been made, due to the lack of accurate data for these uses.

2. Social Analysis

Social benefits are difficult to translate into dollars but are, nonetheless, important to local community welfare. They include the number and type of jobs created, along with recreational opportunities provided by the Lake of the Woods fishery.

The fishery creates over 746 jobs directly in the local Ontario area; however, many are seasonal. Often people employed in a fisheries-related job have another line of employment elsewhere. Job opportunities for Aboriginal people from the Ontario fishery are most important, especially in terms of commercial fishing and guiding. A total of 88 people are involved in commercial fishing in Ontario waters; 55 are Aboriginal. Similarly, in addition to the 658 people employed in Ontario tourist accommodation operations, there are approximately 160 Aboriginal people who guide fishing parties to some extent during the season.

In Minnesota, seven people are employed seasonally in the commercial fishery while 890 are employed at tourist accommodation operations. Jobs at the tourist operations have become less seasonal and more permanent with the expansion of the winter fishery (Table 5).

Ontario receives almost all of the employment benefits from tourist angling in the North Sector, Whitefish and Sabaskong Bays; 97% of benefits from tourist angling in the Central Sector; 78% and 40% of the employment benefits from tourist angling in South Sectors 5 and 6 (Fig. 32).

Minnesota recovered essentially 100% of the employment benefits from tourist fishing in Minnesota waters. Minnesota also received 22% and over 60% of employment benefits from tourist angling in the Ontario South Sectors 5 and 6 (Fig. 32).

3. Future Demands on the Fishery

a. Commercial Fishing

The long-term trend in the Ontario commercial fishery on Lake of the Woods has been towards fewer fishermen and reduced harvests of important sport species. Although recent buy-outs of commercial fisheries by the Ontario government have reduced commercial harvests of walleye and northern pike, harvests of other species such as whitefish, yellow perch and sauger have increased with the development of new markets and changes in fishing practices e.g. smaller mesh gill nets for sauger, yellow perch. The long-term need to accommodate employment and domestic needs of Aboriginal communities remains a high priority in the management of this fishery.

On the Minnesota portion of the lake, commercial fishing for game fish was phased out by 1986. A small fishery will continue to harvest burbot and white suckers.

b. Angling

A 20% increase in angler demand in Ontario waters is anticipated by the year 2000, based on traditional growth of non-resident sports fishing in northwestern Ontario. Present occupancy rates and total number of tourist guest days within the commercial tourist sector on the Ontario side of the lake have remained stable within recent years. Future growth of tourist clientele will depend heavily on the ability of the tourism industry to provide a high quality experience, not only in terms of number and size of fish caught, but also in the type and quality of services/accommodation

offered. Recent studies have indicated that most people are going to tourist accommodations for the prime purpose of relaxation, although the quality of the Lake of the Woods fishery remains the primary tourism attraction in this area.
The Ontario resident population will remain stable, since no major population changes are anticipated locally. The use of the fishery by non-resident property owners will increase proportionally to cottage growth. Substantial growth within this area in Ontario waters is anticipated. Although Crown (public) land is no longer being made available, the many First Nations communities on the lake have good properties for cottage development. At least three First Nations communities to date have actively pursued this possibility.

The sport fishery in Minnesota is expected to increase moderately. The largest increase will probably be in the winter ice fishery. This fishery has expanded considerably in the last 10 years. The 1989-90 winter fishing pressure estimate exceeded the summer pressure estimate for the first time. The total fishery is likely to increase by 10 - 15 percent in the next 10 years. Lake of the Woods will retain its status as one of the premier walleye/sauger lakes in North America.

II. Rainy Lake

A. Socio-Economic Infrastructure

1. History of Use

The Rainy Lake area has long been known for excellent fish and game populations. Accounts of early exploration reference an extensive subsistence fishery by Aboriginals in this area. As early as the 1890s, sportsmen and tourists began to make use of the Rainy Lake sport fishery. Most commercial tourist establishments were built during the period from 1930 to 1960.

Commercial fishing for lake sturgeon and whitefish on Rainy Lake and the Rainy River was an important source of income for local residents by 1890. Rainy Lake had 62 licensed commercial fishermen that operated in 25 designated fishing areas or lots in 1916. The level of commercial fishing activity on this lake has declined substantially since the early years of this century.

2. Local Communities and Population

There are approximately 29,500 people living year-round in the immediate area of Rainy Lake and the upper Rainy River, split evenly between Ontario and Minnesota (Table 6). Sixty-five percent of the population in Minnesota live in municipalities, with the balance residing in unorganized territories.

Municipalities account for 77% of the total population on the Ontario side. Fort Frances alone contains 58% of the people living in this area. The population density on both sides of the border has been relatively stable and no major changes are anticipated in the near future.

Table 6. Ontario-Minnesota population in the Rainy Lake area.

Ontario		
Organized Municipalities (1986)		Population
Fort Frances		8,589
Emo		1,127
Alberton		795
La Vallee Twp		993
	Sub Total	11,504
Indian Reserves (1989)		
Couchiching (16A)		425
Naicatchewenin (17A)		164
Nicickousemenecaning (26A)		101
Seine River (23A)		245
Stanjikoming (18C)		51
	Sub Total	986
Unorganized Townships (1986)		
Dance		55
Halkirk (seasonal)		182
Miscampbell		125
Watten (seasonal)		2,007
	Sub Total	2,369
	Ontario Total	**14,859**
Minnesota		
Municipalities (1990)		
International Falls		8,329
Island View		150
Littlefork		836
Ranier		193
	Sub Total	9,508
Unorganized Territories (1990)		
Northwest Koochiching		545
Northwest St. Louis		487
Rainy Lake		4088
	Sub Total	5,120
	Minnesota Total	**14,628**
Combined Ontario and Minnesota Total		29,487

Table 7. Private tourism accommodation on Ontario and Minnesota sides of Rainy Lake. (Ontario data 1989; Minnesota data 1990). All values are represented as numbers.

	Ontario	Minnesota	Total
Operations	22	24	46
Units	102	696	798
Campsites	96	137	233
Houseboats	8	44	52
Summer Guest Capacity	1,267	2,796[1]	4,063[1]
Summer Occupancy	62%	71%	

[1] 13 of the 24 Minnesota operations are open during winter, generating an additional guest capacity of 1,636 with an average occupancy of 47%. No operations in Ontario are open during this same winter period.

3. Economy

The local economy of the Rainy Lake area is heavily dependent on forestry, agriculture and tourism which provide the majority of job opportunities. The largest industrial employer is Boise-Cascade in both Ontario and Minnesota.

Tourism generates a significant number of jobs in the private sector. Tourism based on the Rainy Lake fishery is responsible for 250 full or part time jobs and 24 tourist establishments on the Minnesota side, and another 58 jobs and 22 tourist operations on the Ontario side of the lake (Table 7).

4. Fishery User Profiles

a. Aboriginal

The domestic harvest of fish is an important food source, as well as a long standing tradition, for Aboriginal people living in five First Nation communities in Ontario around Rainy Lake. This harvest, estimated at 46,000 lbs (20,900 kg) annually, is primarily comprised of walleye (30%), northern pike (30%) and whitefish (30%) while bass and crappie make up the remaining 4,400 lbs (2,000 kg).

b. Commercial Fishermen

Presently there are five commercial fishing operations on eight commercial fishing lots in Ontario waters of Rainy Lake. Walleye, northern pike, whitefish and recently black crappie are the mainstay of the commercial fishery since the 1920s and are now under quota management. Fish are harvested in Ontario with gill nets and trap nets. The commercial harvest of walleye was reduced by 86% from 1986 to 1991 through government buy-outs.

Commercial sport fish harvest on the Minnesota side was gradually reduced by gear restrictions and then eliminated with a legislated buy-out in 1985. There remains one

commercial fishing operation which uses gill nets to harvest 37,700 lbs (17,100 kg) of whitefish on the Minnesota side, south of Brule Narrows.

c. **Resident Anglers**

Ontario residents fish all Ontario sectors of Rainy Lake (Fig. 33). Proportionately, the Ontario resident component of the fishery is highest in Redgut Bay (14%), followed by the North Arm (11%) and the South Arm (e.g. 8% of total angling effort). Ontario residents were responsible for approximately 13% of the total annual sport fish harvest from the Ontario portion of Rainy Lake during 1982-86.

Past estimates indicate that approximately one-half of angling effort on the Minnesota side of Rainy Lake can be attributed to local residents of Minnesota.

d. **Non-Resident/Non-Local Resort Guests**

There are 46 main base tourist accommodation operations on Rainy Lake; 22 in Ontario and 24 in Minnesota (Table 7). Eleven of these operations are on the North Arm, eight on Redgut Bay, three on the Ontario South Arm and 24 on the Minnesota portion of the South Arm. Estimates of occupancy rates range from 62% for Ontario resorts to 71% for Minnesota South Arm operations. Thirteen Minnesota establishments operate during the winter with an occupancy rate of 47% while no Ontario operations are open during this season.

Sixty-eight percent of tourist anglers on the North Arm were resort guests from the North Arm while nine percent originated from Minnesota resorts during 1982-86 (Fig. 34). Thirty-six percent of the Redgut Bay tourist fishery was utilized by guests staying on Redgut Bay while 20% were from Minnesota commercial establishments. Eight percent of the Ontario South Arm tourist fishery were guests at an Ontario South Arm resort while 52% were from a Minnesota commercial base of operations (Fig. 34).

The Minnesota South Arm tourist fishery was entirely composed of angler guests

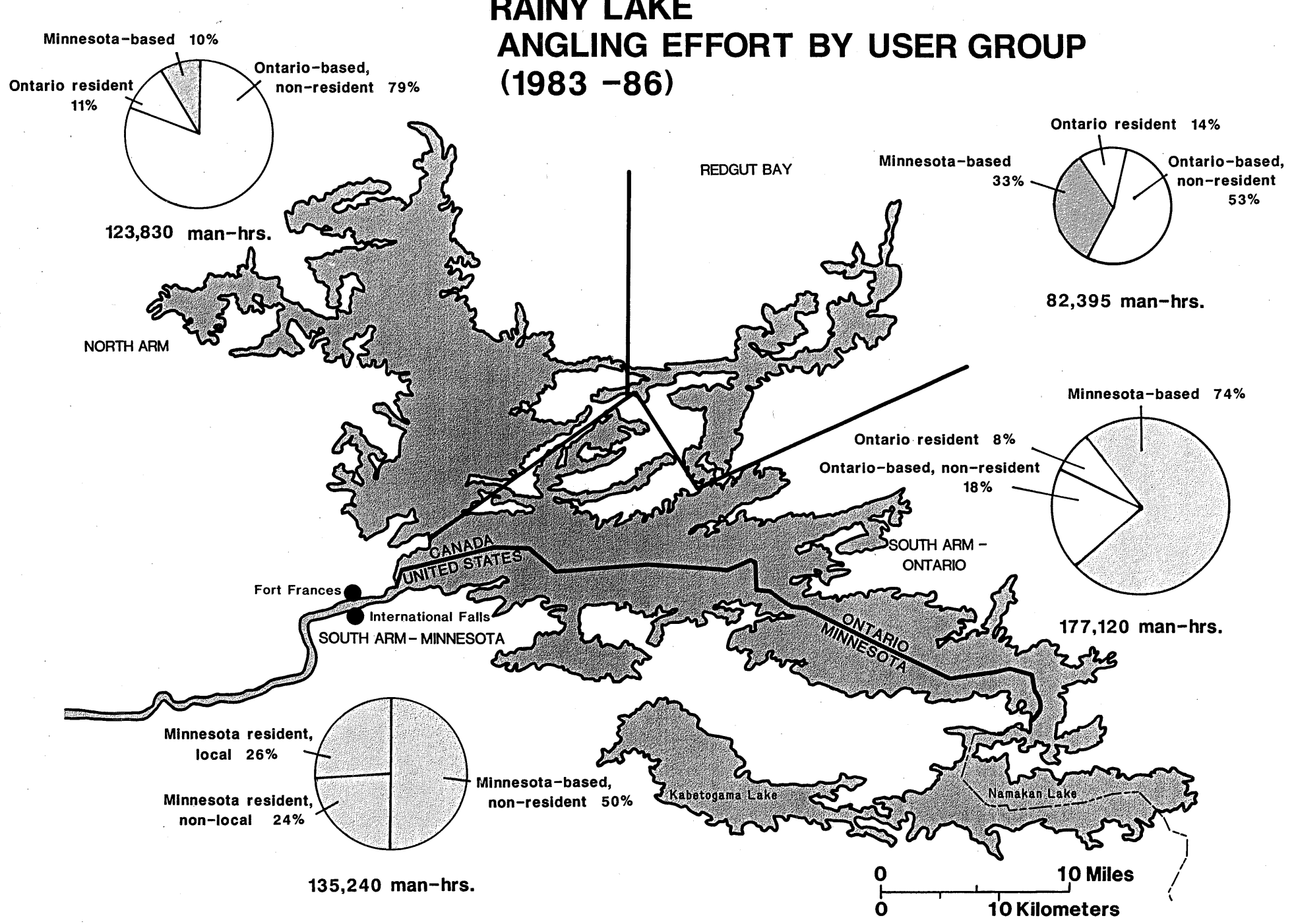
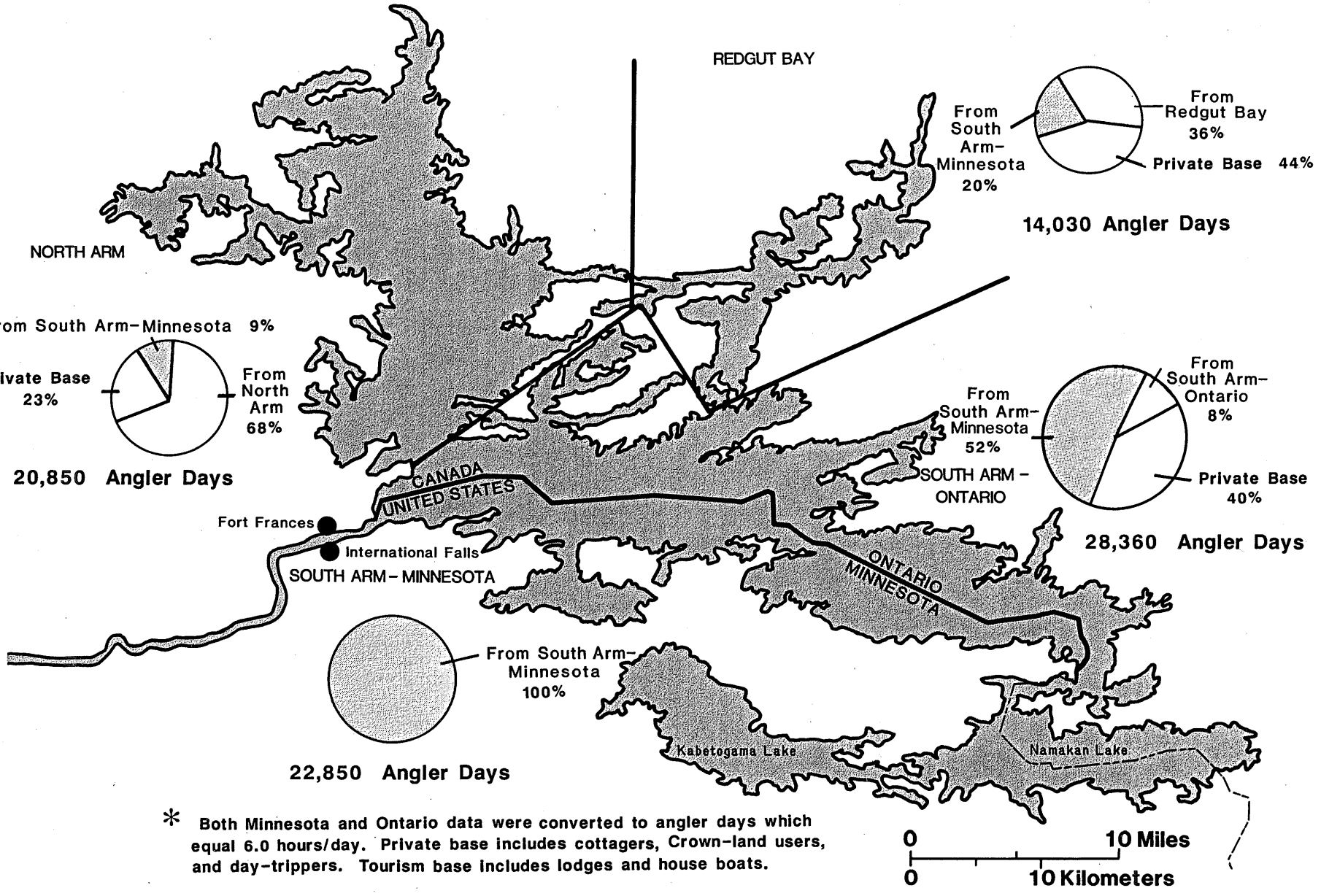

RAINY LAKE
ANGLING EFFORT BY USER GROUP
(1983 -86)
Minnesota-based 10%
Ontario resident 11%
Ontario-based, non-resident 79%
123,830 man-hrs.
REDGUT BAY
NORTH ARM
Ontario resident 14%
Minnesota-based 33%
Ontario-based, non-resident 53%
82,395 man-hrs.
Minnesota-based 74%
Ontario resident 8%
Ontario-based, non-resident 18%
177,120 man-hrs.
CANADA
UNITED STATES
SOUTH ARM - ONTARIO
Fort Frances
International Falls
SOUTH ARM - MINNESOTA
ONTARIO
MINNESOTA
Minnesota resident, local 26%
Minnesota resident, non-local 24%
Minnesota-based, non-resident 50%
135,240 man-hrs.
Kabetogama Lake
Namakan Lake
0 10 Miles
0 10 Kilometers

FIGURE 33

RAINY LAKE
ANGLER DAYS* BY SECTOR OF ORIGIN



* Both Minnesota and Ontario data were converted to angler days which equal 6.0 hours/day. Private base includes cottagers, Crown-land users, and day-trippers. Tourism base includes lodges and house boats.

FIGURE 34

staying in Minnesota.

e. **Non-Resident Property Owners**

This group comprised, on average, 13% of the fishery use on the Ontario portion of Rainy Lake during 1982-86.

f. **Minnesota-Based Anglers**

Creel surveys conducted by the Ontario MNR from 1983-86 indicated that 49% of the anglers using Ontario's portion of Rainy Lake were non-residents based in Minnesota. This group comprised 10% of the North Arm fishery, 33% of the Redgut Bay fishery and 74% of Ontario's South Arm fishery (Fig. 33). Sport fish harvest by Minnesota-based anglers comprised 55% of the total annual catch for this period.

B. Estimate of Socio-Economic Benefits

1. Economic Analysis

All economic data were estimated on an annual basis and standardized to 1990 Canadian dollars where possible.

The Rainy Lake fishery generated approximately $6.7 million (Canadian $) in gross revenues in the local area; $1.35 million in Ontario and $5.35 million in Minnesota (Table 8).

Commercial fish production from Rainy Lake has varied from an average of 375,000 lbs (170,450 kg) in 1957-61 to an annual average of 168,000 lbs (76,400 kg) for the period 1974-78. The 1989 Ontario commercial harvest from Rainy Lake had an estimated dockside value of $109,400, based on a total quota of 119,800 lbs (54,500 kg) of walleye, northern pike, crappie, whitefish and sturgeon. Minnesota commercial harvest from Rainy Lake generated gross revenues of approximately

Table 8. Gross revenues generated by the tourist and commercial fishing industries on Rainy Lake. All values are given in thousands of Canadian dollars (1990). All Ontario-Minnesota commercial fishing data are from 1989 and Minnesota tourism data are from 1990.

	Ontario[1] [2]	Minnesota	Total
Commercial Fishing	109	20	129
Tourist Industry	1,241	5,330	6,571
Total	1,350	5,350	6,700

[1] U.S.$ X 1.17647 = Canadian $ (1990).

[2] Does not include Aboriginal domestic (subsistence) use value.

$20,000 in 1989. Whitefish accounted for all commercial fishing gross revenues in Minnesota.

The tourist accommodation industry is comprised of 46 operations that derive a large proportion of their revenue from the Rainy Lake sport fishery (Table 7). The total gross tourism income which can be tied to angling on Rainy Lake is estimated at $6.57 million annually; $1.24 million in gross revenues in Ontario and $5.33 million in Minnesota (Fig. 35).

2. Social Analysis

The Rainy Lake fishery generates a substantial number of jobs in the private sector within the local area. Two hundred and fifty full or part time jobs in Minnesota and 58 in Ontario were dependent on sport fishing on Rainy Lake in 1989 (Fig. 36). The commercial fishing industry employed eight persons in Ontario and one in Minnesota.

3. Future Demands on the Fishery

a. Commercial Fishing

The number of licensed fishermen and the amount of fish harvested on the Ontario side of Rainy Lake have been on a steady decline over the years. The Ontario MNR has been actively purchasing quotas and/or licences since 1986 on a "willing seller" basis. Commercial quotas for walleye have been reduced by 86%, northern pike by 69%, crappie by 62%, lake whitefish by 36% and sturgeon by 67% through this program within the last five years (1991). The management intent in Ontario is to reduce the commercial walleye quota to zero while maintaining a commercial fishing industry which is based primarily on northern pike, crappie and whitefish. No changes are anticipated, with regard to commercial fishing on the Minnesota side.

It is expected that domestic consumption by Aboriginal people will increase, as their population increases, in the foreseeable future. However, the amount of increase is not known at this time.

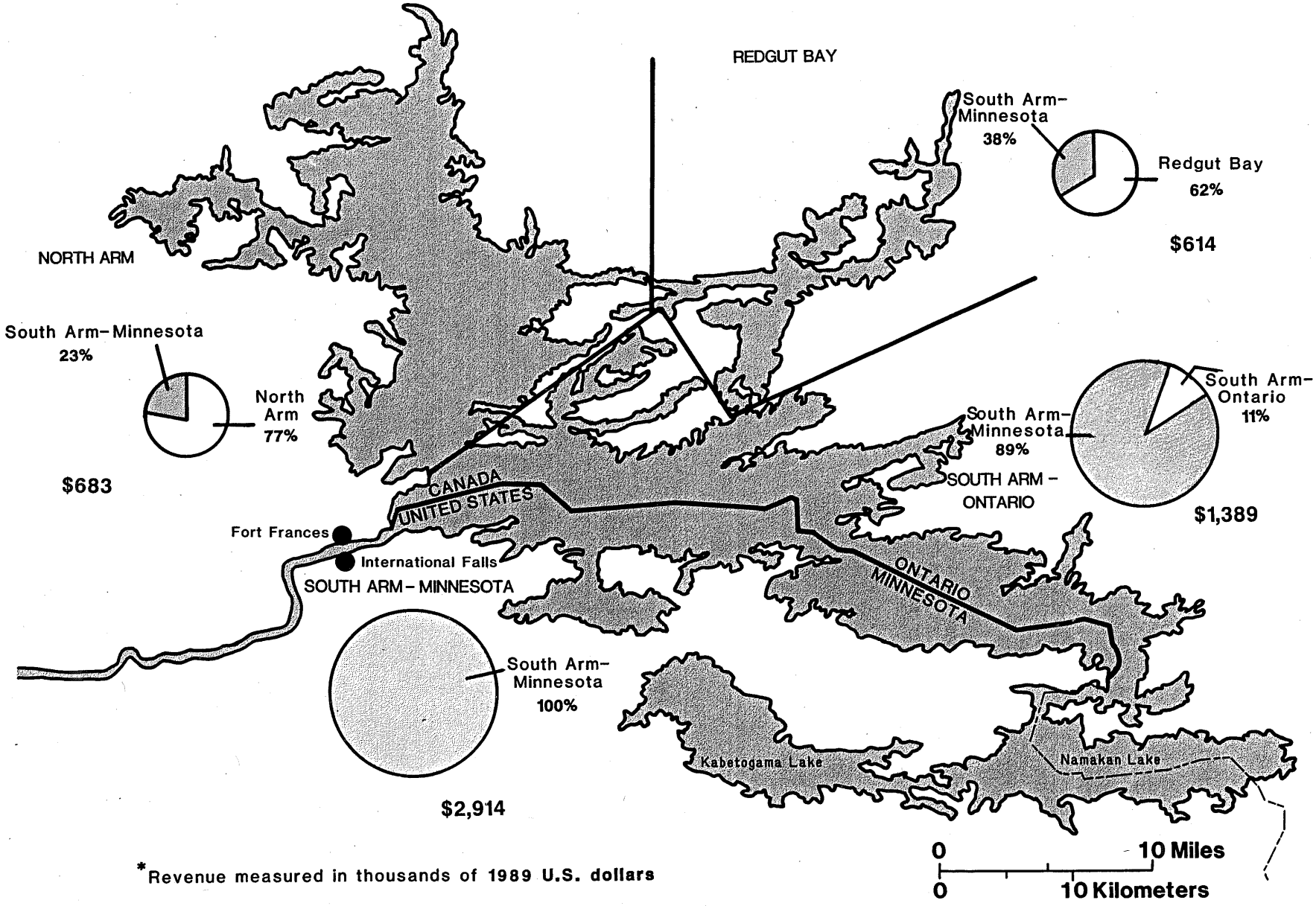
b. Angling

Angling demand is also expected to increase on Rainy Lake, as on Lake of the Woods. An increase in demand of 22% on the Ontario portion of the lake is anticipated by the year 2000 based on observed growth.

The number of anglers in Minnesota increased by roughly 20% between 1980-90. This trend is expected to continue into the immediate future.

RAINY LAKE

SECTOR RECEIVING DIRECT REVENUE FROM TOURIST ANGLERS*

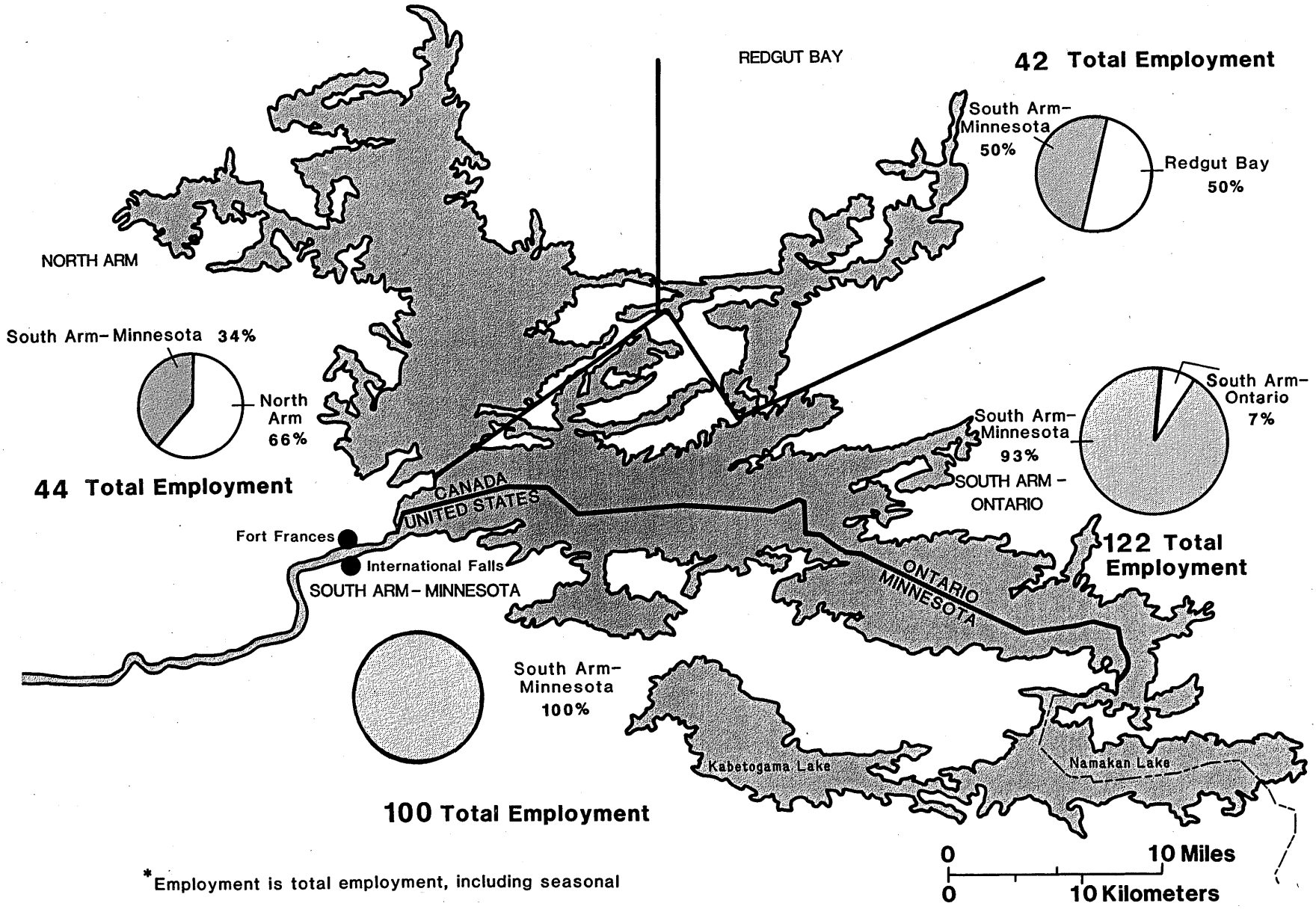


*Revenue measured in thousands of 1989 U.S. dollars

FIGURE 35

RAINY LAKE

SECTOR RECEIVING DIRECT EMPLOYMENT FROM TOURIST ANGLERS*



*Employment is total employment, including seasonal

FIGURE 36

III. Namakan Lake

A. Socio-Economic Infrastructure

1. History of Use

Commercial fishing on Namakan Lake began in 1916-17. Walleye, northern pike, lake whitefish and cisco were the most important species in the commercial catch. Commercial fishing for walleye and northern pike was eliminated in Minnesota waters in 1946. Since the 1950s, two licensed commercial fishermen have been active on the Minnesota side of the lake where they continue to fish for lake whitefish. Commercial fishing on the Ontario portion of the lake began in 1947 with one fisherman. A sturgeon fishery was licensed in 1959 to the same Ontario fisherman. Commercial harvest of walleye and northern pike was prohibited in 1971-72, due to mercury contamination of the fish. The fishery reopened in 1974 but was then closed again from 1976-78. Since 1974, harvest of walleye and northern pike has been controlled by quotas. Quotas were established for lake whitefish and lake sturgeon in 1983.

Angling became popular on Namakan Lake in the late 1920s when a considerable amount of fishing pressure came from Minnesota resorts on Kabetogama and Crane lakes which were accessible by automobile.

2. Local Communities and Populations

There are only two year-round residences on the shores of Namakan Lake; one is an Ontario tourist operation and the other is a Voyageurs National Park establishment at Kettle Falls. There are, however, two areas of localized habitation near Namakan Lake in Minnesota: the unorganized territories of northwest St. Louis County (approx. 600 people), primarily on Kabetogama Lake; and the small community of

Crane Lake. In addition, there are 36 summer cabins on Namakan Lake.

3. Economy

The economy of the area is totally dependent on the utilization of natural resources. Tourism and the forest products industry provide the majority of job opportunities. One hundred and thirteen full or part-time jobs are generated by tourist anglers utilizing Namakan Lake. Thirty-three Minnesota tourist operations and two Ontario tourist operations rely on the Namakan Lake fishery.

4. Fishery User Profiles

a. Commercial Fishermen

Presently there are 3 licensed commercial fishermen on Namakan Lake; one in Ontario and two in Minnesota. The Minnesota commercial fishery which is licensed for lake whitefish only has averaged approximately 3,000 lbs/yr (1,364 kg/yr) since the 1950s. Ontario's licensed commercial fisherman has annually harvested near established quotas for walleye, northern pike, lake whitefish, and lake sturgeon.

b. Anglers

Harvest statistics indicate that 48% of the fishing pressure on the Namakan Lake fishery comes from non-residents, 41.7% from non-local Minnesota residents, 10.3% from local Minnesota residents and less than 10% from Ontario-based anglers (Fig. 37).

Approximately 52% of users access Namakan Lake from operations or public facilities on Kabetogama Lake while the remainder come via Crane Lake. Fishing pressure by user group is the same for both Ontario and Minnesota waters (Fig. 37).

Table 9. Services offered and employment generated by private tourist resorts in Ontario and Minnesota which depend on the Namakan Lake fishery.

	Services			
	Lodging	**Campsites**	**Boat rental**	**Transports**
No. establishments with	32	15	30	7
Number of units	275	198	475	23 trips/wk
Avg. occupancy rate (%	73.3	71.4	NA	NA
% clients who fish	82.9	95.8	80.7	77.4
No. units associated with fishing border waters E. of Rainy L.	133	54	263	17
No. units associated with fishing Namakan L.	108	44	213	14

	Employment			
	Total	**<3 months**	**>3 months**	**Year-round**
No. establishments with	33	12	23	20
No. employees	274	42	168	64
No. employees associated with fishing border waters E. of Rainy L.	140	13	99	28
No. employees associated with fishing Namakan L.	113	10	80	23

* From a 1989 survey of businesses on Namakan, Sand Point, Crane and Kabetogama lakes which depend on sport fishing in the border waters east of Rainy Lake. One Ontario and 33 Minnesota establishments responded.
NA - not applicable

NAMAKAN LAKE
ANGLING EFFORT BY USER GROUP

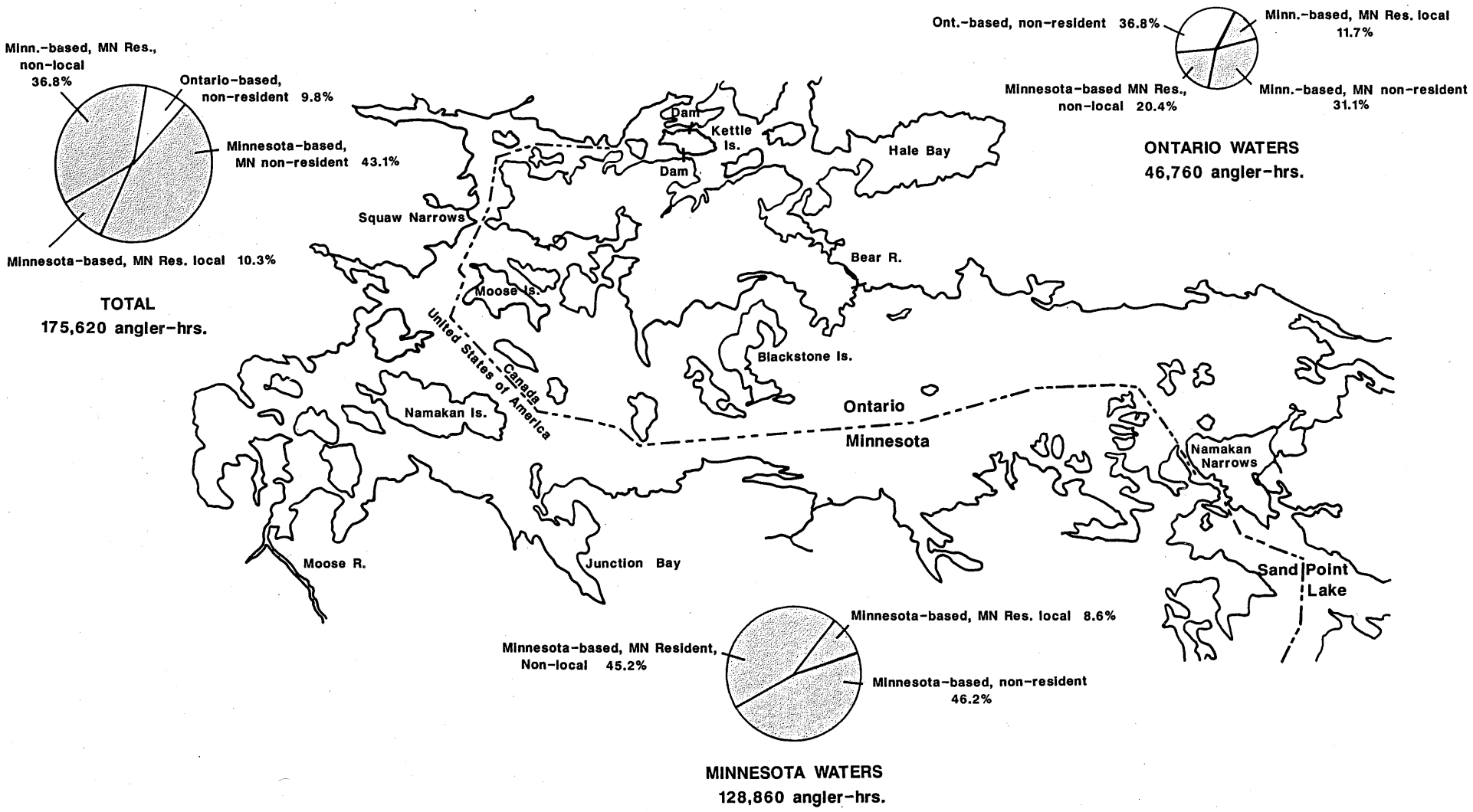


FIGURE 37

MINNESOTA-ONTARIO BOUNDARY WATER FISHERIES ATLAS

B. Socio-Economic Benefits

1. Economic Analysis

The Namakan Lake fishery generates approximately $3.53 million gross revenue (1990 Canadian dollars) annually to the local area. Most of this revenue is contributed by tourists who fish on Namakan Lake. Less than 1% of total revenues are produced by the commercial fishery. Whitefish account for 33.3% of the gross revenues, from commercial fishing, followed by walleye (25%).

The tourist accommodation industry is concentrated at two locations. Twenty-two of the 36 establishments located on Kabetogama Lake rely on the Namakan Lake fishery, as a basis for a large part of their business. Ten resorts on Crane Lake and two on Sand Point Lake have clients who utilize the Namakan Lake fishery. One establishment is located on Namakan Lake itself. Of the 35 operations which rely on the Namakan Lake fishery, 33 are Minnesota-based and 2 are located in Ontario. Occupancy rates averaged 73.3% in 1989 (Table 9). These tourist operations derive 87.4% of their gross revenue from angling in the border waters east of Rainy Lake, of which 70.3% is contributed by the Namakan Lake fishery. Gross tourism income from angling in this area was estimated at $5.0 million in 1989.

2. Social Analysis

Tourism is an important component of the local economy. One hundred and forty full or part-time jobs are attributable to angling on the border waters east of Rainy Lake, of which 113 jobs are associated with angling on Namakan Lake (Table 9). The commercial fishery generates approximately 4 jobs. Minnesota receives almost all of the socio-economic benefits, due to tourist angling on Namakan Lake, from both Ontario and Minnesota waters.

3. Future Demands on the Fishery

Commercial fishing for walleye and northern pike will likely not increase, although reductions in the annual harvest of whitefish may be warranted after evaluation of lake whitefish and rainbow smelt population dynamics. Smelt have had a negative impact on whitefish recruitment in other lakes where they have become established.

Voyageurs National Park estimated that park visitation will grow at a slow to moderate rate (i.e. 2 to 4% per year) for the next 10 years. The Namakan Lake fishery will continue to be an important resource to anglers and to the tourist industry which relies upon it.

SECTION 3
RESOURCE MANAGEMENT ACTIVITIES

Introduction

Direct comparisons of fishery resource management efforts between the Ontario Ministry of Natural Resources and the Minnesota Department of Natural Resources are difficult because of differences in the administrative structure and responsibilities of the two agencies. However, in the major categories of time and expenditures, resource assessment or monitoring, and law enforcement, the two agencies allocate their resources in a similar manner on Lake of the Woods, Rainy and Namakan lakes. During 1989, Minnesota spent 81 percent of its monies on resource assessment and 19% on law enforcement (Table 10). In terms of time expended, Minnesota devoted 87 percent to assessment and 10 percent to law enforcement. The balance of the time was devoted to habitat protection and administration. The assessment category includes annual monitoring programs, environmental review, contaminant monitoring and public relations activities. During 1985-90, Ontario allocated 63% of its resource management funding and 69% of its manpower on the border waters to assessment (including habitat protection) while funding and manpower for enforcement represented 37% and 31% of total allocations.

1. Assessment

A. Minnesota

Area Fisheries offices are located in Baudette and International Falls, Minnesota. The Baudette station is responsible for fisheries management on the Minnesota portion of Lake of the Woods and the Rainy River, while Rainy and Namakan lakes and the upper Rainy River are under the jurisdiction of the International Falls office. Management of border waters constitutes the primary responsibility of personnel at each of these stations with comparable staffing and funding levels (Table 10).

Table 10. Personnel allocation and expenditures associated with resource management and enforcement activities on Lake of the Woods, Rainy and Namakan lakes.

Resource Management Unit	Minnesota Personnel (FTEs)	Minnesota Funding ($)	Ontario Personnel (FTEs)	Ontario Funding ($)
Lake of the Woods				
Assessment	6.5	271,000	8.0	342,000
Enforcement	2.0	169,000	2.5	176,000
Rainy and Namakan Lakes				
Assessment	7.0	235,000	4.0	181,000
Enforcement	2.0	169,000	3.0	135,000
Totals	17.5	844,000	17.5	834,000

FTE (Full Time Equivalent) is used to define personnel allocation where 1 FTE represents one employee working a complete year. Both FTE's and $ reflect hours and dollars of work team assignments.

Funding ($) has been expressed in Canadian dollars (1990).

Personnel allocations and expenditures for Minnesota border waters represent 1990 estimates while those for Ontario are based on the annual average for the period 1986 - 90.

Assessment activities in Minnesota are governed by the standard sampling methodology described in the Large Lake Sampling Guide (Wingate and Schupp 1983). Sampling consists, minimally, of the following programs: July and August young-of-the-year (YOY walleye, sauger and yellow perch) and forage abundance assessment with seines and/or trawls; gill net assessment for post YOY individuals during September; and water sampling. The Baudette office also conducts an electrofishing assessment for spawning walleye near Birchdale on the Rainy River, lake sturgeon assessment at Four Mile Bay and the Rainy River during the spring and spawning northern pike assessment at locations along the south shore of Lake of the Woods. The International Falls office conducts spring electrofishing assessments for walleye and smallmouth bass, fall electrofishing for walleye, and spring assessments for black crappie and rainbow smelt.

Annual creel surveys are conducted on Lake of the Woods, Rainy and Namakan lakes to estimate sport fishing harvest, sport fishing pressure, catch-per-unit-effort (CUE), average size of fish harvested and to assess fishing quality. A creel survey was conducted on the Rainy River during the spring and fall of 1990 and on Lake of the Woods during the winter in 1991 and 1992 to obtain similar information. These activities will be repeated periodically to monitor for trends in both fisheries.

B. Ontario

The Lake of the Woods area manager out of the Kenora District office is responsible for fisheries management of all Ontario waters of Lake of the Woods. The Rainy River, Rainy Lake and Namakan lakes are the responsibility of the Rainy River, Rainy Lake and Flanders managers and their area teams out of the Fort Frances and Atikokan offices. While assessment activities on Rainy Lake and the Rainy River are conducted by Fort Frances District staff, fisheries assessment on Lake of the Woods continues to be the function of the Lake of the Woods Fisheries Assessment Unit (LWFAU) which is based in Kenora but now forms part of the regional Science and

Technology Transfer group out of Thunder Bay.

The Lake of the Woods FAU activities on Lake of the Woods are part of a long-term monitoring program to provide fisheries information on this lake for local management and for comparison with similar lake types and fish communities throughout the province, as part of a provincial network of Fisheries Assessment Units. A provincial "core data" program dictates the type of standardized programs and frequency of sampling conducted. The LWFAU monitors the Shoal Lake fishery annually and other portions of the lake on a two-year rotational basis. Assessment programs include index gill netting, trap netting to assess important spawning populations during spring and fall, commercial fish sampling to monitor commercial harvest, shoreline seining and electrofishing for young-of-the-year fish. Annual programs to monitor the aquatic environment include water quality sampling, physical habitat mapping, and surveys to assess benthic and zooplankton/phytoplankton communities. Lake-wide creel surveys to monitor open water angling and winter creels to provide coverage of lake trout angling areas are conducted for two consecutive years in every five. The LWFAU is also involved in specific programs to assess the effects of regulation changes (e.g. trophy lake trout; maximum size limits for walleye and northern pike) and to provide information on species populations which are of provincial importance (e.g. lake sturgeon in the lower Lake of the Woods-Rainy River).

Assessment activities on the Ontario waters of Rainy Lake are similar to those conducted in Minnesota. These consist of annual fall index gill netting and open water creel surveys. Both shoreline seining and electrofishing are used to monitor year-class success for walleye and abundance of small fish. Sampling to assess the commercial harvest of quota species is also conducted, along with spring trap netting and tagging to monitor walleye spawning populations.

2. Law Enforcement

A. Minnesota

Five conservation officers enforce state and federal laws pertaining to: sport and commercial fishing regulations; boat safety laws; shoreland protection rules (habitat protection) along the border waters. Officers are stationed in Warroad, Baudette, International Falls and Ray, Minnesota. Periodically, extra enforcement officers are used to facilitate road blocks, saturation and under-cover checks, especially when exceptionally good fishing or high use is anticipated. Officers often co-operate with Canadian counterparts in joint enforcement actions.

B. Ontario

Five to six conservation officers, stationed in Kenora, Sioux Narrows, Rainy River, Fort Frances and Atikokan are responsible for enforcing various provincial and federal statutes, including those pertaining to game and fish regulations, migratory birds, forest fire prevention, habitat protection and development on Crown land along the Ontario waters of Lake of the Woods, Rainy River, Rainy Lake and the Namakan system. Additional enforcement officers may be brought in to assist during road checks, saturation and under-cover operations. Officers often co-operate with their American counterparts in joint enforcement initiatives.

3. Legislation and Regulation - Angling

A. Minnesota

There have been numerous regulation changes since the printing of the last Atlas. In 1985, Minnesota's daily walleye/sauger limit was expanded to 20, of which only 10 could be walleyes on Lake of the Woods. On Rainy Lake, the walleye/sauger limit was 20, of which 8 could be walleyes. The northern pike limit on Lake of the Woods was expanded to 6. The crappie limit on Rainy Lake was expanded to 30, of which not more than 15 could exceed 12 inches (30.5 cm) in length. Two lines were permitted while trolling on Lake of the Woods.

In 1987, many of the fishing regulations for Minnesota-Ontario Border Waters were standardized to eliminate confusion to the angler. The northern pike season was opened year-round. The daily limit was increased to 6 for all border waters, except Rainy Lake where it remained at 3. A season closure for bass was eliminated to permit year-round fishing. The size limit on black crappie for Rainy Lake was removed. The minimum size limit for muskellunge was increased to 40 inches (102 cm). The muskellunge season was changed to open on the 3rd Saturday in June and to close on November 30. The lake sturgeon season was opened on June 30.

Fishing on the Rainy River closed on February 28 during the 1988 season. In 1989, the Rainy River fishery was reopened to permit early spring angling. The daily walleye/sauger limit was changed to include a size limit. From the season opener until February 28, the limit is 6 with only one walleye allowed over 19.5 inches (50 cm). From March 1 through April 14, an angler cannot possess any walleye over 19.5 inchese (50 cm).

In 1990, the black crappie limit on Black Bay of Rainy Lake was reduced to 15. A size limit on Rainy Lake northern pike was instituted allowing only one over 28 inches (71 cm).

Present regulations reflect biological, social, political, and enforcement considerations. Minnesota statutes specify that anglers fishing border waters may possess only one limit of fish, regardless of the number of licenses held.

The most recent changes in Minnesota pertain to Lake of the Woods. These changes, effective March 1, 1991, include a reduction in the walleye/sauger limit from 20 (only 10 of which could be walleyes) to 14, of which only 6 can be walleyes. Minnesota has no size restrictions on either species for Lake of the Woods. Anglers may only use one line during the open water season, regardless of fishing method. However, two lines are still permitted while fishing through the ice. Changes have

also been made relative to fish packaging in order to facilitate identification and enumeration of walleye and sauger for enforcement purposes. During the open water season, licensed fish packers must leave head, skin, dorsal fin and tail attached to sauger. Dressed (filleted) fish will be counted as walleye. A summary of regulations pertaining to Lake of the Woods, Rainy and Namakan Lakes and the Rainy River is found in Table 11.

B. Ontario

A number of changes to angling regulations in the Ontario portions of the border waters (Table 11) have been made by the Ontario Ministry of Natural Resources since the last publication of this atlas. While daily possession limits for walleye and northern pike remained unchanged, maximum size limits of 50 cm (19.7") total length for walleye and 70 cm (27.5") total length for northern pike were introduced, whereby only one fish greater than these lengths could be taken in one day. Minimum size limits for muskellunge which had been increased to 102 cm (40") total length for Lake of the Woods in 1988, were further increased to 122 cm (48") for Lake of the Woods and the Rainy River from the Fort Frances dam to Lake of the Woods in 1992. The minimum size limit for muskellunge in all other waters, unless specified, was increased to 102 cm from 86 cm (34"). Regulations were changed in 1988 to allow the harvest of one muskellunge per day, with a possession limit of two fish. Daily possession limits for lake trout were reduced from three fish per day to two fish per day, except where trophy lake trout regulations exist. Trophy lake trout waters include areas on Lake of the Woods where the following regulations apply: Whitefish Bay where a daily catch limit of one fish per day was introduced in 1990, along with a possession limit of two fish, only one of which can exceed 65 cm (25.6") total length; Clearwater Bay where only catch and release angling is permitted, except for tag holders who are allowed to harvest one trout per year; gear and bait restrictions which limit anglers to the use of single barbless hooks only and no fish or fish parts when fishing in Whitefish Bay from January 1 to the 3rd Saturday in May and in the Clearwater Bay area year-round. The daily catch/possession limit

Table 11. Current angling regulations on Minnesota-Ontario boundary waters, including Lake of the Woods, Rainy River, Rainy Lake and Namakan Lake, 1991.

	Ontario			Minnesota		
Species	Season (1991)	Daily Bag Limit	Size Regulations	Season (1991)	Daily Bag Limit	Size Regulations
Northern Pike	Continuous	6	-one over 70 cm (27.5")	Continuous	6	-Rainy L one over 28" (71 cm)
Walleye/Sauger						
-Lake of the Woods	May 19-Apr 14	6	(either/both in aggregate) -one over 50 cm (19.7")	May 11-Apr 14	14	-not more than 6 may be walleye
-Rainy Lake	May 19-Apr 14	6	as above	May 11-Apr 14	12	-not more than 6 walleye -one over 19.5" (50 cm)
-Rainy River	May 19-Apr 14	6	as above	May 11-Feb 29 Mar 01-Apr 14	6 6	-one over 19.5" (50 cm) -none over 19.5" (50 cm)
Namakan Lake	May 19-Apr 14	6	as above	May 11-Apr 14	6	-no size
Largemouth/ Smallmouth Bass	Continuous	6	either/both in aggregate	Continuous	6	either/both in aggregate
Muskellunge	Jun 15-Nov 30	1	-minimum 122 cm(48") for Lake of the Woods and Rainy River -minimum 102 cm (40") for	Jun 15-Nov 30	1	-minimum 40" (102 cm) for all waters

Rainbow Trout	Continuous	5		May 4-Sep 30	5	-no more than 3 over 16" (40.6 cm)
Lake Trout						
-Whitefish Bay, Lake of the Woods	Jan 01-Sep 30	1	-2 in possession, only one can exceed 65 cm (25.6") in length			
-Clearwater Bay, Lake of the Woods	May 18-Sep 30		-catch and release only, except one fish per season for tag holders			
Sturgeon	Jun 30-May 15	1	-minimum 114 cm (45")	Jun 30-May 15	1	-minimum 45" (114 cm)
Whitefish	continuous	25		all year	no limit	
Crappie	continuous	30		all year	30	-except Black Bay, 15/day

for black crappies from Ontario waters in this area was reduced from 60 fish/day to 30 fish/day in 1988. Fish sanctuaries to protect walleye during spring spawning were established from April 1 - June 15 at various locations on Rainy Lake including Stanjikoming Bay, Halfway Inlet, Little and Big Canoe Rivers, Sand Island Falls, Porter's Inlet, Rat River Bay and Stoke's Bay. Regulations prohibiting the possession of smelt for use as bait or using smelt as bait have also been established. The Daily Angling Validation Tag (DAVT) program was introduced in 1985, requiring U.S.-based non-resident anglers fishing the Ontario border waters of Rainy Lake, Rainy River and Lake of the Woods to obtain a DAVT to validate their Ontario angling licences. The current cost of the DAVT is $3.75 (Canadian) per angler per day. Both Kenora and Fort Frances District Fisheries Management Plans (1988) identified the need to review the DAVT program, and to examine the merit of expanding it over a larger geographic area.

4. Legislation and Regulation - Commercial Fishing

A. Minnesota

In 1983, the Minnesota legislature established a quota reduction schedule (buy-out) to phase out commercial fishing for game fish on Lake of the Woods and Rainy Lake by 1992. By 1986, the buy-out of the commercial walleye fishery was completed on Lake of the Woods. At present, there is a small commercial fishery for burbot and white sucker. Similarly, the buy-out of the commercial walleye quota for Rainy Lake was accomplished by 1985. There remains a small fishery for burbot and whitefish on Rainy Lake. There are two licensed commercial fishermen operating on Namakan Lake who fish exclusively for whitefish. They harvest on average, 3,000 lbs. per year.

Current commercial license fees are $45.00 per pound net, $15.00 per submerged trap net and $10.00 per fyke net. A helpers license is $15.00. Gill nets, while permitted for use on Rainy and Namakan lakes for whitefish, are not legal on Lake

of the Woods.

B. Ontario

A total of 14 commercial fishing licences on Lake of the Woods, including Shoal Lake, and 11 commercial fishing licences on Rainy Lake have been purchased by the Ontario Ministry of Natural Resources on a "willing seller - willing buyer" basis since 1984. Licence purchases have been for conservation purposes, primarily to reduce annual harvests of walleye and northern pike to within target levels. This objective has been achieved on the South sectors of Lake of the Woods. The management intent outlined in the Fort Frances District Fisheries Management Plan (1988) is to eliminate the commercial walleye quota on Rainy Lake. It has been reduced by 86% since 1986 by quota purchase and/or trade for other species quotas.

Commercial fishermen on Lake of the Woods have been allowed to fish for sauger with 7.6 cm (3") stretched mesh gill nets under experimental permit since 1986. Most commercial gill netting that does occur in Ontario border waters is restricted to a minimum 10.8 cm (4.25") stretched mesh. Sturgeon gill nets must be constructed of a minimum 30.5 cm (12") stretched mesh.

Only Ontario residents can be issued a licence to take fish for commercial use by means of a gill net, pound net, trap net, trawl net, hoop net, seine net, dip net, or trammel net, or by means of hooks. Annual licence fees for different types of gear, as authorized by the licence, are as follows: $24 for 1,850 m of gill net and $48 for 3,675 m of gill net; $12 for each trap net; $3.75 for each hoop net. A separate licence is required to fish for lake sturgeon.

5. Land Management Activities

A. Minnesota

Land management activities primarily refer to participation in and administration of

various permitting programs aimed at protecting sensitive shoreland areas, aquatic habitat and water quality. Habitat protection consists of inspecting sites where Division of Waters (DOW) permits, U.S. Army Corp of Engineers permits, and Aquatic Plant Management permits are applied for. These programs include review of the following activities: wetland alteration, dredging, bridge and culvert replacement, road construction, boat harbor and dock construction, swimming beach development and alterations to the aquatic plant community. Habitat protection also includes the identification and inventory of critical habitat areas.

B. Ontario

The Ontario Ministry of Natural Resources is responsible for managing public or Crown land, which includes the beds of most navigable lakes, rivers and streams, and shore lands as far as the high water mark. Anyone planning to work in or around water in Ontario must obtain a work permit from MNR. Works may include filling, dredging, removing rocks, stumps, logs or aquatic plants, channelization, building or reconstructing dams, docks, boathouses, and retaining walls. An application for a work permit, along with the work proposal, are reviewed by MNR staff to ensure that fish and wildlife habitat are not harmed and that the work proposal does not conflict with provincial and federal laws and regulations, including the Public Lands Act, the Lakes and Rivers Improvement Act, and the Canada Fisheries Act. MNR can also place restrictions on bed capacity for tourism developments on Crown land, based on existing fisheries potential and current harvest levels.

6. Water Levels

A. Minnesota

Rainy Lake is part of a reservoir system which is used to generate power at a hydro-electric dam constructed at the outlet. Namakan Lake serves as a backup reservoir for the Rainy system. General regulation of water levels has been established by the International Joint Commission (IJC). Water level manipulations in these reservoirs

subsequently influence water levels downstream in Lake of the Woods. Under normal conditions, water levels in Rainy Lake are regulated for a gradual fall and winter drawndown, followed by a spring and summer build-up. In 1969, the IJC revised the regulations to allow for a zone of accepted water levels on specific dates. A minimum of 1,105.4 ft (336.93 m) and a maximum of 1,106.8 ft (337.36 m) have been established for the first two weeks of May which corresponds to the spring spawning period.

Operation of the dam on the Rainy River and the Kettle Falls dam upstream on Namakan Lake is the responsibility of Boise-Cascade Corporation. When water levels are outside of the rule curves and emergency conditions exist, the IJC assumes control of the dam. It is recommended that water levels on Rainy Lake be above 1,106.8 ft (337.4 m) for fifteen days following ice-out, which covers the major walleye spawning period.

Cohen et al. (1991) in a study jointly funded by MDNR, OMNR and Boise Cascade Corporation, compiled and analyzed existing data to determine how water level regulations affect fish communities in Rainy Lake and Namakan Reservoir. They found a clear link between changes in the yearly maximum range of water levels and changes in fish populations. The frequencies and amplitudes of water level fluctuations can be as important as changes in annual mean water levels in determining fish community structure. The study re-emphasized the connection between ecosystem dynamics and fish population dynamics, i.e. the injection of nutrients into water bodies from flooding and exposure of large areas; changes in both the quantity and quality of spawning habitat for walleye and northern pike.

B. <u>Ontario</u>

Water levels on Lake of the Woods are primarily controlled by Boise-Cascade hydro-electric dams at the two major outlets at Kenora which form the headwaters of the Winnipeg River. The Lake of the Woods Control Board which is composed of

representatives from the federal government and the provinces of Ontario and Manitoba, regulates water levels on Lake of the Woods within elevation and discharge requirements established by the International Joint Commission (IJC) in 1925. Outflows are managed to maintain the lake level at elevations between 321.87 m (1,056.0 ft) and 323.47 m (1,061.0 ft), so as to ensure that the lake does not rise above elevation 323.85 m (1,062.5 ft). When water levels are outside of this regulation band, the IJC assumes responsibility for approving outflows from Lake of the Woods.

Lake levels are normally controlled for a gradual buildup during spring and summer, followed by a gradual drawdown during fall and winter for hydro-electric generation at dams downstream on the Winnipeg River in Ontario and Manitoba. The Lake of the Woods FAU which represents the fisheries concerns of the Ministry of Natural Resources at Lake of the Woods Control Board meetings has recommended minimum spring water levels of 322.46 m (1,058 ft) to insure availability of spawning substrates for successful walleye/northern pike spawning and minimum fall-winter drawdown to 322.16 m (1,057 ft) to protect eggs laid by fall spawners (e.g. lake trout, lake whitefish).

7. Contaminants

A. Minnesota

The analysis of fish tissues for the presence of contaminants is the responsibility of the Minnesota Pollution Control Agency (MPCA). The Minnesota Department of Health uses MPCA information for providing risk assessment to anglers through their publication, Minnesota Fish Consumption Advisory. The Department of Natural Resources (DNR) is responsible for obtaining fish samples to be analyzed by the MPCA. Routine water quality monitoring is conducted by the DNR. Samples taken from the Minnesota portion of the Rainy Lake indicate that mercury concentrations range from 0.11 - 1.38 mg/kg (1976) for northern pike and from 0.15 - 0.72 mg/kg

(1982) for walleye. Fish flesh has also been sampled for PCBs (<0.2 mg/kg); DDE and DDT (<0.7 mg/g); dieldrin, aldrin, endrin, arsenic, cadmium, lead, and copper (present in low concentrations). The Department of Health recommends one meal per month for all species from Rainy Lake and one meal per month of northern pike, sauger and lake whitefish from Namakan Lake.

Rainy River samples indicate a mercury concentration ranging from 0.70 - 0.87 mg/kg (1986) for northern pike and 0.27 (1978) to 0.98 (1986) mg/kg for walleye. Total PCBs ranged from < 0.05 - 0.06 mg/kg. Dioxin was found in concentrations up to 5.6 parts per trillion in walleye. The Minnesota Department of Health (MDH) recommends one meal/week for northern pike, walleye and sauger from the Rainy River. A single sturgeon was found with 28.4 parts per trillion of 2,3,7,8-TCDD (dioxin). The MDH does not recommend consumption of sturgeon from the Rainy River.

Mercury concentrations in walleye from Lake of the Woods in 1986 ranged from 0.40 to 0.42 mg/kg of flesh and PCB concentrations <0.05 mg/kg. Northern pike had mercury concentrations ranging from 0.31 to 0.52 mg/kg of flesh and PCB concentrations of <0.05 mg/kg. The MDH has not issued consumption advisories for most game fish species from Lake of the Woods, with the exception of an advisory for lake sturgeon of one meal/month.

B. Ontario

Fish from the Ontario waters of Lake of the Woods, the Rainy River and Rainy Lake are regularly sampled by MNR and analyzed by the Ontario Ministry of Environment (MOE) for the presence of contaminants. Current test results appear in the annual MOE publication, **Guide to Eating Ontario Sport Fish**.

Testing of fish from Namakan Lake indicated mercury levels in walleye, 30 - 55 cm

(12 -22 ") in length and in northern pike, larger than 45 cm (18") in length, of between 0.5 parts per million (ppm) or 0.5 mg/kg and 1.5 ppm or 1.5 mg/kg. Mercury levels in walleye larger than 55 cm (22") in length exceeded 1.5 ppm or 1.5 mg/kg. While some restrictions on consumption of walleyes larger than 30 cm and northern pike larger than 45 cm long exist, no walleyes greater than 55 cm (22") in length should be consumed.

The following mercury levels were found in fish from Rainy Lake: greater than 0.5 mg/kg in walleyes larger than 35 cm (14") and in northern pike larger than 45 cm (18") long; greater than 1.0 mg/kg in walleyes larger than 45 cm (18") and in northern pike larger than 65 cm (26") long; and greater than 1.5 mg/kg in walleye larger than 55 cm (22") long. Testing of walleye, northern pike, lake whitefish, and white sucker for organic contaminants such as PCBs, mirex, pesticides (e.g. DDT, toxaphene, HCBs) and 2,3,7,8-TCDD (dioxin) indicated that the presence of these substances did not exceed federal guidelines for restrictions on sale or consumption (e.g. >2.0 mg/kg for PCBs; >0.1 mg/kg for mirex; > 20.0 parts per trillion for 2,3,7,8-TCDD). However, limited consumption of walleye, greater than 35 cm (14") long, and northern pike, greater than 45 cm (18"), is recommended due to the presence of elevated mercury levels. No walleye larger than 55 cm (22") should be consumed.

Consumption of fish from the Rainy River is not restricted, with the exception of a limited consumption guideline for walleye and smallmouth bass greater than 35 cm (14") from immediately downstream of Fort Frances. Testing of walleye, northern pike, smallmouth bass, white suckers, and lake sturgeon for mercury and organic contaminants indicated that most levels fell within federal guidelines for sale and consumption.

Mercury levels in fish sampled from Lake of the Woods were generally below 0.5 mg/kg with the following exceptions where limited consumption is recommended:

levels between 0.5 and 1.0 mg/kg in walleye larger than 45 cm (18") long from Whitefish Bay, in walleye larger than 55 cm (22") from Little Traverse Bay, and in walleye larger than 65 cm (26") from Shoal Lake; levels between 0.5 and 1.0 mg/kg in sauger larger than 35 cm (14") from most areas of the lake, with the exception of Yellow Girl Bay where levels exceeded 0.5 mg/kg in saugers larger than 30 cm (12") and 1.0 mg/kg in saugers larger than 35 cm (14"); levels between 0.5 and 1.0 mg/kg in northern pike larger than 55 cm (22") from Yellow Girl and Little Traverse bays, in northern pike larger than 65 cm (26") from Four Mile and Whitefish bays, and in northern pike larger than 75 cm (30") from Sabaskong Bay and Shoal Lake. Testing for organic contaminants indicated that levels in all species including smallmouth bass, whitefish and lake trout were within federal guidelines for consumption and sale.

8. Exotic Species

Historical records suggest that smallmouth bass and black crappie were introduced into Lake of the Woods and Rainy Lake in the 1920s and 1930s. Their abundance in the North Arm of Rainy Lake may hinder the recovery of depressed walleye stocks in this area. Largemouth bass, pumpkinseed and longear sunfish were identified from both Lake of the Woods and Rainy Lake in the 1960s. Black bullhead invaded the Rainy Lake system in the early 1970s and they are now present in Minnesota waters of Lake of the Woods. In 1983, 80,000 rainbow trout were stocked into the Minnesota portion of Lake of the Woods by a coalition of resort owners. Rusty crayfish (Orconectes rusticus) were first found in Whitefish Bay but they have since dispersed northwards throughout the North and Central sectors of Lake of the Woods. All introduced species have become established, with the exception of rainbow trout.

The invasion of rainbow smelt was confirmed in Rainy and Namakan lakes in 1990. Young-of-the year smelt were also captured by MDNR in Minnesota waters of Lake

of the Woods in August 1991 and in Rainy Lake in 1992. The possible impacts of smelt on the native walleye and lake whitefish populations in these lakes are not known. Smelt in similar lakes have produced faster growth rates in adult walleye but do not appear to have affected other walleye life stages. Lake whitefish recruitment may be reduced by smelt.

Bluegill sunfish were identified by Minnesota DNR in Rainy Lake in 1991. This species will probably move downstream to Lake of the Woods, as have black bullhead and smelt.

9. Resource Enhancement

A. Minnesota

Several projects aimed at accelerating the recovery of walleye stocks in Rainy Lake have been attempted by Minnesota DNR since 1984. Approximately 2,800 cubic yards of spawning material have been placed at several sites in Black Bay where evidence suggests that fish spawned in the past. One new site has also been built to expand available spawning habitat.

Walleye fingerlings were stocked annually from 1984-90. Thirty thousand of the 190,000 fish released in 1988-89 were marked using coded wire tags. Tag returns from assessment netting and creel surveys will provide information relative to the extent of natural reproduction, recruitment and the contribution of stocked fish. Walleye fry were stocked in 1984, 1985 and 1987. Stocking fry and fingerlings in the same year has been discontinued.

The 1989 Minnesota legislature appropriated $100,000 to be used for the development of fishing reefs in Lake of the Woods. Three separate reefs, ranging from 0.5 - 1.0 acres in size are being developed using approximately 7,000 cubic yards of field rock (6 - 24 " in diameter) at sites near Pine Island and offshore from

Warroad.

Researchers from the DNR's Ecological Services Section identified a group of spawning lake sturgeon in the Little Fork River during the spring of 1990. In addition to documenting habitat utilization data, these researchers assisted personnel from the International Falls and Baudette offices in taking eggs from several ripe females. The eggs were successfully hatched at the DNR hatchery in Bemidji and returned as fry to the Little Fork River. This represents the first successful egg-take operation for lake sturgeon in Minnesota. It presents the opportunity for future reintroduction of this species into locations within the Hudson Bay drainage where it has been extirpated or spawning sites have been lost.

In 1992, the Section of Fisheries and the Lake of the Woods Area Catch and Release Committee embarked on a $25,000 catch and release program to promote the release of 'keeper size' fish so the existing high quality fishing in the area is maintained or enhanced for future generations. This program involves highway billboards, stick-on rulers for measuring fish, posters, certificates, education brochures, and lectures on fishing and catch and release methods.

B. Ontario

Ministry of Natural Resources and local sportsman groups, working together through the Community Fisheries Involvement Program (CFIP), have rehabilitated a number of known walleye spawning sites on Rainy Lake (e.g. Egg Island, Wasaw Creek) by the addition of over 1,000 cubic yards of rock cobble. Other CFIP projects have involved improving access for walleyes to upstream spawning areas on both Big and Little Canoe creeks by removing obstructions such as beaver dams and log-jams.

Fort Frances District was also involved in stocking up to 20,000 walleye fingerlings per year into the North Arm of Rainy Lake during 1985-88. Fish originated from the North Arm stock and were raised to fall fingerling stage in an open pond.

A number of spawning ground rehabilitation projects have been conducted on Lake of the Woods since 1984 by workers from local First Nations, CFIP volunteers and participants in the MNR Junior Ranger program. Extensive improvements to known walleye spawning sites have been made at Snake and Log bays in the Whitefish Bay area, at the mouth of the Falcon River on Shoal Lake, and at the Splitrock River on Sabaskong Bay.

A strategy to improve environmental quality and to protect lake trout populations in the Clearwater Bay area of Lake of the Woods was developed in 1988 by MNR and the Clearwater Bay Fisheries Advisory Committee which was composed of representatives from a number of other government agencies, including the ministries of Environment and Tourism, local tourist operators, First Nations groups, local cottage and property owners, and sportsmen groups. The Lake of the Woods FAU had identified that lake trout in these basins were threatened by overharvest from angling and by the loss of both deepwater summer habitat and inshore spawning areas, as the result of nutrient enrichment and shoreline development from cottaging. Steps have been taken to control nutrient inputs into this area by monitoring the condition of existing septic systems and educating the public in environmentally "friendly" cottaging practises. Measures to restrict future development within prescribed guidelines were enacted in this part of the lake. Overexploitation of lake trout in the Clearwater Bay area was addressed by closing the winter lake trout angling season and introducing a "catch and release" fishery only, except for a limited harvest by tag holders, during open water. A number of known lake trout spawning shoals which had become degraded were rehabilitated by adding clean cobble to improve spawning substrates. Lake trout populations and environmental quality in this area continue to be regularly monitored.

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