FISH OF CANADIAN LAKE SUPERIOR:

THROUGH THE YEARS, SPECIES BY SPECIES

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ABSTRACT

Selected biological features of Canadian Lake Superior's fish species are examined (prior to 1984). Spawning and fishing grounds are summarized with texts, tables, and maps, and species' movements and interactions are noted. Attention is given to the possible existence of stocks. Through time there have occurred changes in fish habits, habitats, and abundances: these are reviewed along with influencing factors.

A background history of hatcheries on Lake Superior is also presented. Sources of spawn and planting locations of fish raised in Canadian hatcheries are outlined, and when possible survival is assessed. Hatcheries engaged in the artificial propagation of species both native to Lake Superior (lake whitefish, lake herring, walleye, lake trout, brook trout) and exotic (rainbow trout, brown trout, salmon).

INTRODUCTION

Lawrie (1978) lists 73 fish species which have been present in Lake Superior, ten of these exotics. The species now supporting the commercial fishing industry are lake herring, lake whitefish, deepwater cisco (chub), lake trout, smelt, sucker (mullet), yellow perch, and round whitefish (menominee). Sportsmen direct their efforts towards yellow perch, walleye, and species of salmon and trout.

Today the angling and commercial fisheries are no longer free to evolve in accordance with their past opportunism and expansionism. An age of restrictive quotas and tougher government controls has arrived. International agreement brought lake-wide lake trout quotas in 1961 so that sea lamprey control measures and active stocking programs might restore *S. namaycush* to health within the Great Lakes. In 1972 the Ontario government first imposed a quota on Black Bay herring. Whitefish, deepwater chub, and yellow perch have joined the list of controlled species.

It has become a time for reassessment and forward planning. Fish communities are being more closely monitored, past processes of transformation reexamined. Fishermen have admitted former fishing excesses; government officials have admitted past errors of judgement and management. At times the agents of fish population change have been obvious (exotics, pollution, overexploitation, and so on). Often, however, as research continues and analytical techniques improve, there emerge complex patterns of cause and effect. Abiotic and biotic components of the aquatic environment are found to be intricately interwoven. A single fish species within a single lake may show a wide spectrum of habit, habitat, and appearance at the level of its individual stocks. Stock management is an essential goal of government policy, but it is generally hampered by lack of information. In order to fill a few of these information gaps, this paper addresses the subject of intra-species diversity and change within Canadian Lake Superior. The report also traces the history and success of stocking efforts and exotic introductions. Emphasis centres upon:

1) the physical appearance of the fish species,

2) spawning locations and times,

3) spatial-seasonal distribution,

4) species interactions, and

5) evidence for the existence of stocks.

The term stock is here used in the sense of Marr's (1957) ‘group":

> "A group is a fraction of a population with distinctive characteristics, the nature of which (phenotypic or genotypic) has not yet been determined."

Loss of stocks may mean a loss of genetic diversity and a consequent reduction in species resilience and stability. Changes in the status of a stock are often hard to monitor. Once exploited stocks have reached some level of depletion, resource users shift their efforts io others, thereby maintaining overall production but disturbing species integrity (I.awrie and Rahrer 1973). Improved methods of identifying stocks are required.

METHODOLOGY

The following report is based upon information gathered during the years 1977 to 1984. Much kas been drawn from manuscripts, log books, diaries, newspapers and correspondence housed in libraries and archives scattered throughout the province, as well as from files held in district and regional offices of the Ontario Ministry of Natural Resources. Most valuable of all were conversations with those people personally involved with Lake Superior's fisheries. Regrettably, only a small portion of the knowledge they have shared is included here. The scope of my concerns was narrow; most people spoke of far more than I have had wit or opportunity to record properly. Many fascinating tales, an historical treasure trove, fade from memory. It can only be hoped that other researchers will seek out these "old-timers" before they are no longer with us.

Approximately 45 sports and commercial fishermen were requested to indicate on Canadian Hydrographic Service (or National Oceanic and Atmospheric Administration) Great Lakes navigation charts the spawning and fishing grounds with which they were familiar. These grounds, along with information concerning the "varieties" of fish reported as having been dominant, are summarized in figures.

Background information and bibliographic references concerning the history of the commercial fisheries may be found in Goodier (1984, 1985, 1989).

CATCH STATISTICS

This report utilizes some information and statistics from government reports. For the period 1867 to 1907, official statistics were published in the annual reports of the federal Department of Marine and Fisheries (or Department of Fisheries). In 1907 the Ontario Department of Game and Fisheries began publishing annual catch returns. Data for the years 1871 to 1917 are recorded by station of

landing and so permit examination of regional fishing intensities. After 1917 stations were grouped into progressively larger units of area, until 1926 when the practice of recording individual stations was discontinued (until 1948 when C.F. forms again permitted detailed data collection).

It is obvious that reported and actual harvests often differed significantly in the early records. The following illustrates the problems inherent in compiling returns:

> "[Overseer Keefer] experienced great difficulties in obtaining reliable data for the statistical statements. Fishermen were unable to give their individual catches: this information was sought from sub-officers, buyers, shippers of fish, &c. Interested parties appear to apprehend a curtailment of their privileges or an increase of the license fees, should their catch appear too large--others, who had been fishing more nets than they were licensed for, were also unwilling to give correct returns." (Canada. Dept. of Marine and Fisheries, Ann. Rep. 1891).

Poaching by both Americans and Canadians was rampant and difficult to control. Around 1900, for example, illegal pound net fishing was judged a serious problem for Thunder Bay. Dunn (1895), captain of the federal patrol boat, discovered 12 of the 28 pound nets fished in Port Arthur division to have been unlicensed. In the early years of this century, officers of the provincial government (which had assumed control of law enforcement in 1899) were ill-equipped with patrol boats adequate for preventing violations (Elliot 1910).

Some fishermen made a practice of landing fish on the American side, thereby avoiding both Canadian inspectors and American duty. To these unrecorded catches must be added the culls and undersize fish (which often found their way to market):

> "There is no inspection of fish caught between here and Mamainse, a distance of 60 miles and small undersized fish are caught and sold here by the Dominion Fish Co. and others.' (Elliot 1911).

Other researchers have questioned the reliability of early official statistics (Tomkins 1951; Moenig 1977).

BACKGROUND OF STOCKING

The pursuit of commercial fishing in the American waters of Lake Superior was intensive, and after 1880 production losses were reported for various waters along the south shore (Smiley 1882; Kumlien 1887). Fearing further decline, the U.S. federal government erected the first fish hatchery on

Lake Superior at Duluth and placed it under the direction of Dr. R.O. Sweeney in 1888. The first stock of lake trout eggs arrived from the Northville, Michigan hatchery the following year (McNab March 1917).

Encountering difficulties in procuring sufficient whitefish and lake trout spawn along the south shore, the American hatcheries at Duluth, Sault Ste. Marie, and Alpena arranged in 1893 to seek spawn at various Canadian locations, including Rossport and Black Bay (Elliot 1897; McNab Sept. 21, 1919). In 1918 U.S. officers were still gathering "considerable quantities" from Batchawana and Whitefish bays. In exchange for this privilege, their hatcheries promised to return some percentage of the fry to the Canadian waters from whence they had originated.

The Dominion of Canada eventually constructed its own hatchery at the mouth of the Current River (Port Arthur), and Manager A.J. McNab (formerly of the Duluth hatchery) and staff commenced taking whitefish spawn from Lake Superior in 1911. A provincial hatchery was erected at Port Arthur in1918 and equipped for the rearing of up io 15 million brook trout, lake trout, lake whitefish, lake herring and walleye (Ontario Dept. Game and Fisheries, Ann. Rep. 1918). William Kenefick was its first manager. The province assumed control of the federal establishment at Current River in 1926, but ordered it closed in 1934 after a new brook trout hatchery at Dorion began operations. Efforts at the provincial Port Arthur hatchery were now devoted entirely to whitefish and lake trout, and between 1955 and 1966 white sucker cultivation (the laner derived from Sandstone R. stock and transferred each year to Deer Lake Hatchery). Production of whitefish was suspended in 1957, and the station was finally abandoned.

In 1931 brook trout from eastern hatcheries were first released in the tanks of the Dorion hatchery. The hatchery was reconstructed in 1947 and equipped for the raising of a host of salmonid species, including lake trout, Atlantic salmon (transferred from North Bay Hatchery, 1951) rainbow trout (from Sault Ste. Marie Hatchery, 1952), and grayling (from Prince Albert, 1958, stocked in 10 Thunder Bay District lakes; Anon. 1957).

To serve the east-end Algoma district, the Sault Ste. Marie provincial hatchery (on Huron Street) was opened in 1921. On the outskirts of town the Tarentorus trout-rearing station was erected in 1929, renovated in 1953 and reopened in 1955 with a capacity for 2 to 3 million eggs (including brook trout, lake trout, splake, and rainbow trout; Anon 1965).

In the general scramble to fill their egg quota each fall, hatchery staff experimented with a wide variety of methods and sources of procurement. Stocks of eggs derived from a long list of spawning grounds, both those of Lake Superior and of various other, often distant inland lakes. It was a tradition of long-standing that hatcheries would place men on the tugs io collect spawn. The Sault Ste. Marie hatchery in 1934 began io pay fishermen to take their own spawn, but the experiment was abandoned after only 3 years.

COREGONINAE

LAKE WHITEFISH, *Coregonus clupeaformis* (Figs. 2-4, Table 1)

In the earliest days of settlement and exploration, Lake Superior whitefish were the most highly acclaimed fish of the Great Lakes. The Sr. Mary's River spawning stocks were especially abundant:

> "This river forms at this place a rapid so teaming with fish, called white fish, or in Algonkin Attikamegue, that the Indians could easily catch enough io feed 10,000 men... Each weighs six to seven pounds, but it is so big and so delicate that I know of no fish that approaches ii." (Casson and Galinée 1670).

For Anna Jameson (1838) they were unsurpassed:

> "There is no more comparison between the white-fish of the lower lakes and the white-fish of St. Mary's, than between plaice and turbet, or between a clam and a Sandwich oyster... It is really the most luxurious delicacy that swims the waters. It is said by Henry that people never tire of them. Mr. McMurray [the HBCo post factor] tells me thai he has eaten them every day of his life for seven years, and that his relish for them is undiminished. The enormous quantity caught here, and in the bays and creeks around Lake Superior, remind me of herrings in the lochs of Scotland..."

Understandably, with such a prize commanding top market prices, fisheries were pursued with vigour. The activities of man soon posed a threat to the bounty of the rapids and diminishing harvests were noted as early as 1870 (Canada. Department of Marine and Fisheries, Ann. Rep. 1871). However, as suggested by Macdonald (1979), the construction of the Canadian and American lock systems prior to l900, plus periodic alterations of water levels in subsequent years, probably destroyed habitat for a major portion of the whitefish population. Today reduced both in size and number, whitefish continue to visit the rapids above the sixteen control gates and, according to Macdonald, migrate to the tailrace of a local carbide plant. Canadian waters of the river are now closed to commercial harvest.

The toll of destruction of Lake Superior whitefish first became evident in United States waters, where annual production diminished after the peak year of 1885 (2,074,800 kg). Consequently, much American investment was redirected across the border, and the Canadian industry geared-up to harvest its comparatively healthy

whitefish stocks. Canadian production peaked in 1894 at 479,000 kg (Baldwin and Saalfeld 1979). By 1910 fishermen were reporting damage to populations at the Michipicoten Island grounds (Duncan 1910). Government overseers warned of widespread losses:

> "The west end of Lake Superior is about depleted of whitefish and trout, as a result of overfishing with pound and gill nets... In the east end of Lake Superior the whitefish is becoming very scarce, but the trout seems to hold its own." (Canada. Department of Marine and Fisheries, Ann. Rep. 1911).

Reports in the popular press were more sensational:

> " .. That Lake Superior, known as the abode of the finest whitefish in the world, is fast becoming a fishless sea is a sanding statement, but that is what fishermen assert. Fishermen have been doing less business each year for some time. Tugs have been going farther and farther out each succeeding season and now nets are set as much as five hours run from shore, but even in these unfrequented waters there are few fish." (Sault Express Nov. 25, 1910).

For approximately 30 years, prior to World War I, the Thunder Bay-Black Bay area sustained total annual whitefish catches of 68,000 to l67,000 kg:

> 'The catch of Whitefish taken from the waters in the vicinity of Caribou Island beats all records... nearly 32 tons... (one fisherman] with a gas boar from Oct. l5th to Dec. 15th killed over 10,000 lbs. of Whitefish.
>
> The estimate of Whitefish peddled all over the city over and above what went through the Booth fish house is 40,000 lb. The above catch does not include the spring fishing by three tugs, 30 days fishing in Thunder Bay. Each Tug kills Whitefish and Trout 24,000 lb. Nearly all the fish were killed at the lower end of the Bay." (McNab Dec. 31, 1920).

The Kaministakwia River spawning stock met its demise prior to 1920, possibly a victim of the combined effects of dredging and dumping of grain screenings into the river (McNab Sept. 18, 1920; Oct. 4, 1921). At an input rate of 500,000 bushels each fall, this pollutant was once regarded as a serious problem afflicting the western fisheries:

> '... the screenings sometimes comes up in lumps when the nets are lifted and ii has been known whitefish and trout being caught with swelling of the gills with seeds stuck in their gills and also the herring." (McNab Dec. 10, 1923).

Screenings were known to drift far beyond Thunder Bay.

LOCAL VARIETIES

Size classes of whitefish varied among the spawning grounds. The small "number-one" fish so common about Gros Cap, for example, were supplanted by medium to jumbo-sized fish on the western shoals of the Sandy Islands and along the north end of Parisienne Island. Local fishermen of the last century claimed the existence of whitefish peculiar to Batchawana Bay (Ontario Game and Fish

Commission 1892). Barnston (1874), once factor of the Hudson's Bay Company's Michipicoten Post, recalled:

> "... in spring we sometimes had sent to us from a small outpost at Bachewaino Bay a fish or two, longer than our own and much thicker and heavier... I never had an opportunity of submitting these white-fish to a close comparison with the large specimens taken at the Sault Ste. Marie, below the rapids, but I conjecture they might be the same species."

Reaching a maximum depth of 45 m, the eastern half of the bay is effectively separated from the main lake by Batchawana Island and its shoal zones. Partial isolation of resident deep-water species appears to have promoted stock formation among lake trout, as well as whitefish (Goodier 198 l).

Whitefish of Nipigon Bay, as compared with those of the main lake, also traditionally tended to weigh less (averaging 1.4 kg or 3 lb during the 1950s) and to possess shorter but deeper bodies. Samples collected by the Ontario Ministry of Natural Resources between 1975 and 1978 revealed some of the oldest mean ages but smallest mean length distributions found in western waters. Fishermen have always been of the opinion that the bay fish avoid the main lake and make only occasional forays into Moffat Strait or Nipigon Strait (as far as Moss Island; W. Schelling, pers. comm. 1980).

Certain whitefish were evidently transients to the bay. In August (but rarely during the spawning months), fish of high fat content would appear on the north shore fiats west of Burnt Point (St. Ignace Island). Similarly, fat whitefish would enter the 45 m deep waters extending northward from Nipigon Strait; F. Legault (pers. comm. 1980) knew these as "red-nosed whitefish", so-called because of a slight tinge of colour on their snouts. In the experience of G. Gerow (pers. comm. 1981), a fisherman for many years prior to 1955, large whitefish were rare in Nipigon Bay at spawning time, but could be captured up to 10 kg (22 lb) at other times.

In addition to migrant fish from the main lake, fishermen also recognized a resident population whose members lend to be shorter but somewhat fatter:

> “The Black Bay whitefish appear io be notably deeper bodied, on the whole, than those from the open lake. The meager data on hand also indicate that the bay fish tend to have fewer lateral-line scales, as in the case of the Lake Erie race, which is also deeper bodied... The *artedii* of Black Bay are known also to be deep bodied, and both the whitefish and the herring show the same general characters that these species exhibit in Lake Erie. It is probable that in each case the peculiar characteristics are a response io the environment. While there are no data to indicate exactly what the environmental conditions are, it is known that Black Bay is conspicuously shallower and warmer than Lake

> Superior and even than other much smaller but more open bays near it… It is noteworthy also in this connection that the whitefish and herring of Lake Winnipeg and certain other shallow lakes, which must become fairly warm in summer, show the same peculiar features...[Black Bay Whitefish} were notably small, according to the fishermen, not often exceeding 4 pounds in weight." (Koelz 1929).

Thunder Bay has undoubtedly supported a number of different stocks. One fisherman, G. Tyska (pers. comm. 1980), identified four visibly distinct whitefish groups on these grounds. Near Kent Island (Amethyst Harbour) and south of Lambert Island, there spawns a hump-backed form of variable colouration. At Amethyst Harbour the whitefish of late fall are rounder-bodied, with smaller head, and (frequently) orange-coloured fins. A third, smaller variant, dark of body and fin with more pointed tail, is found on the shoals north of Caribou Island between October 20 and November 1. Finally, whitefish averaging 1.4 kg (3 lb) with long thin bodies spawn over shoals south of Blende River.

In July whitefish collect near Mutton Island (near the Kaministikwia River) and there many become tainted with industrial pollutants. Nicknamed "diesels", these fish are again found at Melancon Point in September, although it is the experience of certain fishermen that they form no part of the spawning runs. Purvis (1977} suggested:

> " . This might indicate then, that the run comes from possibly a mid-water source and that the tainted fish or 'phenols', as they are often called, are a discrete stock and spawn in an, as yet, undiscovered location".

Diesels may rove as far as Grand Portage Bay, 56 km to the south, where tainted fish periodically are captured (Neil 1970).

In the l800s men of the Hudson's Bay Company post at Fort William exploited two inshore runs each summer, the first occurring in late June or early July, and the second in mid-August (Goodier 1984). According to Purvis (1977) the first run generally occurs in mid-July and lasts approximately one week. Similar patterns of pelagic and inshore movements probably occur widely throughout the lake. Along the Minnesota shore:

> " [Whitefish] come in certain areas. In spring they're usually out deeper and then it starts warming up, then there's a trout and whitefish run that comes in real shallow. Thai come right in next to the beach. Then later on in the summer, you'll get them all along, but not as good. Then in August they get sluggish. They don't move. The fish are there but they don't move fast enough to gill even. ... a lot of them go out on the surface." (Ogberg 1977).

HATCHERY EFFORTS

Lake Superior has a long history as both source of whitefish spawn and recipient of hatchery-reared whitefish fry. To supplement eggs from indigenous stocks, spawn drawn from whitefish at the Mud River site, Lake Nipigon were raised at Port Arthur hatchery in 1912 and 1913 (McNab Oct. 4, 1913). Supplies of eggs from the waters of Whitefish Lake filled American hatcheries from as early as 1885 and Port Arthur hatchery between 1914 and 1917. By this time yields were falling amid reports that this lake had been "fished out", and spawn-taking operations were abandoned (McNab Nov. 15, 1914; Sept. 19, 1919). Dominion hatcheries also maintained an active trade in surplus, and during its period of operation Port Arthur hatchery received whitefish eggs from Collingwood, Kingsville, Sandwich, Thurlow, and Wiarton hatcheries, as well as from Pelican Lake (in 1921). In addition to Lake Superior, certain regional inland waters also received fry: in 1920 these included lakes Nipigon, Long Lake, Shebandawan (these three also receiving lake trout), Kashabowie, Wabigoon, Whitefish, and Little Long Lake (Ont. Dept. Lands and Forests Ann. Rep. 1920).

The culture of whitefish continued ai the Sault Ste. Marie hatchery until 1952, drawing heavily from Bay of Quinte stock. At this time "it was found to be biologically unsound to produce whitefish fingerlings and plant in large numbers" (Hatchery Inspection Report 1956).\

LAKE HERRING, *Coregonus artedii* (Figs. 5-7, Table 2)

Lake herring are pervasive throughout Lake Superior. When spawning these fish are less site selective than whitefish, and Scott and Crossman (1973) note a wide range of acceptable substrates. Traditionally, however, many of the major spawning aggregations have been on grounds also favoured by whitefish. At various locations this no longer remains the case.

The processes and patterns of transformation experienced by the lake's herring populations have been reviewed by Rahrer and Elsey (1972), Lawrie and Rahrer (1973), Lawrie (1978), Hamilton (1978a,b,c), Jacobson et al. (1987) and Selgeby (1982). Until the mid-l960s, almost all of Ontario's production came from the waters of Black Bay and Thunder Bay. Eastern harvests (predominately from south of Cape Gargantua) increased from 8,240 kg in 1964 to a record 329,440 kg in 1970. Subsequent years were marke4 by production losses. These became obvious in the western fisheries after 1965, although catches began to stabilize during the 1970s. As

noted by Lawrie (1978), production failures probably occurred during a fishing-up process of semi-discrete stocks, a process which may have begun long before annual production statistics gave cause for concern.

One should be aware that fishermen have a tendency to classify as herring breeds those chub species captured in shallow herring nets. Terminology can be confusing. Many stocks and certain species have become rare, and retrospective identification is sometimes difficult. Fishermen report, "herring and chub are not the same" as they were 40 years ago.

Fishermen report localized depletions of the herring stocks. The former abundances of the GrosCap area are now past:

> "For more than a decade their presence has been minimal on the St. Mary's River. The most strongly supported reason for the decline has been a changing environment caused by the dumping of wastes from the Algoma Steel Corporation in the upper river, near Gros Cap." (Purvis 1977).

Once herring were plentiful in spring on the grounds northwest of Corbeil Point, but have declined in recent years. On the other hand, fishing has improved at Griffon Reef (O. Bjornaa, pers. comm. 1981).

A number of traditional spawning schools existed about Michipicoten Island. Also, each summer, fishermen would float gill nets and capture numerous herring as they moved into Quebec and False harbours; in the early 1980s fishermen of the region believed these populations to be failing.

The northeastern shores of Lake Superior do not support commercial herring fisheries. Peninsula Harbour continues to receive herring in November, although effluent and debris from the American Can paper mill is undoubtedly deleterious. During the era of the Hudson's Bay Company, Heron Bay and the Pic River mouth were popular reining sites for the herring available (at least in small numbers) from mid-May until late July (Goodier 1984). According to MacMillan (1951), herring would crowd the Pukaskwa River in mid-July:

> "The river from Anchorage pool out to the sand bar was just alive with Herring. You could look over the side of the boat and down as far as you could see in the water was layer after layer of Herring."

In response to the food demands generated by World War I, a herring fishery was established in the Nipigon Bay and Rossport area. Production in 1914 totalled over 136,000 kg (a figure including some percentage of chubs; Canada. Department of Marine and Fisheries, Ann. Rep. 1914). In recent decades, however, there have been no commercial fisheries, and most herring are caught incidentally.

Without a fishery, the current status of stocks in the Nipigon Bay area is difficult to assess. Once

waters near the town of Rossport were a "mass of herring" in the fall, and local citizens would snag fish from the point or the dock. It was in the 1920s that F. Legault (pers. comm. 1978) first perceived the species to be failing. Most of Lake Superior's commercial herring have traditionally come from Thunder Bay andBlack Bay:

> "Thunder Bay seemed alive with fish, and in some cases as much as twelve tons were taken in one lift." (Ontario Department of Game and Fisheries, Ann. Rep. 1911).

The largest tug operating in 1918 hauled 400 tons of herring between November 15 and December 6 (McNab Dec. 31, 1918):

> "... the number of herring killed at Port Arthur last fall is 3300... tons... killed within three miles square. That is the most herring ever killed in Thunder Bay and it is all due io planting out from 8,000,000 each year. ... there was 500 tons of herring killed last fall more than the market required and the result was they had to be sold this spring to the farmers to be taken out and used as fertilizer for the soil, and many car loads shipped out that was refused at their destination. This has ruined the herring market so that I believe that none of those customers will want herring this fall." (McNab Sept. 23, 1919).

Various large-scale schooling movements typify the Thunder Bay herring stocks as they converge upon the spawning shoals. Moving northward toward Pie Island, herring enter pound nets first at Point Caldwell and then at Jarvis Bay**:**

> "In Thunder Bay, out of Port Arthur and Fort William, Ontario, the schools begin moving in from the west between Pie Island and the mainland about the middle of November and spread northward and eastward. They remain until early December and depart then rather suddenly over the same course. While in the bay they are taken at depths of 6 io 25 fathoms on mud and clay bottom... most incredible quantities were a ken by the virgin fisheries." (Koelz 1929).

In eastern Thunder Bay herring are first captured about Thunder Cape, from whence they disperse toward the major grounds of the north end and the Welcome Islands. Variations in the spawning periods at these locations may arise from a diversity of stocks. About Pie Island spawning begins November 20, and north of Caribou Island spawning continues from November 25 to December 15. At the Welcome Islands herring first appear at 36 m in the second week of November, soon commence to spawn and continue to a later date than herring in the north end of the bay (G. Tyska, pers. comm. 1979; V. Bergman, pers. comm. 1981).

Spring weather brings herring into nearshore zones. Much favoured are the waters north of Caribou Island and south of Finlay Bay, where herring move into shallows at the beginning of May. Patterns of wind and weather strongly influence the availability of the schools; these may remain offshore

during cold weather. Herring of southern Black Bay tend to move against the currents, a northeast wind driving the fish farther into the bay. (Interestingly, whitefish seem to behave quite differently, tending to follow the currents toward the main lake; O. Kukko, pers. comm. 1980). Early in September, herring begin to advance through Middlebrun and Magnet channels and spread through the pelagic waters of Black Bay. Floated nets are abandoned when the herring "hit bottom" at 18 to 23 m and move to the spawning shoals a short time later. Two weeks may elapse between the start of spawning in Black Bay and the start of spawning in Thunder Bay. The shallow waters of Black Bay cool rapidly and so encourage earlier spawning.

LOCAL VARIETIES

Local fishermen claim that Black Bay and Thunder Bay harbour different discrete stocks. Koelz (1929) distinguished Black Bay herring, finding them to be deeper-bodied and more compressed than those of the main lake. Black Bay fishermen confirm this statement and recall more than one breed. For example, the ‘blue back” or "black back" herring was a fish possessing dark dorsal colouration and average individual weight of approximately 0.14 kg (0.3 lb; A. Nuttall, pers. comm. 1980). It may have disappeared from Black Bay in the 1950s. There existed also the "bluefin", a fish with dark fins, green-blue back, dearth of fat, and an abundance of parasitic worms. The breed is called a herring by some fishermen and a chub by others. (Koelz (1929) draws attention to the close similarity of Lake Superior lake herring and the blackfin cisco). These fish were once part of the early summer fisheries and might remain in Black Bay for 1-I/2 months. Fall spawning occurred in 4 metres of water or less in bay and shoal areas as far north as Mary Ellen Point. During the 1940s a large bluefin run spawned in Squaw Bay (A. Ronquist, pers. comm. 1980). These fish are a rarity today. According to McNab (Sept. 1923) the Duluth hatchery on several occasions planted "bluefin whitefish" as an experiment.

Green-backed fish were also been captured in Sheesheeb Bay, Blind Channel, and about Bowman Island Harbour in the 1970s, but it is not known if these were herring or a species of chub (P. Hamilton, pers. comm. 1980). At Bowman Island Harbour they moved into 12 to 18 m of water for two weeks each spring.

Since the early 1960s, herring have grown larger and now average approximately 0.5 kg (1 lb) each. Fishermen of western Lake Superior have progressively increased the mesh sizes of their gill nets

from 6.4 to 8.2 cm, stretched measure. According to W. Schelling (pers. comm. 1980), higher percentages of large herring are to be found near Pott Coldwell than in the Rossport region. During the past two decades there has occurred nor only an increase in the average size of herring, but also an increase in their relative fat content. Herring of deeper waters are visibly fatter. At certain depths they undoubtedly mix freely with chub species, and it is a general opinion of fishermen that certain forms are the result of interbreeding.

HATCHERY EFFORTS

Between 1915 and 1920 the Port Arthur hatchery annually planted over 8 million herring fry (of Thunder Bay origin) in local waters. Grounds on the lee side of the Welcome Islands were a prime sites for spawn collection:

> "... According to the number of herring caught last fall in the vicinity of the Welcome Islands, I am of the opinion that the eggs must have reached a depth of at least 14 inches on the bottom of the water... Last fall the total catch of herring reached the 1,986 ions mark; all those were caught in about 2 - 1/2 square miles." (McNab June 30, 1915).

From 1923 to 1926 1.5 million or more eggs were shipped annually to Fort Qu'Appele Hatchery (Lake Winnipeg) and the fish subsequently were distributed in the alkaline waters of Big and Little Quill lakes, Saskatchewan. Prospects for the continued survival of these experimental plants were considered favourable at the time (Canada. Dept. Marine and Fisheries, Ann. Rep. 1925).

DEEPWATER CISCOES (CHUBS), *Coregonus* spp.

Under the umbrella classification "chub", five species once constituted the Lake Superior fishery: bloater, Coregonus hoyi, kiyi, *C. kiyii,* blackfin, *C. nigripinnis;* shortnose, *C. reighardi,* and shortjaw, *C. zenithicus.* All have undergone profound population changes. The larger and more economically important species were successively cropped, and the blackfin was actually driven to extinction in American waters. Bloaters have come to dominate the catch in many areas (Smith 1968; Lawrie 1978).

Canadian waters of eastern Lake Superior have supported a growing chub fishery since the early 1970s. Chub fisheries have been established for longer periods of time in American waters, and certain areas have recently experienced decline in abundance and production (Schorfharr 1977; King and Swanson 1978).

The chub fishery of Canada's western Lake Superior waters is a very recent one. Only low levels of exploitation occurred prior to 1977. C.U.E.s have been far higher than any estimated from eastern Lake

Superior and the American waters of lakes Superior and Michigan (Peck et al. 1974; King and Swanson 1978).

SAULT STE. MARIE TO MICHIPICOTEN ISLAND (Fig. 8)

In southeastern Lake Superior, fishermen have noted changes in the chub populations of certain grounds. Thirty-five years ago "mooneyes‘ *C. kiyi* or perhaps an *artedii* form) could be snagged in trout nets set at about 35 m in Havilland Bay. According to G.A. Jones (pers. comm. 1981), "hookjaw" chub (possibly *C. reighardi*), fat fish weighing up to 0.9 kg (2 lb), were once common off Mica Bay, Alona Bay, and Montreal Shoal but have been scarce since about 1970. Formerly, chub would move into Alona Bay in summer; here, as on a number of other grounds, they now seem to have been displaced by banker lake trout (W. Mitchell pers. comm. 1981). Those chub haunting shallow waters in summer months differed in both colour and body shape from the deep-water "varieties" common at depths greater than 60 metres.

MICHIPICOTEN ISLAND TO SCHREIBER (Fig. 9)

The major chub fishing grounds of northeastern Lake Superior presently exist south of Pori Coldwell, west of the Pic River, and generally among the extensive series of shoals known as the Pic

ank. Fishing along the Pic Bank is conducted from early May until the end of October. In summer chub move progressively higher onto Fred Shoal, reaching their shallowest depth at 30 metres in August. Similarly, chub are located off the Pic River, Playter Harbour, and Willow River for one or two weeks in mid-summer. According to W. Mitchell (pers. comm. 1981), the basin west and southwest of the Pic River yields a brown-coloured chub (possibly *C. reighardi*), highly prized by markets. In his experience, chub from the Mamainse Point area are generally of poorer market quality and include a higher percentage of bloaters.

September months during the 1940s found small "brown-backed" chub in the Slate Island waters around Edmonds Island and westward through the channel south of Mortimer Island (F. Legault, pers. comm. 1980). Spawning habits are not known.

SCHREIBER TO PIGEON RIVER (Fig. 10)

Once a component of the Black Bay fisheries, the "brown-back" chub are said to have weighed

no more than 0.7 kg (1.5 lb) and to have possessed heads broader, but shorter, than other ciscoes (H. Goulet, A. Ronquist, pers. comm. 1980). Prior to 1960, July movements occurred off Demers Point or in the vicinity of Finlay Bay. The brown-back chub is now seldom found in Black Bay nets.

Thirty years ago, G. Tyska (pers. comm. 1980) set nets at about 35 m for the chub congregating around Caribou Island. Chub fishing begins in June in the Thunder Bay region and is now limited by permit to waters greater than 90 meters. Popular grounds exist in the vicinity of Thunder Cape and northeast Pie Island, but recently the fisheries have expanded to include grounds west of Thompson and Spar Islands (K. Maki, pers. comm. 1980). Off Turtle Head (Pie Island) chub are known io spawn in August and September; in spring they attain their greatest concentrations between 110 and 130 m (J. Sameluk, pers. comm. 1980).

ROUND WHITEFISH, *Prosopium cylindraceum*

Round whitefish or menominee occur widely throughout the lake, although only a small number of fishermen actively seek this species; commercial production was a record 54,070 kg (118,950 lb) in 1975. According to Koelz (1929), the fish ran into creeks around Gargantua and Michipicoten Island in the fall. In the 1950s menominee would foul seine nets by the thousands and hamper lake trout spawn-taking operations at the Dog (University) River (W. Sanders, pers. comm. 1978). The Michipicoten River still receives a spawning run in mid-November. Menominee will also enter this river in May, coincident with upstream movements of rainbow trout and smelt. Other heavy concentrations have been reported about the Lizard Islands, Parisienne Island, and southern Black Bay (especially about northern Edward Island).

SALMONINAE

RAINBOW (STEELHEAD) TROUT, *Oncorhynchus mykiss*

Rainbow trout joined the lake's aquatic community in 1883 when the Ontario provincial government introduced fish of McCloud River, California origin to waters near Sauli Ste. Marie (Huxtable 1936). The species thrived and by 1912 had grown to a sizable population in the St. Mary's River rapids:

> "... a specimen of 14 lbs weight [was] caught by angling in the Canadian waters of the Soo Rapids in 1909, while in the press of 1910 the capture in a net of a monster weighing 35 lbs was recorded as a fact. Doubtless in the course of time it may be expected io spread west into all the streams entering Lake Superior and indeed a small specimen of about 1/2 lb. weight was caught as far west as Steel River in 1910". (Ontario Game and Fisheries Commission 1912).

According to MacCrimmon (1971), the earliest plants of trout classed as steelhead were made io Isle Royale streams by the Minnesota Fish Commission in 1895, while Canadian efforts began in 1912 (when fry were planted in McVicar Creek, Port Arthur). However, McNab (24 July 1917) claimed to have personally placed steelhead fry of Columbia River origin into McVicar Creek in June 1894. Two thousand more were planted in 1899.

By 1901 steelhead salmon were being hauled from Canadian pound nets and a year later were reported to be common in American waters (Canada. Dept. of Marine and Fisheries, Ann. Rep. 1902; MacCrimmon and Gots 1972). An annual harvest of about 900 kg was being drawn from McVicar Creek by 1914. Inspired by such success, the Port Arthur Hatchery experimented with spawn-taking operations at McVicar Creek and the MacKenzie River (McNab Nov. 15, 1914):

> "... they range now from Port Arthur to Otter Head. Last summer a great number of them were caught in Portage Creek which empties into Black Bay, and in the Mackenzie River. One man caught 12 weighing 2 lb. one mile from the shore of Thunder Bay. Those were caught about the middle of July." (McNab April 24, 1915).

Following a hiatus in the provincial stocking program hetween 1923 and 1934, rainbow trout were introduced into many eastern Lake Superior watercourses, including the Agawa, Montreal, White, and Current rivers. Progeny of stocks from the Rogue River (near San Francisco) and a privately-owned Montana pond were also utilized (W. Sanders, pers. comm. 198 l). Prior to 1945 the Sault Ste. Marie hatchery deposited fingerlings at points where selected rivers crossed the railway line. In support of these experiments, the Algoma Central Railway would install a special car equipped for the transport of live fish. The Montreal River, for example, gained renown for its trout, and it was a popular fishing excursion to ride the train northward from the Soo, debark, and raft down the river to its mouth.

Rainbow trout spawn in the St. Mary's Rapids from May 15 to early June, but may inhabit the river throughout July. In the Wawa district:

> "... the peak rainbow trout run occurs during the first one or two weeks in May coincident with peak spring runoff and stream temperatures ranging from 10-15

°C." (Thomas 198la).

Spawning runs of rainbow trout tend to succeed but overlap those of smelt, although it is not unusual for trout to avoid streams until peak densities of smelt have abated. Spawning in the Heron Bay and Marathon areas usually commences late April and continues until about May 15.

BROWN TROUT, *Salmo trutta*

The state of Michigan introduced brown trout to Lake Superior around 1883 (MacCrimmon et al. 1970). Now widely distributed along the American south shore, expansion into Ontario waters has nevertheless been slow, and the species continues to occur only in small isolated groups (Lawrie 1978). In 1955 brown trout were raised at the Port Arthur hatchery and planted at an unknown location.

The first brown trout from Thunder Bay district was captured off McKellar Point on October 20, 1951: this specimen was in spawning condition, measured 52 cm long, weighed 1.8 kg, and was afflicted with a vertebral deformity (Anon n.d.). In 1977 a few young-of-the-year and yearlings were found in McKellar Creek. Small populations have also been noted at the Steel, Doré, Magpie, and Michipicoten rivers and Mink Creek (Gots 1979a, 1979c; O'Grady 1980). Incidental catches have been made at Otter Cove, Morrison Harbour, Neys Park, and Holly Creek, including specimens of 5.9 and 7.7 kg from the last two sites (McCulloch 1977; Gots 1979b).

BROOK (SPECKLED) TROUT, *Salvelinus fontinalis*

Brook trout kas always been a pervasive native species:

> 'On Lake Superior there are hundreds of creeks and several large Rivers full of Speckled Trout; Current River, McKenzie River and various creeks in Thunder Bay, near to Fort William. Capt. Dick, of the "Rescue" has taken very large Speckled Trout in Current River. On the various Lakes (16 in number) on Michipicoten Island, and a creek running into the Quebec Harbour, they are plentiful and of large size. In a creek near to Michipicoten Fort they are said to be numerous, and in nearly all the streams from Gros Cap to Current River they abound. I have been told by reliable parties - men who have been in the Hudson's Bay Company's service for years - that in the Rivers entering into Black and Nipigon Bays, they are to be seen as large as the Salmon Trout, weighing 10 to 13 lbs." (Gibbard 1860).

The species has also been among the most susceptible to degradation of its stream habitat.

At the St. Mary's River, Lanman (1847) reported abundances unsurpassed in his experience. Tourist

establishments and guides prospered as sportsmen dropped money into local coffers. However, an apparent decline in the river's population was noted in 1882 and attributed to the extravagant destruction of small fish during the summer months and to poaching and ice fishing in the winter (Canada. Dept. of Marine and Fisheries, Ann. Rep. 1882). Luard (1950) noted the belief held by many local residents, that propagation of rainbow trout within the St. Mary's River was in part responsible for brook trout losses. Nevertheless, construction of the Canadian and American lock systems prior to l9tXI, water level fluctuations, and stream modification were probably most detrimental.

The Ontario Game and Fish Commission report of 1913 distinguished the Steel River as a superb trout stream. Both Agawa and Michipicoten rivers also received significant runs (Herrick 1863); the Michipicoten River continues to attract feeding brook trout to its mouth each spring and upstream spawners each fall. Periodically during the past century, human activities (including hydro-electric dam construction in recent decades; MacCallum 1977) have had adverse effects on its trout and other river fish:

> "For fifteen years now there have been mining operations on the Michipicoten for ten miles up-stream from Lake Superior. The blasting has killed and driven out the trout." (Alexander 1911).

The Michipicoten was quite susceptible to storm damage, and siltation and disruption of spawning beds:

> "... The flood swept down the Michipicoten River like a tidal wave. All the low lying land was covered with several feet of water, thousands of cords of pulpwood stacked along the river banks were swept on with the flood. The large boom at the Mission was torn from its moorings and 1l,000 cords pulpwood swept out into Lake Superior.' (Sault Star 2 July 1920).

Degradation of aquatic life by lumbering activities is difficult to assess, but probably has been significant at certain localities. Dams were built to facilitate log drives, which disturbed river bottoms and deposited large quantities of bark. Large-scale rafting down the St. Mary's River developed between 1880 and 1890 (Anon. 1965). The first drive down the Pic River was in 1891; other major rivers of transport for many years included the Michipicoten, Little Pic, Steele, Aquasoban, Nipigon, Black Sturgeon and Wolf rivers. Sheltered areas, such as Jackfish, Heron and Terrace bays, Peninsula Harbour and the inner Slate Islands, served as storage areas for wood prior to its collection in large booms and rowing to the mills. Fishermen frequently found cause to complain about the stringy bark and stray logs ("deadheads') which fouled the grounds and damaged their nets (Eastern Lake Superior Association of Commercial Fishermen

1954). Certain indirect effects of logging also impinge upon stream communities: increased erosion of shoreline and siltation, loss of shade cover through tree removal, and so on. Extensive deforestation occurred prior to l900:

> 'Along the Pic, Pays Plat and Gravel rivers a considerable quantity of timber has been removed in the past, as evidenced by wood roads and choppings.“ (Collins l906).

During the past twenty years notable fluctuations in abundance have occurred within certain stocks. Concerning the Port Coldwell to Rossport region:

> "In conversations with local "coasters" fishermen, particularly with Willie Heinrich, an ardent long time enthusiast, it appears that this condition started approximately five years ago and has become progressively worse. "Hot spots" for coasters such as McKellar Harbour and Bead Island are just nor producing anymore. A few speckled trout are taken in early summer at outlets of tributary streams but as the summer progresses the catch becomes insignificant." (Anon. 1968a)

("Coasters" are brook trout which inhabit the main body of large lakes. Often large, in Lake Superior coasters move inshore at ice break-up and in mid-summer at certain locales.) H. Bussineau (pers. comm. 1978) reported that the once abundant populations of Indian Harbour have disappeared.

The federal hatchery at Port Arthur and the provincial hatcheries at Port Arthur, Dorion, Sault Ste. Marie, and Tarentorus have all participated in the culture of brook trout. In 1912 the Port Arthur dominion hatchery began seeking brook trout eggs at Lake Nipigon's Surgeon River rapids, Wendigo Bay, and West Bay (Lesprence 1915). Small numbers of brook trout were planted into Lake Superior waters at Nipigon River (in 1914), St. Ignace Island (1915), and the Blende River (1917). Other bodies of water stocked during this period included Leon Lake and Lake Helena (McNab June 18, 1913).

LAKE TROUT, *Salvelinus namaycush*

Former spawning and fishing grounds of native lake trout have been outlined by Goodier (1981). Varieties distinguished by fishermen are discussed in detail and so are not considered here. Following is a summary of hatchery efforts on Lake Superior.

Prior to 1920 the Port Arthur federal hatchery obtained its lake trout spawn from grounds throughout Superior (Thunder Bay, Rossport, Port Coldwell, St. Ignace Island, Michipicoten), various inland lakes and occasionally depended upon additional supplies from the hatchery at Wiarton. Inland sources included Arrow, Allen, Kashabevia, Long and Nipigon lakes. Of the Sturgeon Rapids spawning run on Lake Nipigon (McNab Oct, 4, 1913) wrote:

> “The rapids in that river were so crowded with salmon trout that their fins were almost worn, just the same as the salmon running up the rivers."

Between 1918 and 1926 approximately 200,000 eggs were shipped annually to the Banff federal hatchery (McNab Dec. 31, 1923).

Following the devastation of Lake Superior's lake trout populations in the 1930s, the Ministry of Natural Resources energetically sought egg supplies from a host of provincial lakes (summarized for the period 1950-1970 in Table 4). Certain of these were especially important.

Lake Manitou, Manitoulin Island, for example, has been a prime source of lake trout eggs for many years. Since 1959 the Ontario Ministry of Natural Resources has annually returned to the lake yearlings (of predominantly native stock) to guard against depletion. Federal involvement with Lake Manitou predates that of the province. In 1904 the Department erected a hatchery, and in the course of the following 3 years 150 million young whitefish (from Lake Erie) and 10 million lake trout were raised planted. In 1905 fisherman S. Fraser leased the lake from the department for 20 years:

> ". . In 1910 fishing in the lake was [again] started. It was then five years since the first whitefish was put in, but they did not average over one pound weight, although they were increasing fast in numbers, so fishing was stopped... There were plenty of whitefish but... the food is not in the lake for the fish to grow on, as there are more suckers than whitefish and they eat the whitefish food. I am now asking your help to enable us to realize something out of this venture, by passing an order-in-council allowing whitefish one pound and over to be taken out of Lake Manitou... I also think 1 can repair the Hatchery, which has not been in use for some time..." (Fraser 1920).

In 1958 4000 lake trout of Lake Superior Dog River spawning stock were planted in Lake Mishibishu of the Dog River system. In 1963 a further 5500 fish, many of Montreal River brood stock, were planted in Mishibishu and nearby Mishi and Katzenback lakes. At the time, their fish communities were comprised solely of white suckers and minnows, a condition which may have existed for some time:

> “... It is remarkable that Michi-Biju Lake, Michi Lake, and Katzenback Lake contain no fish, although they are all good-sized bodies of fine clear water. The absence of fish is said by Indians io be due io the presence of certain sulphur springs, but I could find no visible evidence to support this hypothesis.” (Bell 1905)

Mysterious sulphur springs notwithstanding, the original plants survived and spawning occurred for the first time in 1961. However, due to continuing slow growth rates and the emaciated condition of **many** specimens (appropriately named ‘racers‘ or ‘razorbacks“, and also noted among trout stocks at Superior

Shoal and in Lake Nipigon earlier in this century; Goodier 1981), in 1965 and 1966 the Ministry of Natural Resources successfully introduced Lake Superior herring as a forage base.

Fish in Katzenback Lake were larger than those of the other two lakes. Also, during the course of spawn-taking operations in 1972, four groups of trout visibly distinct in body form and colouration were noted: the so-called silver grey, yellowfin, redfin, and dark brown shoal-spawned types (Stinnissen 1972). The reason for this variation from the original river-spawning type is not known. Interestingly, these types correspond to native shoal- and river-spawning stocks which were once distinguished by fishermen of Lake Superior (Goodier 1981).

The planted trout of Killala Lake (Geraldton District) were raised in the hatcheries of Dorion and Port Arthur. Fish deriving from this introduced stock tend to be a silvery cast with reddish fins, and are easily distinguished from the smaller and darker natives. The introduced stock are located in the located at the southern basin andcommence annual spawning at a somewhat later date (Goddard and Odorizzi 1961).

ATLANTIC SALMON, *Salmo salar*

In 1912 Atlantic salmon eggs from the Miramachi hatchery were transferred to Port Arthur. A total of 304,000 fry were released in Nipigon River, Rossport area streams, and rivers tributary to Thunder Bay, and Loon Lake received an additional 20,000 (McNab May 4, 1912). For a time they thrived, and after only two years specimens weighing 1.0 kg were captured in Thunder Bay. In 1915 salmon ran 19 km up the Nipigon River to complete their spawning at Camp Alexander on June 20; two specimens weighed 1. 1 and 1.4 kg. By 1920 there were reports of spawning in the Blend and Mackenzie Rivers of Thunder Bay (McNab Nov. 1914; June 30, 1915; Feb. 23, 1920).

Stocking was discontinued after 1923, and extinction seems to have beset the various Atlantic salmon runs during the 1920s or 1930s. The state of Wisconsin planted salmon in 1972 and 1973, but few were recaptured and the experiment was deemed a failure (Lawrie 1978).

PINK SALMON, *Oncorhynchus gorbuscha*

Events surrounding the accidental introduction of pink salmon to Thunder Bay in 1956 and the startling viability and dispersal of the species throughout Lake Superior and ultimately the other Great

Lakes, have been outlined in various papers (Nunan 1967; Kwain 1978; Kwain and Lawrie 1981; Emery 1981). The different stocks display considerable seasonal and geographical variation in spawning period. South of Michipicoten Bay, salmon may enter rivers throughout September, reaching peak numbers during the second week of that month (Kwain and Lawrie 1981; Thomas 198 lb). River runs of Terrace Bay district occur progressively later from the west to the east; the years 1975 and 1977 were heavy, spawning occurring in the Jackpine River around September 20 (Townes 1976; Swanson 1978). The Steel River run of 1979 lingered from early September until mid-October but peaked about October 3 (Kwain and Lawrie 1981).

Typically pink salmon mature in two years and so spawn in odd-numbered years; however, since 1976 certain Lake Superior stocks have apparently acquired even-year habits (Kwain and Chappel 1978). Populations appear to have significantly declined since 1980 (MacCallum and Selgeby 1987).

COHO SALMON, *Oncorynchus kisutch*

Initial introductions of coho salmon were made in 1966 by the state of Michigan. Minnesota followed suit in 1969, and in its turn Ontario planted 78,000 yearlings in the Jackpine and Gravel **rivers** of Nipigon Bay between 1969 and 1971 (Lawrie 1978). Coho have subsequently been reported at many places along the Canadian shore. In 1979 schools of 5 to 7 cm fish, identified as coho salmon parr and reportedly numbering in the "tens of thousands", were observed feeding on insects along the shoreline of Michipicoten Bay in July (Orr 1979).

CHINOOK SALMON, *Oncorhynchus tshawytscha*

Chinook salmon have been planned by the states of Michigan since 1967 and Minnesota since 1974 (Lawrie 1978). On October 30, 1974, an 11 kg chinook was caught at the mouth of the Dead River, Nipigon Bay (Haas 1974b). Ontario Ministry of Natural Resources employees have since identified specimens near Red Rock in 1977 and below Scott Falls on the Nipigon River in 1979, and G. Primeau (pers. comm. 1981) has found chinooks in the St. Mary's River.

PERCIDAE/ESCOCIDAE

YELLOW PERCH, *Perca flavescens*

SAULT STE. MARIE TO MICHIPICOTEN ISLAND (Fig. 11)

In eastern Lake Superior yellow perch are generally limited to Goulais, Havilland, and Batchawana bays, where they are the dominant species of the angler's creel. Average annual commercial production south of Cape Gargantua was 1653 kg (3640 lb) between the years 1976 and 1980. Spawning occurs in early June.

SCHREIBER TO PIGEON RIVER (Fig. 13)

The Nipigon Bay perch fishery began in 1974; the year 1977 showed a peak commercial production of 10,130 kg. Red Rock's sports-fishing industry, which had collapsed with the loss of the walleye, was resurrected as perch fishing became increasingly popular. Fishing currently centres about Hughes Point, where perch move inshore in June to spawn. In addition, the species spawns 4 km south of Five-mile Point and is to be found in Fire Hill and Mazokamah bays.

Log rafting in Nipigon Bay seemed io attract perch, and good net catches were often made near the boom edges. W. Schelling (pers. comm. 1980) noted an apparent decline in commercial catch subsequent to the abandonment of rafting. A similar phenomena has been noted among walleye of Black

Spawning in Black Bay occurs in May and is concentrated in that part of the bay north of Granite Point. With the decline of the walleye, fishermen shifted effort to perch, and the fishery developed rapidly; from 2,620 kg in 1970 to 59,345 kg in 1976.

WALLEYE (PICKEREL), *Stizostedion vitreum* AND NORTHERN PIKE, *Esox lucius*

Around 1868 Sault Sie Marie's commercial fishermen would set pound nets near the town in May to catch pike and pickerel of the upper St. Mary's River, as well as targeting Lake Huron stocks of Mud, George, Echo, and Hay lakes (Canada. Department of Marine and Fisheries, Ann. Rep. 1972; United States Commission of Fish and Fisheries 1887). The western pickerel fisheries of Black and Thunder bays began in 1878:

"Pickerel were caught in large quantities. When pickled, these fish can only be

> disposed of in United States markets, and at a time when the navigation is closed. Owing, however, to the spirit of enterprise and energy of some of the fishermen, a market for fresh pickerel was found this year and a good business done in that line.“ (Canada. Department of Marine and Fisheries 1880).

Despite a growing popularity, pike and pickerel were not infrequently condemned as destructive io spawn: in certain rivers serious efforts were made to reduce their numbers (Sault Star Sept. 24, 1908). Decline in the numbers of these species were reported prior to l900 (United States House of Representatives 1897). One overseer attributed an apparent decline of pickerel (and sturgeon) in Batchawana and Goulais bays to overfishing with pound nets (Canada. Department of Marine and Fisheries, Ann. Rep. 1894). Nevertheless, the Ontario pickerel fisheries as a whole prospered until the collapse of the Nipigon and Black bay populations in the 1960s.

During the 1930s pickerel were propagated at both Port Arthur federal hatchery and Sault Ste. Marie provincial hatchery. Stock at the latter location was from Echo Lake but none was allocated to Lake Superior (Ont. Dept. Lands and Forests, Ann. Rep. 1930).

SAULT STE. MARIE TO MICHIPICOTEN ISLAND (Fig. 11)

Below the rapids of the St. Mary's River, anglers still seek the walleye which Heriot (1807) noted as so abundant. Walleye are found throughout inner Batchawana Bay; important spawning grounds are located along the northern shores of Batchawana Island, and in the Batchawana and Chippewa (Harmony) rivers. Concentrations are also found in the vicinity of the Goulais River, where a spawning run occurs from May until June 15 (G. A. Jones, pers. comm. 1981).

Improved walleye catches reported by some anglers may mark the reversal of a decline noted, especially in the Batchawana Bay area, during the 1960s (Anon. 1965; 1968b). In the early 1980s the species appeared in the Agawa River for the first time (O. Bjornaa, pers. comm. 1981). Catches have been reposed in the Montreal River, also an unusual occurrence. During a 1977 survey of the Michipicoten River, Ontario Ministry of Natural Resources personnel captured walleye 8 km above the mouth (W.-H. Kwain, pers. comm. 1981).

MICHIPICOTEN ISLAND TO PIGEON POINT (Fig. 12, 13)

The large numbers of walleye noted in the journals of the Hudson's Bay company are still to be found along the present day Pukaskwa Park shore. Collecting near the mouths of the Pic and White rivers each

September, walleye swim near the surface and will sometimes move upstream. Spawning occurs in the spring. For many years English Fishery has been known to sportsmen as a prime source of pike (MacMillan 1951). The walleye fishery of Nipigon Bay was established many years after that of Black Bay; it grew to significant dimensions following World War I. Ryder (1968) has demonstrated that the stocks of these two bays are discrete. After spawning in the lower reaches of the Nipigon River in early May, walleye would disperse southward to be intercepted by fishermen in the vicinity of Five Mile Point and the Clay Banks. Lost now are the great populations of the past:

> "A gentleman who revisited the river... is pleased to report that war waged against the pike (which were fast taking control of certain portions of the river) has been a decided success. Some thousands of pike which would average 10 lbs each have been destroyed, as well as large numbers of pickerel (equally destructive of the trout) and suckers. ...there are still large quantities left, and the more that are taken out the better will be the fishing." (Ontario Department of Game and Fisheries, Ann. Rep. 1902).

In 1913 the Ontario Department of Game and Fisheries even recruited men to continue the “war" using hoop nets.

Beginning in 1958 the walleye fishery began to slump, and in the late 1960s numerous deformed fish were appearing in the nets (German 1970). Ryder (1968) concluded that industrial pollution from Red Rock dispatched the walleye. MacCallum and Selgeby (1987), however, suggested that overfishing was also a factor in the walleye decline, citing tagging evidence of Kelso (1977) which demonstrated that other species avoided the effluent plume.

An electrical lamprey weir erected along the Jackfish River may have hastened the demise of that spawning stock (Lawrie 1978). As a source of both walleye and pike, the Jackfish River was long renowned, as both its present name and original French name, Rivière la Pique, attest (Long 1791). Believing recent efforts at water quality control to have been successful, the Ontario Ministry of Natural Resources began 10 years ago to plant walleye eggs in the Jackfish River. Their source was a stock spawning in the Current River of Thunder Bay (Koistinen 1980).

Black Bay supported a walleye fishery from the 1880s until the late 1960s. According to Department of Marine and Fisheries reports, annual production between 1885 and 1890 averaged almost 30,000 kg. Even in the 1920s, when walleye brought only 3/4 cents per lb, the pound net boats would land

in Hurkett "loaded to their gunwales" (N. Thrower, pers. comm. 1978). Walleye spawned at the north end of Black Bay, both east and south of Hurkett Cove. Ryder (1968) also located a minor run in the Black Sturgeon River. In the course of their movements, walleye were captured in pound nets set on the northeast point of Edward Island and were abundant in Finlay Bay in early September (M. Gerow, O. Nordlander, pers. comm. 1980).

As the Nipigon Bay walleye population failed, fishermen escalated the pressure being placed on the Black Bay population. Fishing was heavy between 1962 and 1966, and soon catches started to decline. In 1968 J. Nuttall (pers. comm. 1981) began to discover deformed fish (about the same time they were first noted in Nipigon Bay), and in subsequent years walleye eggs appeared "yellow and hard". The downfall of *S. vitreum* seems to have been paralleled by the loss of the emerald shiner (*Notropis atherinoides*), once abundant in Black Bay. Fishermen turned their attentions to the sauger (*Stizostedion canadense*), today no longer a viable commercial species in Black Bay. The bay is now closed to pickerel fishing.

The Thunder Bay fishery began shortly after 1890. Government statistics (available for the years 1871 to 1922) reveal drastic production losses (for reasons unknown) after the peak years of 1907 io 1911, when an average of 50,000 kg of pike and walleye were harvested each year.

Cultural modifications of stream drainage may have affected a few spawning stocks:

> "... in early days when the country was well wooded pike and pickerel might go up io spawn in the Neebing River. Pike may go a short distance yet but Pickerel will not leave the pure water of Lake Superior. They spawn on the banks." (McNab March 8, 1915).

The Weekly Herald and Lake Superior Mining Journal (July 22, 1888) noted that pickerel (pike?), like whitefish, were plentiful in the Kaministikwia River. South of Thunder Bay, the pickerel which formerly flourished in Sturgeon Bay have now been reduced to a remnant stock; some people blame the effects of angling and cottage development.

ASCIPENSERIDAE

LAKE STURGEON, *Acipenser fulvescens*

Once reviled by fishermen as a coarse fish and destroyer of nets, lake sturgeon in the late l800s assumed a position of esteem and high market demand. Scott and Crossman (1973) chronicle its rise to

favour and outline its diverse market uses. According to one old-time Lake Superior fisherman, there are seven different kinds of sturgeon meat, each delicious. At one time, sturgeon gristle was even employed in the manufacture of ping-pong balls (H. Servais, pers. comm. 1978).

Lawrie and Rahrer (1973) noted a nine percent average annual rate of decline after 1885. Although overexploitation was probably the major cause, river drives and log rafting were also considered by these authors.

SAULT STE. MARIE TO SCHREIBER (Fig. 11, 12)

A small but self-sustaining sturgeon population continues io exist in Goulais Bay, concentrated in the Goulais River and along the shore north of the river's mouth. Once among the most famous of the region, grounds along the southern shores of Batchawana Island continue to support a remnant stock, as do the Batchawana and Chippewa (Harmony) rivers (G.A. Jones, pers. comm. 1981). The largest lake sturgeon ever recorded, 140 kg (310 lb), was hauled in 1922 from a pound net set in Havilland Bay by F. Lapointe. Pound nets ranged along Parisienne Island shore also entrapped surgeon, but the present status of the species on these grounds is not known.

Sturgeon still inhabit Oiseau Bay and the Willow, White, and Pic rivers. Spawners were formerly abundant at Camp 19 rapids on the Pic River (C. MacMillan, pers. comm. 1978).

SCHREIBER TO PIGEON RIVER (Fig. 13)

Black Bay once contained the most productive sturgeon grounds of Lake Superior. Reports of the Department of Marine and Fisheries show average annual production to have been 25,000 kg between the years 1886 and 1890. Prior to 1962 the bay still yielded over 1,400 kg of sturgeon each year. J. Nuttall (pers. comm. 1981) perceived the loss of the sturgeon to have been accompanied by a decline in "crayfish" abundance; in the early l980s both species seem to have been making a comeback. Sturgeon are found in the Black Sturgeon River.

During the l800s, rapids of the Kaministikwia River attracted numerous spawning sturgeon in mid-July (Goodier 1984). In the past, Nipigon Bay also contained important sturgeon grounds (W. Schelling, pers. comm. 1978).

CATOSTOMIDAE, SUCKERS

Reported Canadian commercial landings of suckers reached over 171,711 kg in 1987. It is a general consensus among fishermen that suckers are on the increase.

SAULT STE. MARIE TO MICHIPICOTEN ISLAND

At Parisienne Island, the Sandy Islands, and south of Gros Cap, the sucker populations were on the rise during the 1970s. In eastern Lake Superior, white suckers *C. commersoni*) tend to frequent bay areas, including Gargantua, Indian, and Michipicoten harbours, and Batchawana and Goulais bays. Less abundant are the suckers inhabiting the shore zones of the Lizard Islands. Westerman and Van Oosten (1937) reported large numbers in the St. Mary's River.

Longnose suckers (*C. catastom*us) are not common in Batchawana Bay, preferring instead open areas of shore (G.A. Jones pers. comm. 1981). At Steamboat Island (North Sandy Island) they are especially prolific. Sucker spawning commences late April and usually continues until at least mid-May. Both longnose and white suckers will spawn in streams, although the former tends to arrive earlier but remain for a shorter period of time (Scott and Crossman 1973). Also present within the lake are the silver redhorse *Moxostoma anisurum*) and shorthead redhorse (*M. macrolepidotum*), both fish liable to be confused with the sucker. Redhorses spawn in streams, usually somewhat later than suckers.

MICHIPICOTEN ISLAND TO SCHREIBER

The famous biologist, Agassiz (1850) procured most of his samples of longnose sucker at the Pic River. Somewhat east of Port Coldwell is Red Sucker Cove (a name alluding to *C. catostomus*). Suckers also crowd the waters of Quebec Harbour (Michipicoten Island) and between July and September collect in the vicinity of the hydroelectric tailrace emptying into Terrace Bay. Traditionally suckers have been abundant in Victoria and Jackfish bays, but rare about the Slate Islands (P. Dahl, pers. comm. 1978).

SCHREIBER TO PIGEON RIVER

According to Haas (1974a), suckers usually spawn in and about the rivers of the Rossport area around June 1. During the first week of June, suckers also invade the southern shores of St. Ignace Island, push through

Nipigon Strait, and disperse into Nipigon Bay itself. The bay's fishermen pull their nets during the month of July and avoid entangling mesh with these coarse fish (R. Dampier, pers. comm. 1980).

Wolf River and Postage Creek of Black Bay receive significant sucker runs in the later part of April (Bougie 1973). Suckers are found along many stretches of Thunder Bay shoreline in water of 20 m or less, but are most common in bays (such as Amethyst and Mackenzie bays). Many whitefish fishermen are forced to suspend operations in June (Purvis 1977). Traditionally, suckers throng in and about the Kaministikwia River from early May until July, and for a time supplied the Port Arthur hatchery with a ready source of fish food (McNab Aug. 10, 1920).

OSMERIDAE, RAINBOW SMELT, *Osmerus mordax*

The establishment of smelt in the Great Lakes probably stems from plantings made in waters of the Lake Michigan drainage basin. The inexorable advance of this species throughout Lake Superior following their initial appearance in 1930 in Whitefish Bay has been detailed by Dymond (1944). Now widely distributed, smelt will run into streams a couple of metres wide.

About the shores of Whitefish and Batchawana bays, spawning immediately follows ice-out in the second half of April, while farther north movements in the Old Woman and Michipicoten rivers usually commence between April 25 and May 2 (Thomas 1977-79). In 1959 it was noted that:

> "... the smelt, noticeably absent from our shores in former years as a spawning population, ran in good numbers this spring in streams adjacent to the mouth of the Michipicoten River. There has been some suggestion that the run may have also existed prior to 1951, but for some unaccountable reason was non-existent during the intervening years." (Anon. 1959).

In Jackfish and Port Coldwell areas, runs are on the first week of May and continue for I to 3 weeks. Mid-June the smelt may be found at 27 io 55 m in the Terrace Bay area and for approximately one week are heavily preyed upon by lake trout (I. Johnson, pers. comm. 1981).

At certain times of the year, smelt constitute an important part of the lake trout diet. It is the opinion of many fishermen that lake trout have altered their habits in accordance with those of the smelt and are now available ai places and at times contrary io their behaviour decades ago.

OTHER SPECIES

The burbot *(Lota lota*) is a pervasive species, and fishermen of eastern Lake Superior noted significant

population expansion during the late 1970s and early 1980s, accompanied by increasing fish size (Lawrie 1978; E. LaBlance, pers. comm. 1981). Burbot are common along the western shores of Parisienne Island and the shallows of Batchawana Bay, where it is their habit to spawn in February. According to Organ et al. (1978) spawning also occurs in the rapids of the St. Mary's River.

The burbot of Black Bay are large, frequently exceeding 4.5 kg (10 lb), but averaging 1.4 kg (3 lb). During the 1950s J. Nuttall (pers. comm. 1981) discovered the value of burbot as a mink food, and managed to capture large quantities in a pound net erected at Bent Island. P. Dahl (pers. comm. 1978) would also catch burbot near Jackfish.

The alewife *(Alosa pseudoharengus*), native of Canada's eastern coast, was first reported in Lake Superior in 1954 (Scott and Crossman 1973). It has become firmly established in southeastern Lake Superior, and its populations occasionally reach significant proportions. In the mid 1960s, for instance, local residents reported thousands of fish running in the Michipicoten River (Holder 1972). Since that âme the species kas gained a foothold in western Lake Superior. it is possible, however, that alewives were established in the area of Jackfish prior to 1963 (P. Dahl, pers. comm. 1978). First captures were made in the Pigeon River in 1964 and Black Bay in 1963; a July run exists in the Black Sturgeon River of Black Bay (Affleck 1972; J. Nuttall, pers. comm. 1981).

The first documented gizzard shad from Lake Superior was a 0.7 kg (1 .5 lb) specimen obtained by G.A. Jones in Batchawana Bay during 1961 (Scott and Crossman 1973). However, Burger (1972) reported:

> "... One of the Sault Fishermen said he was 15 years old when he first saw 'them flat fish' ... this would be about 1937??"

Bass species are most prevalent in the warmer waters of southeastern Lake Superior. It was noted by the Ontario Game and Fish Commission (1912): "Bass is on the increase in the St. Mary's River". Smallmouth bass (*Micropterus dolomieui*) and rock bass (*Ambloplites rupestris*) are caught by anglers in Goulais and Batchawana bays, including the Chippewa and Batchawana rivers, and southeast Batchawana Island (Vozeh 1969; W. Mitchell, pers. comm. 1981). Pumpkinseed (*Lepomis gibbosus*) are occasionally found in these areas.

As noted by Lawrie (1978), the sculpin species are "literally everywhere". Myriads occur at Superior Shoal and "Cockatouch (i.e. sculpin) Bank" (27 km due south of Schreiber Point) and are

drawn from Black Bay during the fall trawling season.

Approximately 30 years ago, G.A. Jones (pers. comm. 198l) first captured a specimen of "Mississippi carp", a fish possessing:

> "...a mouth more similar to the bass than the carp, and a dorsal fin like that of a pickerel."

Subsequent captures have been made. Such a description conforms with that of the freshwater drum or sheepshead (*Aplodinotus grunniens*), although Scott and Crossman (1973) note it as absent in Lake Superior. However, a single reference to the drum is made in the 1798 journal of the Hudson's Bay Company post at Michipicoten (Goodier 1981).

CONCLUSION

Fishermen, through long experience with Lake Superior from which they derived their livelihood, came to recognize intraspecific varieties of lake trout, whitefish, herring and chub, differing in time of spawning, appearance, abundance, and movements. Strategies of fishing were gauged to the habits of the different varieties; grounds were sequentially visited throughout the season, mesh sizes were altered, depth of net sets changed. Some stocks were stressed unduly, notably those in the Thunder Bay area and in southeastern Lake Superior. Hardest hit were certain river-spawning stocks including lake trout, brook trout, sturgeon, pickerel, and pike. They were most susceptible to the agents of environmental change: severe storms, dredging, deforestation, log rafting, and pollution. These, along with factors of overfishing, the parasitic sea lamprey, and interspecific competition drove certain stocks to a precarious state of survival and even to extinction.

To alleviate the damage, government agencies embarked on vigourous programmes of fish stocking. However, as noted by Christie (1969), the philosophy of "glorious optimism" which fish culture inspired during the late l800s, gave way finally to wide-spread reassessment and skepticism after the 1930s, and in its wake many hatcheries were dismantled (Van Oosten 1942; Miller 1946). True, the hatchery programs had their success stories, rainbow trout and the salmons; where these species had not existed they developed to flourishing populations. Judging the success, and justifying the costs of introducing already established species is of course more difficult. Fishermen for decades held the belief

that constant inputs of walleye or whitefish to the Great Lakes rejuvenated existing stocks and so were strong advocates of the hatchery program. Nevertheless, the 1943 International Board of Inquiry for the Great Lakes Fisheries was moved to comment:

> "There is some divergence of opinion among those in the fishing industry and among these that have been particularly concerned with the subject either as administrators or investigators as to the value of this work in maintaining the stock of fish. As yet no proof has been furnished that there is actual increase in the stock of fish from such planting of the young. To determine whatever effectiveness their plantings may have is a difficult matter.

Regier et al. (1969) also summarized historical assessments of plantings to the Lower Great Lakes and remarked that the stocking programs may even have acted as destabilizing red herrings by shifting attention away from overfishing and allowing the need for regulations to be downplayed. In this way they in fact hastened the decline of certain stocks.

Efforts at restoring lake trout io Lake Superior have met with some success (e.g. MacCallum and Selgeby 1987), although the re-establishment of a strong breeding population has been slower than was originally hoped. The planting of either non-native strains or the progeny of trout repeatedly inbred in hatcheries are reasons which have been forwarded for failure to adopt to natural habitats. However, in recent years increasing attention has been paid to returning genetic strains to the same general area from which they derived.

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Table 1. Spawning grounds and periods, movements of Lake Superior whitefish.

Location	Approximate Period			Dominant	Weight Range [kg(lb)]			Comment	Source
	Start	Peak	Finish	Variety	Min.	Max.	Avg.		
SAULT STE. MARIE TO MICHIPICOTEN (Fig.2)									
St. Mary's R.					1.8(4)	6.4(14)			McKenney (1827)
							1.8(4)		Michigan State Fish Comm (1874)
St. Mary's R. to Gros Cap shore banks	Nov.1	Nov.10	Nov.20	No.1			0.9(2)	≤ 4 m. Prespawning movements began after mid-Oct.	Van Oosten (1927), Purvis (1977)
Taquamenon Is. (Michigan)	late-Oct.		mid-Dec.						Organ et al. (1978)
Western shoals Sandy Is., N. end Parisienne Is.	Nov.25			medium large	1.8(4)	3.6(8) 9.1(20)		larger fish came later	
Clay R. & Sand R. shore banks, Montreal Is.				large jumbos				18-25 m; now rare	C. Cook (pers. comm. 1981)
Ganley Rock, Griffon Reef			mid-Dec.						
Barrett Blueberry Is.	Nov.10			No.1					G.A. Jones (pers.comm. 1981)
Agawa Rocks, Bald Head				No.1					Purvis (1977)
Michipicoten R., Dog R. (river runs)	late-Sept. or early-Oct.		late-Oct. or early-Nov.				0.7(1.5)	HBC record	Goodier (1984)
NON-SPAWNING MOVEMENTS									
Dog & Isacor banks	May		July	No.1, large jumbo ("slams")				move to progressively shallower waters	J. Purvis & Sons, Ltd. (1934-55); L. Morden (pers. comm. 1978)
Inside Goulais Bay	after ice-out for 2 weeks								W. Mitchell (pers. comm. 1981)
Halfway Bank to Sandy Is.	summer								

(Table 1, cont.)

Location	Approximate Period Start	Peak	Finish	Dominant Variety	Weight Range [kg(lb)] Min.	Max.	Avg.	Comment	Source
MICHIPICOTEN ISLAND TO SCHREIBER (Fig. 3)									
Inside Quebec Hbr., shore banks, E of False Hbr.	Nov.			jumbos					
SW Caribou Is.								pre-1955	W. Sanders (pers. comm. 1981)
Shore between Ganley Hbr. & Richardson Hbr.								Pte. La Candienne especially good	
Entrance Otter Cove	late-Nov.		early-Dec.	large jumbos				pre-1940's	F. Legault (pers. comm. 1979); McNab (Dec. 8, 1914)
NON-SPAWNING MOVEMENTS									
Inside Quebec Hbr.	late July								
Butch, Chummy Hummock, North Bays	summer								
Oiseau Bay	summer								
Entrance Playter Hbr., off Sewell Pt. & Willow R.	spring								
Pukaskwa Flats	June		July	No.1					M. Leblance (pers. comm. 1981)
Terrace Bay on N.E. shore	July		late-Aug.						I. Johnson (pers. comm. 1981)
Victoria Bay	June, late-Aug.-Sept.			jumbos				nets moved into < 30 m as inshore spawning movements began late Sept.	

(Table 1, cont.)

Location	Approximate Period Start	Peak	Finish	Dominant Variety	Weight Range [kg(lb)] Min.	Max.	Avg.	Comment	Source
SCHREIBER TO PIGEON RIVER (Fig. 4)									
St. Ignace Is.						7.7(17)		19th c.	Thomson (1883)
Fluor Is.							1.1(2.5)		
Nipigon Bay, Piledriver Sh. (S. Outer Is.), Craigie's Hbr., (SW Vert Is), N. Grant Pt.	Oct.27-Nov.5		late-Nov.				1.4(3)	1950's best traditional grounds	
Black Bay							1.0(2)-1.4(3)	bay residents	J. Nuttall (pers. comm. 1980)
Shoals of N. Caribou Is.	Oct.20		Nov.1				1.4(3)		G. Tyska (pers.comm. 1980)
Blende R. shore			Nov.1				1.0(23)-1.4(3)		McNab (Nov. 1914, Nov. 3, 1917); G. Tyska (pers. comm. 1980)
Mt. McKay Indian Reserve			early-Nov.						H. Charlie (pers. comm. 1980)
Kaministikwia R. (river run)	Sept.30-Oct.7						0.5(1)	exterminated prior to 1920	Goodier (1984); McNab (Oct. 1921)
NON-SPAWNING MOVEMENTS									
Armour Hbr.	spring				4.5(10)	5.4(12)			P. Hamilton (pers. comm. 1980)
Black Bay	spring						> 1.4(3)	from outside bay	J. Nuttall (pers. comm. 1980)
N. end Thunder Bay	winter								
N. Caribou Is.	May							35 m basin - then disperse westward and eventually move to shore banks	G. Tyska (pers. comm. 1980; Purvis 1977)
Thunder Bay	early July for 1 week mid Aug.							2 inshore runs	Goodier (1984); Purvis (1977)

Table 2. Spawning grounds and periods, movements of Lake Superior herring.

Location	Approximate Period			Comment	Source
	Start	Peak	Finish		
SAULT STE. MARIE TO SCHREIBER (Fig. 5, 6)					
SE whitefish Bay	early-Nov.	Nov.25	early-Dec.		
Nadoway Pt. to Gros Cap Reefs (US)	Oct.		Nov.		Organ et al. (1978)
Penninsula Hbr.		Nov.			
NON-SPAWNING MOVEMENTS					
Michipicoten R. shore banks	mid-May	June	mid-July	also present today	Goodier (1984)
Alona Bay, S of Pancake Bay	spring			also fall	
Mica Shoal, Jockey Lump	summer			no spawners	
Inside Quebec & False hbrs. (Michipicoten Is.)	summer			near surface	
Caribou Is.	Aug-Sept.				
Pukaskwa R.	mid-July				MacMillan (1951)
Schreiber Beach, mainshore N. of Nicol Is.	winter				F. Legault (pers. comm. 1980)

(Table 2, cont.)

Location	Approximate Period Start	Peak	Finish	Comment	Source
SCHREIBER TO PIGEON RIVER (Fig. 7)					
SE of Copper Is.				max 1.3kg (3lb),1940's	F. Legault (pers. comm. 1980)
E of Vert Is. (Nipigon Bay)				avg. 0.1kg (0.25lb)	F. Legault (pers. comm. 1980)
Pie Is.	Nov. 20				
N. of Caribou Is.	Nov. 25	Dec. 1	Dec. 25		
Welcome Is.	Nov. 15				
NON-SPAWNING MOVEMENTS					
Caribou Is., S. of Finlay Bay	early May				

TABLE 3. SPAWNING RIVERS OF SELECTED CANADIAN LAKE SUPERIOR FISH SPECIES (EAST TO WEST)

Location	Species				
	Rainbow Trout	Brown Trout	Pink Salmon	Chinook and Coho Salmon	Smelt
St. Mary's R.	1		1	1	
Davignon Cr.	1				
Bennett Cr.	1				
Roundwood Cr.	1				
Carp R.	1				
Prince Cr.	1				
Unnamed Cr. (6.0 km (N.E. of Prince Cr.)	1				
Unnamed Cr. (1.8 km S. of Cranberry Cr.)	1				
Cranberry Cr.	1				
Goulais R.	1				
Little Goulais R.	1				
Havilland Cr.	1				
Stokely Cr.	1			1	
Harmony R.	1				
Government Cr.	1				
Sawmill Cr.	1				
Jones Cr.	1				
Downey Cr.	1				
Chippewa R.	1			1	
Batchawana R.	1				
Carp R.	1				
Pancake R.	1			1	
Unnamed Cr. (W. Pancake Bay)	1				
Mamainse Cr.	1				
Mica Bay Cr.	1				
Dobson's Cr.	1				
Alona Bay Cr.	1				
Metheany Cr.	1				
Montreal R.	1			1	
Laughing Br.	1				
Speckled Trout Cr.	1		1		
Agawa R.	1		1	1	1
Unnamed Cr. (at Agawa Pt.)	1				
Barrett R.	1				
Sand R.	1		1		1
Coldwater R.	1			1	
Baldhead R.	1		1		
Unnamed Cr. (1.5 km S. of Buckshot Cr.)					
Buckshot Cr.	1				

Table 3. continued

Location	Species				
	Rainbow Trout	Brown Trout	Pink Salmon	Chinook and Coho Salmon	Smelt
Unnamed Cr. (at Gargantua Bay)	1				
Unnamed Cr. (at Gargantua Hbr.)	1				
Gargantua R.	1				
Unnamed Cr. (1.5 km N. of Indian Hbr.)	1				
Unnamed Cr. (N. of Ryan Pt.)	1				
Red Rock R.	1				
Unnamed Cr. (N. of Bushy Bay)	1				
Old Woman R.	1		1		1
Unnamed Cr. (at Brulé Hbr.)	1				
Unnamed Cr. (at Brulé Hbr.)	1				
Unnamed Cr. (at Beauvier Pt.)	1				
Noisy Cr.	1				
Unnamed Cr. (2.5 km N. of Smoky Pt.)	1				
Fort Cr.	1				
Michipicoten R.	1	1	1		1
Magpie R.	1	1	1	1	
Unnamed Cr. (at Michipicoten Hbr., E. of Clergue I.)	1				
Doré R.	1	1		1	
Little Makua R.	1				
Makua R.	1				
Little Bear R.	1				
Mountain Ash R.	1				
University (Dog) R.	1		1		
Feather R.	1				
Unnamed Cr. (0.8 km E. of Tamarock Bay (Creek))	1				
Eagle R.	1				
Ghost R.	1				
Unnamed Cr. (2.4 km W. of Ghost R.)	1				
Unnamed Cr. (2.2 km E. of Floating Heart R.)	1				
Floating Heart R.	1				
Campbell Cr.	1				

Table 3. continued

Location	Species				
	Rainbow Trout	Brown Trout	Pink Salmon	Chinook and Coho Salmon	Smelt
Pipe R.	1				
Unnamed Cr. (5.6 km W. of Pipe R.)	1				
Unnamed Cr. (8.8 km W. of Pipe R.)	1				
Unnamed Cr. (at N.E. end of Quebec Hbr., Michipicoten I.)	1				
Julia R.	1				
Imogen R.	1				
Holly Cr.	1				
Swallow R.	1				
White Gravel R.	1				
White R.	1				
Pic R.	1		1		1
Angler Cr.	1		1		1
Red Sucker Cr. (at Port Munro)	1		1		1
Craddock Cr.	1		1		1
Little Red Sucker Cr.	1		1		1
Mink Cr.	1	1	1		1
Neys Cr. (2.5 km S. of Little Pic R.)	1		1		1
Little Pic R.	1		1		1
Dead Horse Cr.	1		1		1
Ripple Cr.	1		1		
McKellar Cr.	1	1	1		1
Prairie R.	1		1		1
Camp 91 Cr. (3.4 km W. of Prairie R.)	1		1		1
Unnamed Cr. (at Bottle Pt.)	1		1		1
Steel R.	1	1	1		1
Jackfish Cr. (from Jackfish L.)	1		1		1
Aguasoban R.	1		1		1
McCausland Pond	1		1		1
Aguasoban Dam (Terrace Bay)	1		1		1
Lost Cr. (at Les Petits Eorits)	1		1		1
Worthington Cr.	1		1		1
Schreiber Cr.	1		1		
Cooks Cr. (at Schreiber Beach, Collingwood Bay)	1		1		1

Table 3. continued

Location	Species				
	Rainbow Trout	Brown Trout	Pink Salmon	Chinook and Coho Salmon	Smelt
Blind Cr.	1		1		1
Hewitson R.	1		1		1
McLeans Cr.	1		1		1
McKellar Cr.	1		1		
Pays Plat R.	1		1		1
Tedesco Cr.	1				
Brook R.	1				
Gravel R.	1	1	1		1
Little Gravel R.	1				
Gurney R. (0.5 km E. Little Cypress R.)					1
Little Cypress R.	1				
Cypress R.	1		1		
McInnes Cr.	1				
Dublin Cr.	1		1		
Jackpine R.	1		1	1	1
Ozone Cr.	1				1
Jackfish R.	1				1
Firehill Cr.	1				1
Cash Cr.	1				
Nipigon R.	1		1		1
Stillwater Cr.	1		1		
Big Trout Cr.	1				
Little Trout Cr.	1				
Unnamed Cr. (at Moss Hbr.)	1				
Unnamed Cr. (Otter Cove from Moss L.)	1				
Black Sturgeon R.	1		1		1
Little Squaw Cr.	1				
Wolf Cr.	1		1		1
Coldwater Cr.	1		1		
Welch Cr.	1		1		
Pearl R.	1		1		
D'Arcy Cr.	1		1		
Portage Cr.	1		1		
Joeboy R.	1				
Blende R.	1		1		
Mackenzie R.	1		1		
Blind R.	1		1		
Wildgoose Cr.	1				
Current R.	1		1		1
McVicar Cr.	1				
McIntyre R.	1		1		
Neebing R.	1		1		
Kaministiqwia R.	1		1		

Table 3 . continued

Location	Species				
	Rainbow Trout	Brown Trout	Pink Salmon	Chinook and Coho Salmon	Smelt
Whiskeyjack Cr.	1				
Lomond R.	1		1		
Jarvis R.	1		1		
Cloud R.	1		1		
Pine R.	1		1		
Little Pine R.	1		1		
Pigeon R.	1		1		

1 - known

1 - suspected

*Information has been drawn from Anon. (1976) and Ontario Ministry of Natural Resources reports, correspondence, and personnel.

Table 4. Sources of lake trout spawn raised at provincial hatcheries on Lake Superior, 1958 to 1970.*

Source	Years
Port Arthur Hatchery, and Dorion Hatchery (after 1966)	
Lake Simcoe	1958-1959
Lake Manitou	1958-1960
Loch Lomand	1959-1963, 1972
Crowe Lake	1959-1962
Big Trout Lake	1959-1960
Manitoba (Clear, Whiteshell, Atikameg lakes)	1960-1966, 1969-1970
Lake Innis	1960
Dryberry Lake	1962-1963
Baril Lake	1965, 1969-1970
Hill's Lake (hatchery)	1965, 1969-1970
Tarentorus Hatchery	
Lake Simcoe	1959, 1961-1966
Lake Manitou	1959, 1961-1966, 1969-1970, 1972
Lavieille Lake	1961-1962
Lake Opeongo	1961-1962
Ranger Lake	1961-1963
Elliot Lake	1962-1963
Mishibishu Lake	1962-1966, 1969-1970
Lake Superior Broad Stock (Tarentorus T.R.S.)	1962-1966, 1969-1970
Charlevoix Hatchery (Michigan)	1963
Lake Superior Broad Stock (Hill Lake T.R.S.)	1963
Chiblow Lake	1964-1965

*Compiled from records of Fish Culture Section, Ontario Ministry of Natural Resources.

Fig. 1. Lake Superior (from Goodier 1989)

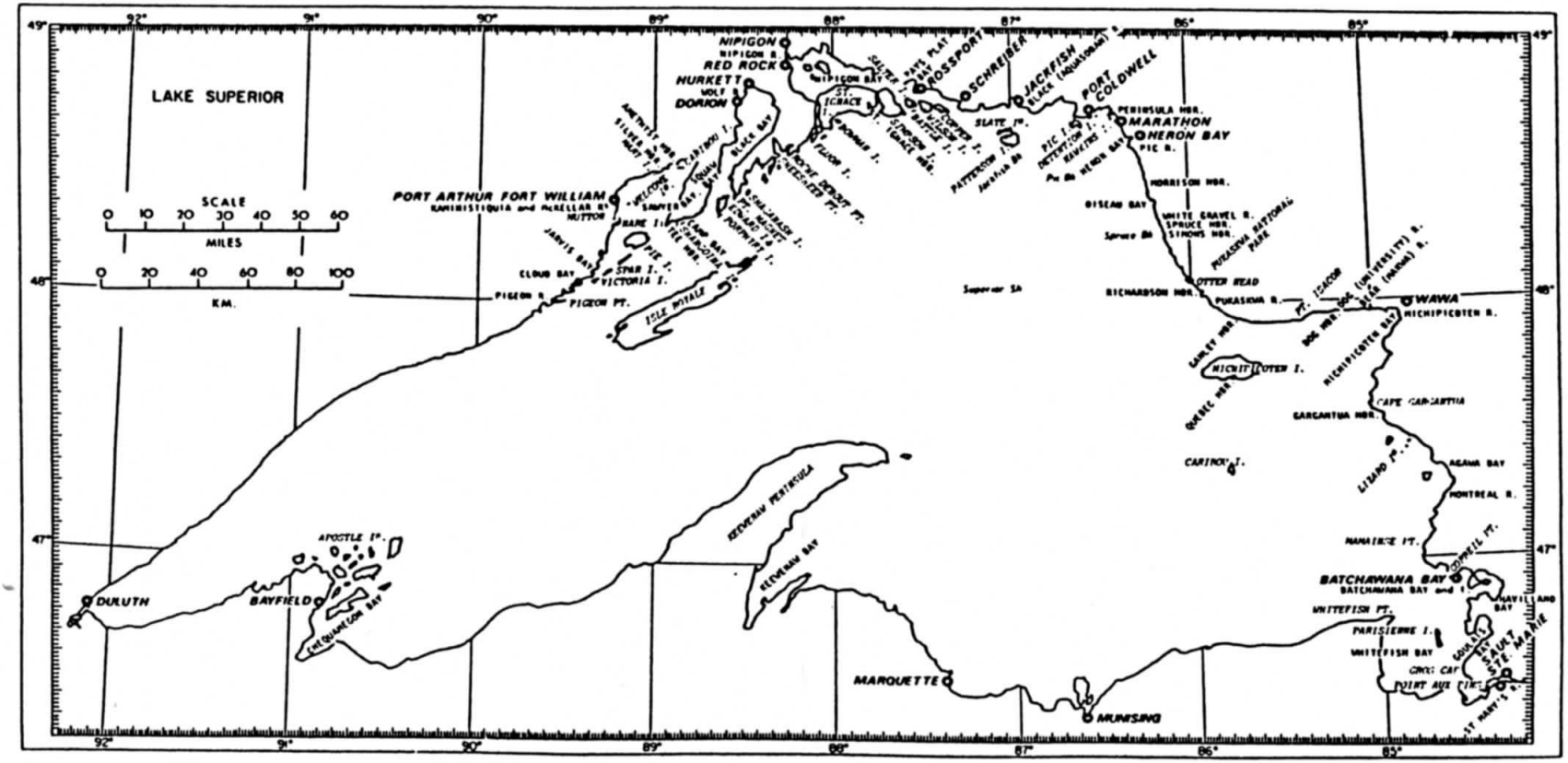


Fig. 2. Spawning grounds of lake whitefish (Coregonus clupeaformis), Sault Ste. Marie to Michipicoten Island. Major ○ , Minor □ , River ↗ .

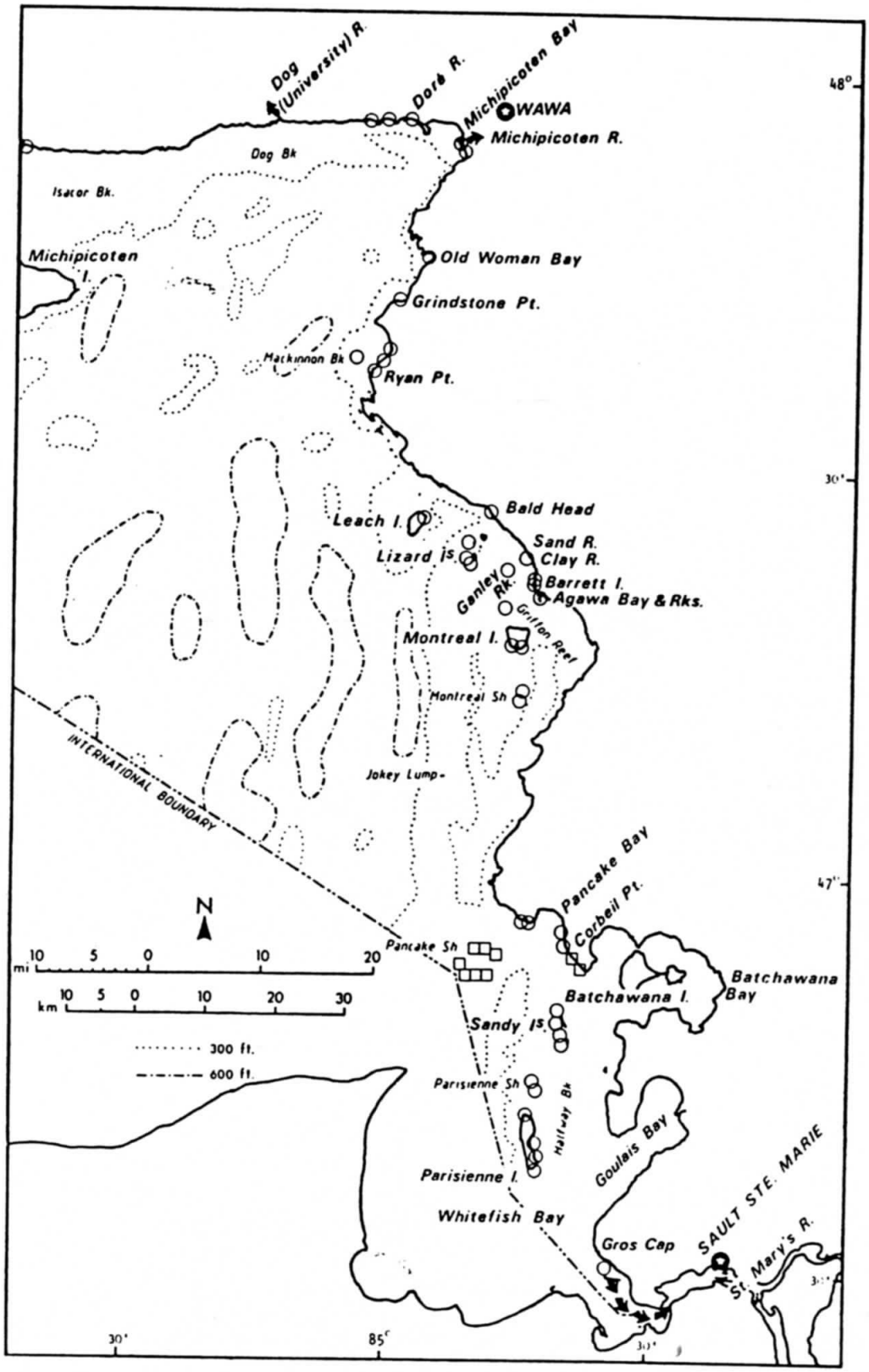

Dog (University) R.
Dore R.
Michipicoten Bay
WAWA
Michipicoten R.
48°
Dog Bk
Isaac Bk.
Michipicoten I.
Old Woman Bay
Grindstone Pt.
MacKinnon Bk
Ryan Pt.
30'
Bald Head
Leach I.
Sand R.
Lizard Is.
Clay R.
Ganley Rk.
Barrett I.
Agawa Bay & Rks.
Grillon Reef
Montreal I.
Montreal Sh
INTERNATIONAL BOUNDARY
Jokey Lump
Pancake Bay
Corbeil Pt.
47'
N
Pancake Sh
10 5 0 10 20 mi
10 5 0 10 20 30 km
300 ft.
600 ft.
Batchawana Bay
Batchawana I.
Sandy Is.
Parisienne Sh
Halfway Bk
Goulais Bay
Parisienne I.
Whitefish Bay
Gros Cap
SAULT STE. MARIE
St. Mary's R.
30'
85°
30'

Fig. 3. Spawning grounds of lake whitefish (Coregonus clupeaformis), Michipicoten Island to Schreiber. Major ○ , Minor □ , River ↗ .

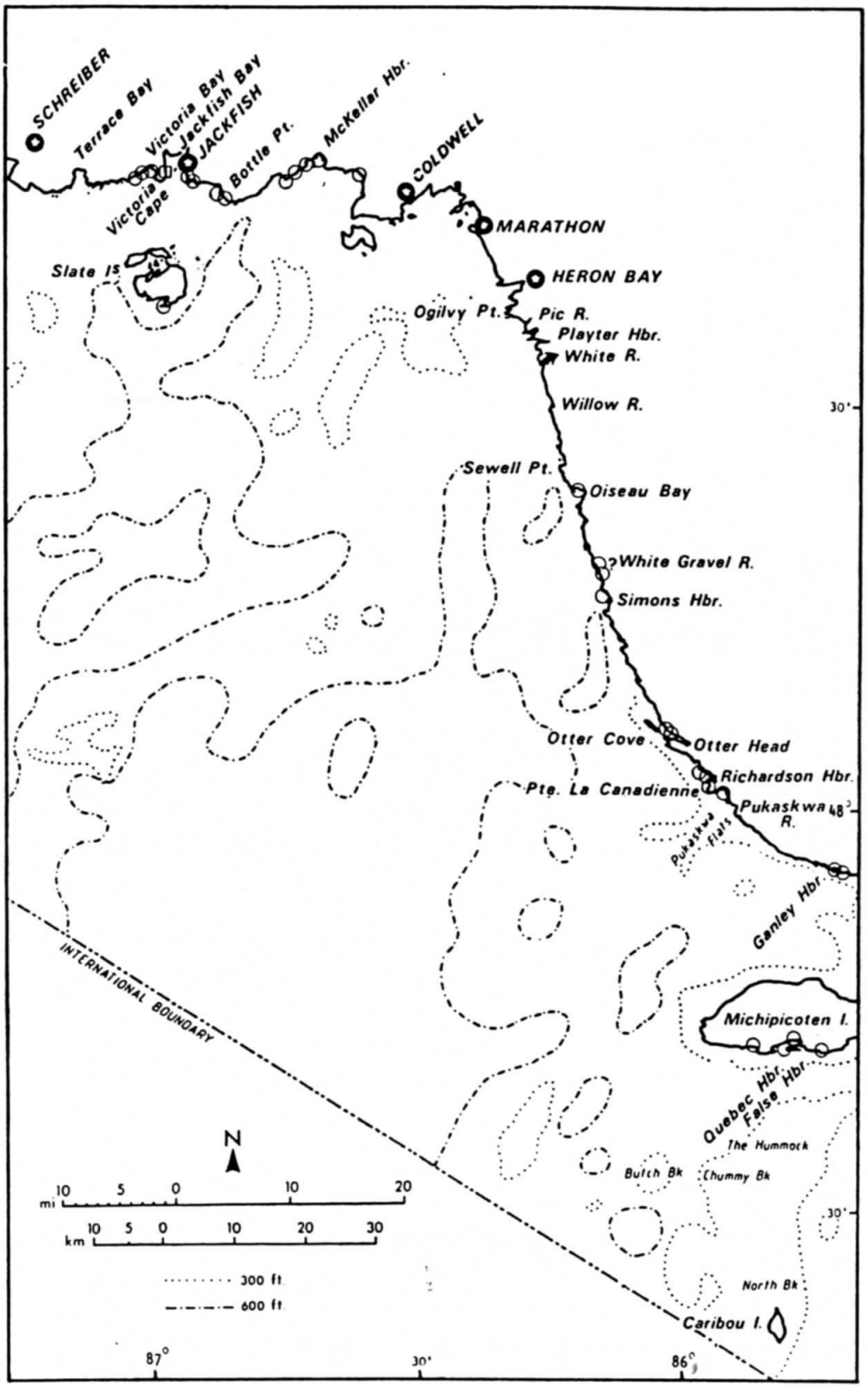

SCHREIBER
Terrace Bay
Victoria Bay
Jackfish Bay
JACKFISH
Victoria Cape
Bottle Pt.
McKellar Hbr.
COLDWELL
MARATHON
HERON BAY
Slate Is
Ogilvy Pt.
Pic R.
Playter Hbr.
White R.
Willow R.
30'
Sewell Pt.
Oiseau Bay
White Gravel R.
Simons Hbr.
Otter Cove
Otter Head
Richardson Hbr.
Pte. La Canadienne
Pukaskwa R.
48°
Pukaskwa Flats
Ganley Hbr.
INTERNATIONAL BOUNDARY
Michipicoten I.
Quebec Hbr.
False Hbr.
The Hummock
Bulch Bk
Chummy Bk
30'
North Bk
Caribou I.
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
87°
30'
86°

Fig. 4. Spawning grounds of lake whitefish (Coregonus clupeaformis), Schreiber to Pigeon River. Major ○, Minor □, River ➶.

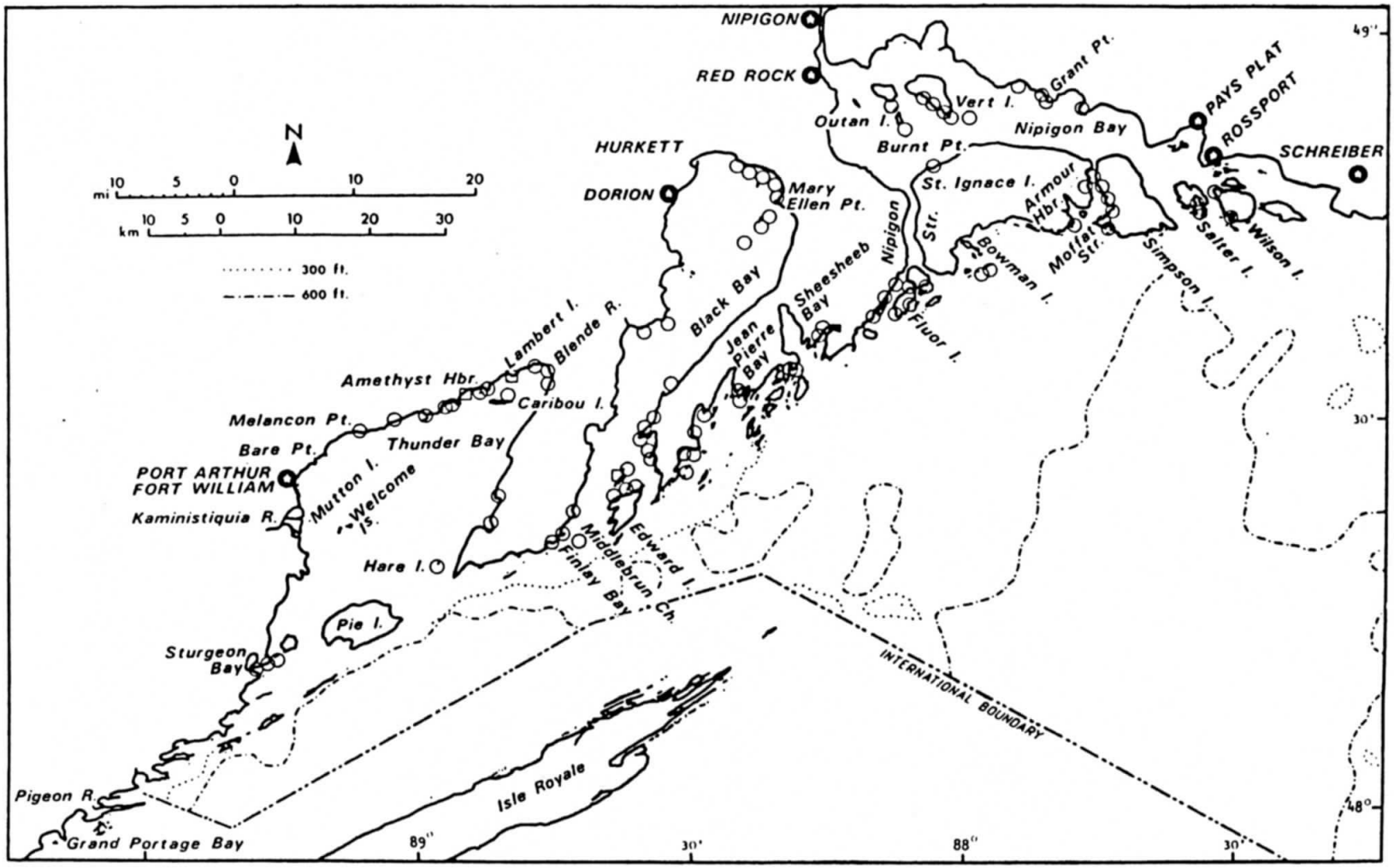

NIPIGON
RED ROCK
HURKETT
DORION
Grant Pt.
Vert I.
Outan I.
Nipigon Bay
Burnt Pt.
PAYS PLAT
ROSSPORT
SCHREIBER
St. Ignace I.
Armour Hbr.
Mary Ellen Pt.
Nipigon Str.
Bowman I.
Moffat Str.
Simpson I.
Salter I.
Wilson I.
Sheesheeb Bay
Fluor I.
Black Bay
Jean Pierre Bay
Lambert I.
Blende R.
Amethyst Hbr.
Caribou I.
Melancon Pt.
Bare Pt.
Thunder Bay
PORT ARTHUR
FORT WILLIAM
Kaministiquia R.
Mutton I.
Welcome Is.
Hare I.
Middlebrun Ch.
Finley Bay
Edward I.
Pie I.
Sturgeon Bay
Pigeon R.
Grand Portage Bay
Isle Royale
INTERNATIONAL BOUNDARY
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
49°
30'
48°
89°
30'
88°
30'

Fig. 5. Spawning grounds of lake herring (Coregonus artedii), Sault Ste. Marie to Michipicoten Island.

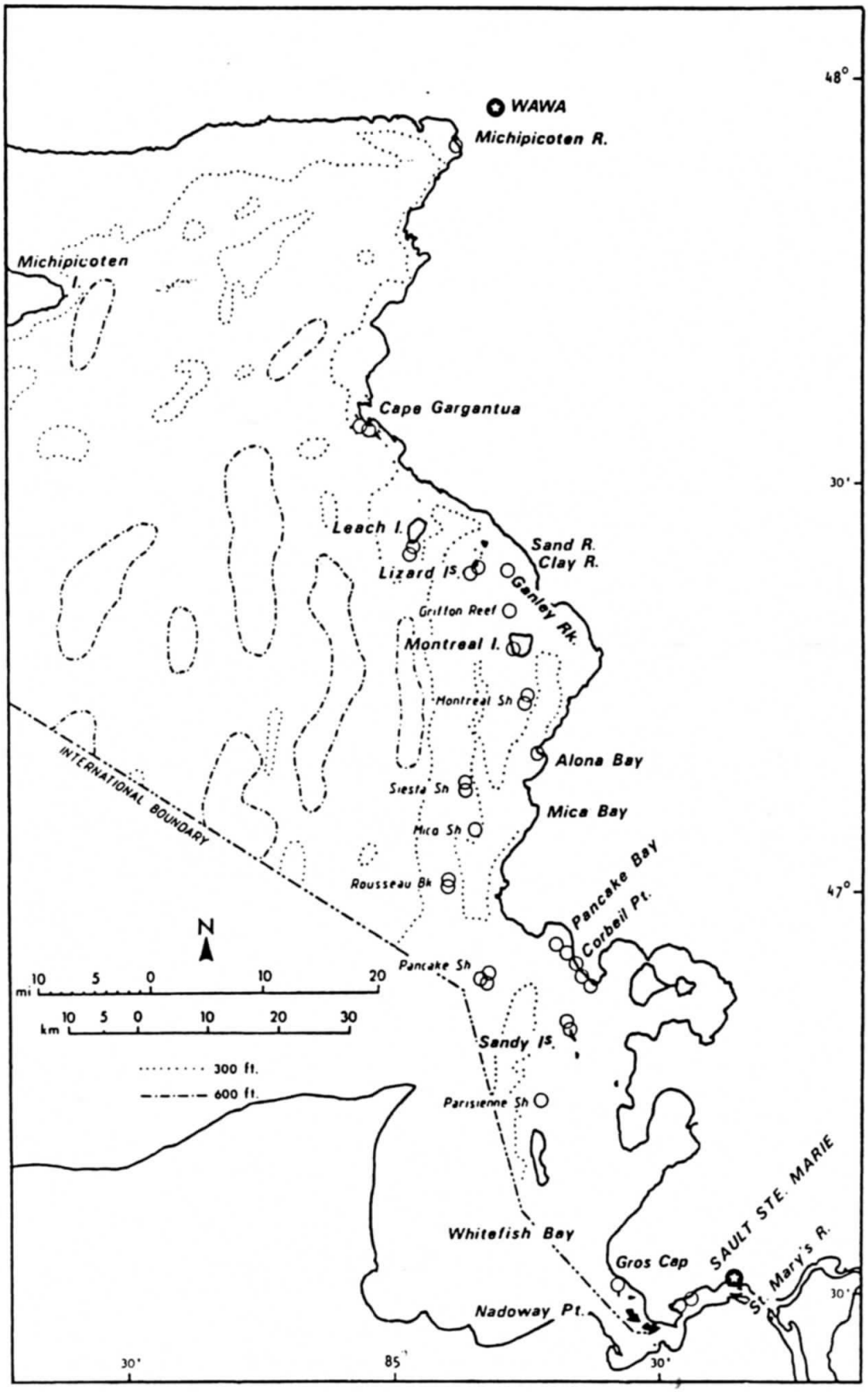

48°
WAWA
Michipicoten R.
Michipicoten I.
Cape Gargantua
30'
Leach I.
Sand R.
Clay R.
Lizard Is.
Ganley Rk.
Grifton Reef
Montreal I.
Montreal Sh
Alona Bay
INTERNATIONAL BOUNDARY
Siesta Sh
Mica Bay
Mica Sh
Rousseau Bk
Pancake Bay
Corbeil Pt.
47°
N
Pancake Sh
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
Sandy Is.
Parisienne Sh
Whitefish Bay
SAULT STE. MARIE
Gros Cap
St. Mary's R.
Nadoway Pt.
30'
30'
85°
30'

Fig. 6. Spawning grounds of lake herring (Coregonus artedii), Michipicoten Island to Schreiber.

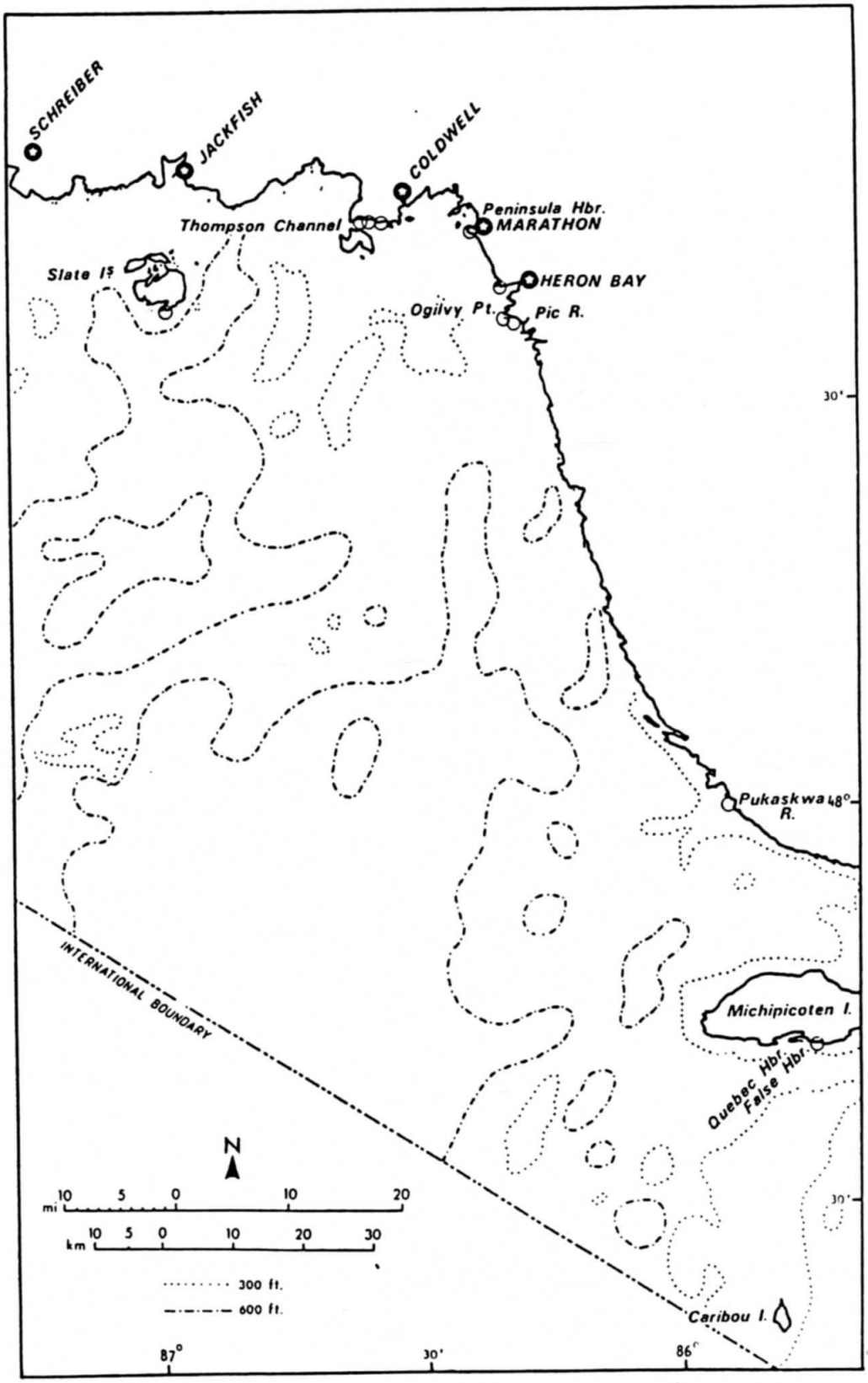

SCHREIBER
JACKFISH
COLDWELL
Peninsula Hbr.
MARATHON
Thompson Channel
Slate Is
HERON BAY
Ogilvy Pt.
Pic R.
30'
Pukaskwa R.
48°
INTERNATIONAL BOUNDARY
Michipicoten I.
Quebec Hbr.
False Hbr.
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
Caribou I.
87°
30'
86°

Fig. 7. Spawning grounds of lake herring (Coregonus artedii), Schreiber to Pigeon River.

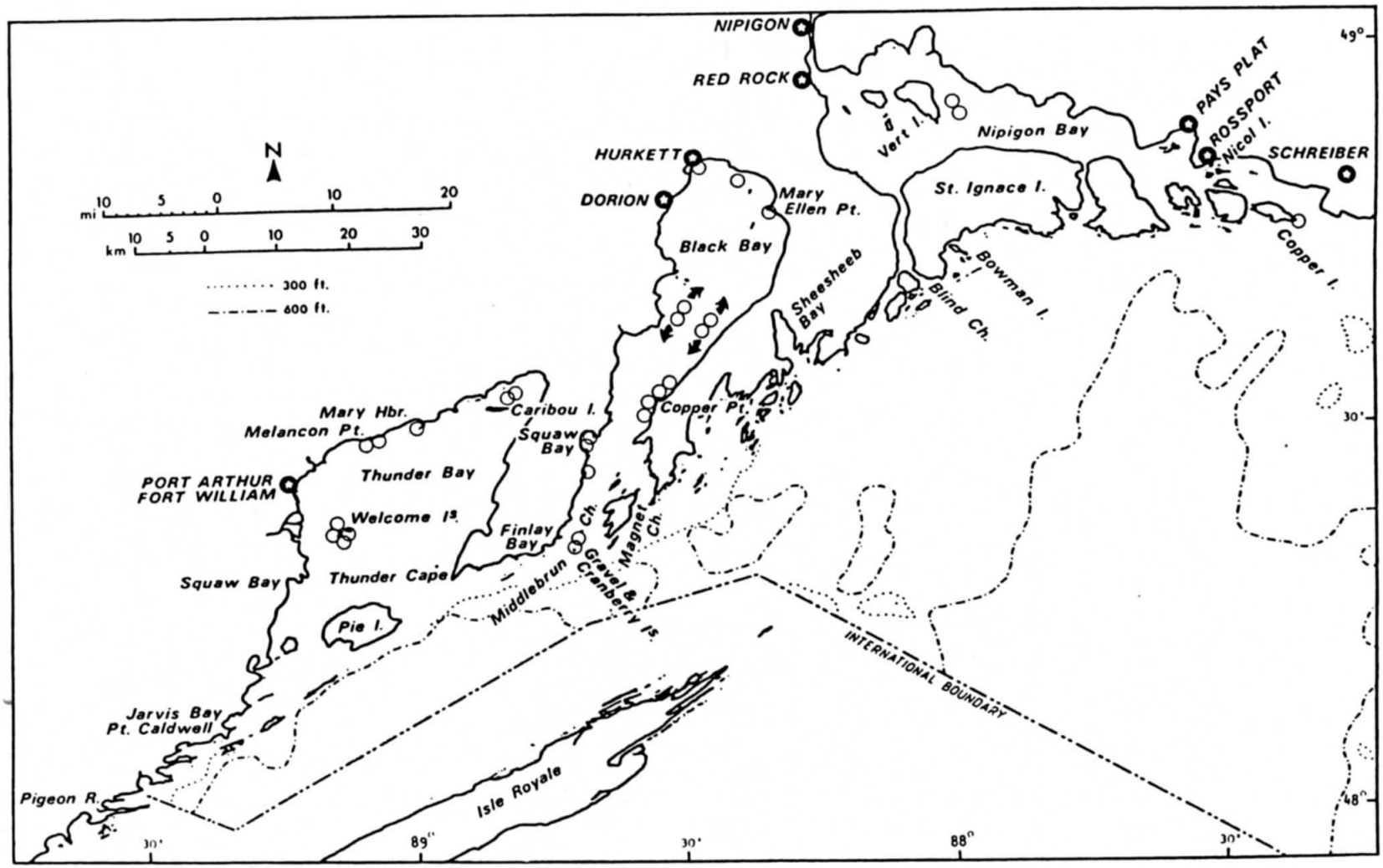

NIPIGON
RED ROCK
HURKETT
DORION
Mary Ellen Pt.
Black Bay
Sheesheeb Bay
Vert I.
Nipigon Bay
PAYS PLAT
ROSSPORT
Nicol I.
SCHREIBER
St. Ignace I.
Copper I.
Bowman I.
Blind Ch.
Copper Pt.
Caribou I.
Squaw Bay
Mary Hbr.
Melancon Pt.
PORT ARTHUR
FORT WILLIAM
Thunder Bay
Welcome Is.
Finlay Bay
Ch.
Magnet Ch.
Squaw Bay
Thunder Cape
Pie I.
Middlebrun
Gravel & Cranberry Is
INTERNATIONAL BOUNDARY
Jarvis Bay
Pt. Caldwell
Pigeon R.
Isle Royale
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
49°
30'
48°
89°
30'
88°
30'

Fig. 8. Fishing grounds of chub species (Coregonus spp.), Sault Ste. Marie to Michipicoten Island.

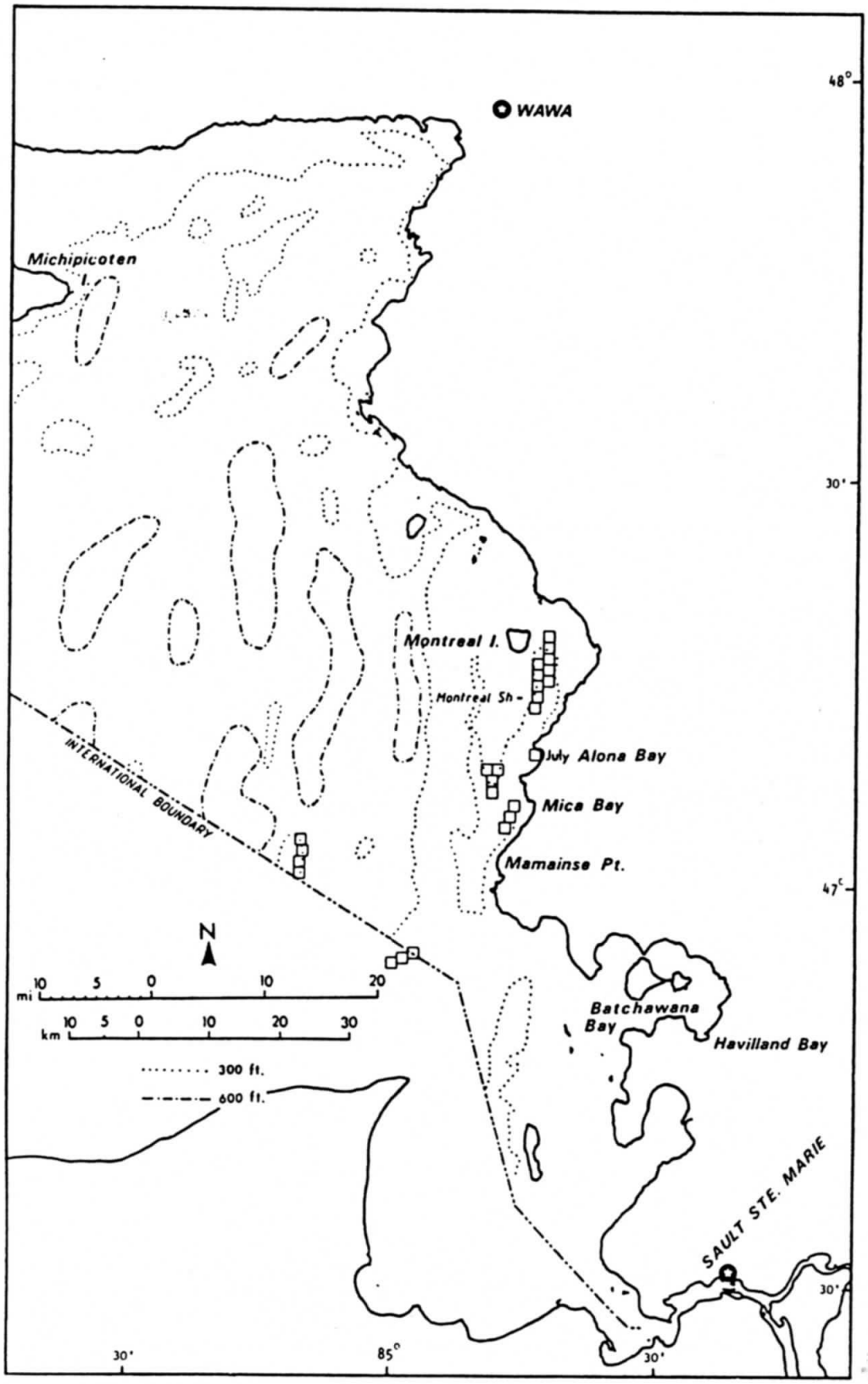

48°
WAWA
Michipicoten I.
30'
Montreal I.
Montreal Sh.
July Alona Bay
Mica Bay
Mamainse Pt.
INTERNATIONAL BOUNDARY
47°
N
mi 10 5 0 10 20
km 10 5 0 10 20 30
300 ft.
600 ft.
Batchawana Bay
Havilland Bay
SAULT STE. MARIE
30'
85°
30'
30'

Fig. 9. Fishing grounds of chub species (Coregonus spp.), Michipicoten Island to Schreiber.

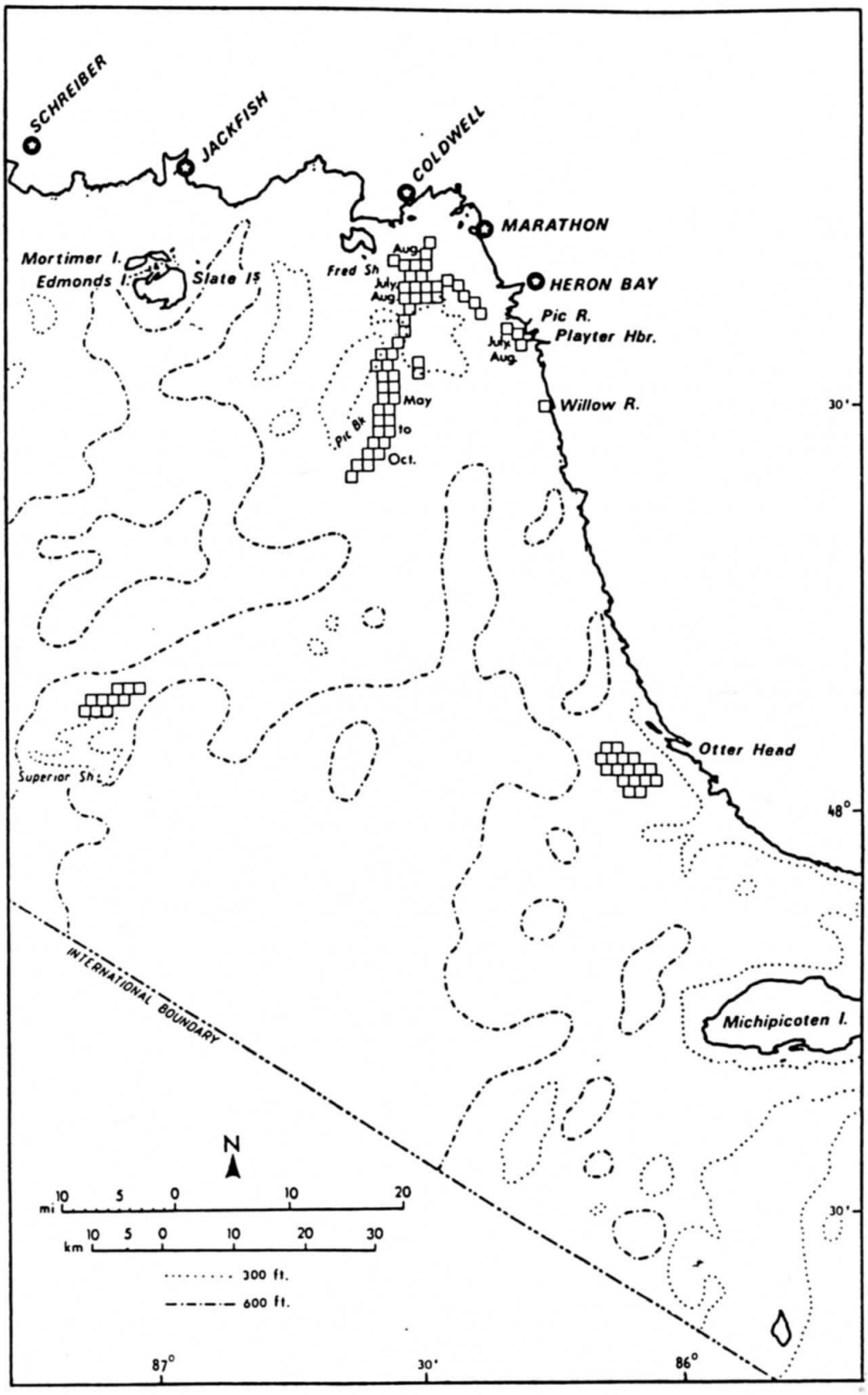

SCHREIBER
JACKFISH
COLDWELL
MARATHON
HERON BAY
Pic R.
Playter Hbr.
Willow R.
Mortimer I.
Edmonds I.
Slate Is
Fred Sh
Aug
July
Aug
July
Aug
May
to
Oct.
Pic Bk
Otter Head
Superior Sh.
INTERNATIONAL BOUNDARY
Michipicoten I.
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
87°
30'
86°
48°
30'
30'

Fig. 10. Fishing grounds of chub species (Coregonus spp.), Schreiber to Pigeon River.

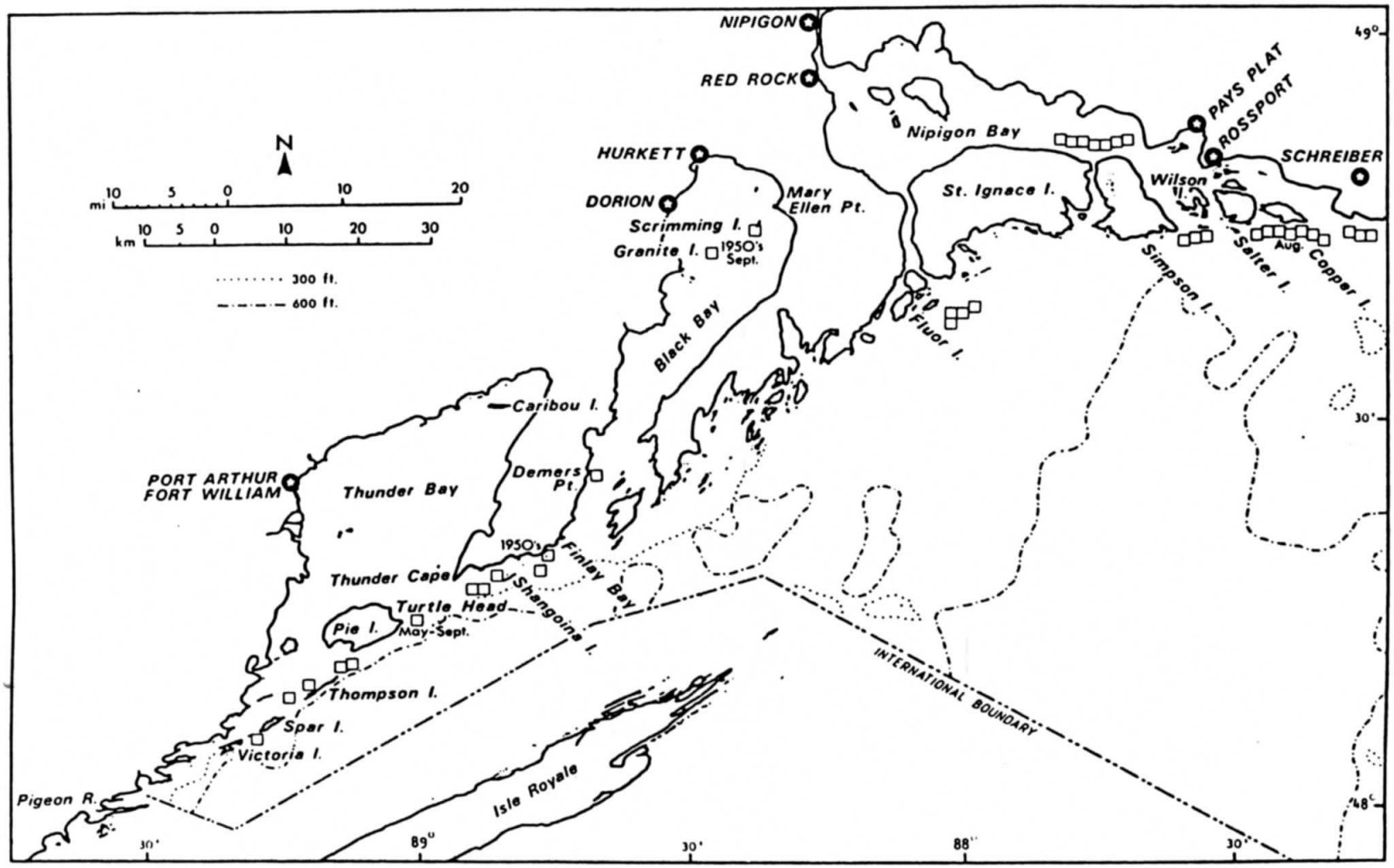

NIPIGON
RED ROCK
HURKETT
DORION
Scrimming I.
Granite I.
1950's Sept.
Mary Ellen Pt.
Nipigon Bay
PAYS PLAT
ROSSPORT
SCHREIBER
St. Ignace I.
Wilson I.
Salter I.
Aug.
Copper I.
Simpson I.
Fluor I.
Black Bay
Caribou I.
PORT ARTHUR
FORT WILLIAM
Thunder Bay
Demers Pt.
1950's
Finlay Bay
Thunder Cape
Shangoina I.
Turtle Head
Pie I.
May-Sept.
Thompson I.
Spar I.
Victoria I.
Pigeon R.
Isle Royale
INTERNATIONAL BOUNDARY
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
49°
48°
30'
89°
88°

Fig. 11. Spawning grounds of walleye (Stizosedion vitreum) *S*, northern pike (Esox lucius) *E*, yellow perch (Perca flavescens) *P*, and lake sturgeon (Acipenser fulvescens) *A*, Sault Ste. Marie to Michipicoten Island. Shore □, river ↗.

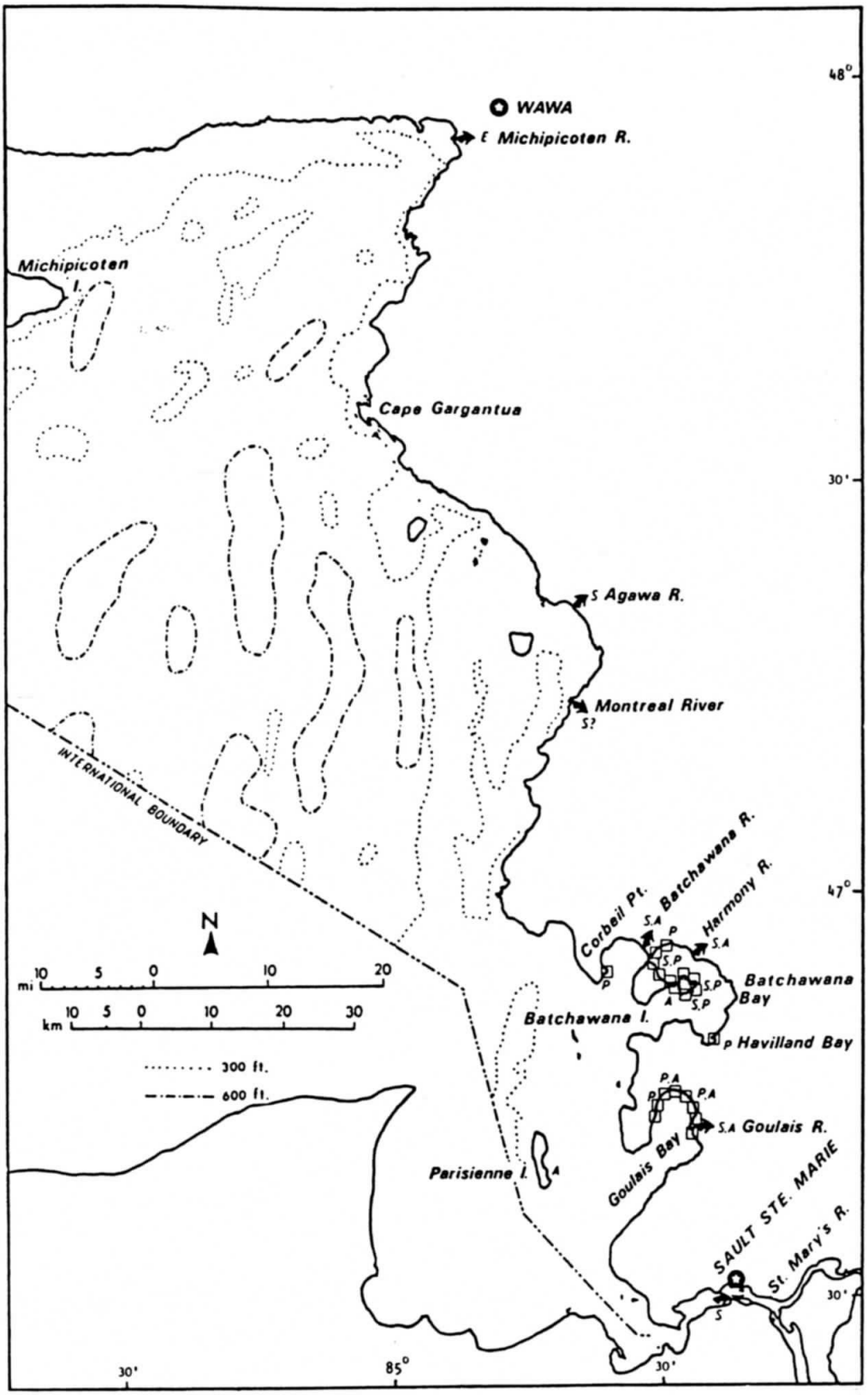

48°
WAWA
E Michipicoten R.
Michipicoten I.
Cape Gargantua
30'
S Agawa R.
Montreal River
S?
INTERNATIONAL BOUNDARY
47°
Corbeil Pt.
Batchawana R.
Harmony R.
S,A
P
S,P
A
Batchawana Bay
Batchawana I.
P Havilland Bay
P,A
Goulais R.
Goulais Bay
Parisienne I.
SAULT STE. MARIE
St. Mary's R.
S
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
30'
85°
30'
30'

Fig. 12. Spawning grounds of walleye (Stizosedion vitreum) *S* , northern pike (Esox lucius) *E* , yellow perch (Perca flavescens) *P* , and lake sturgeon (Acipenser fulvescens) *A* , Michipicoten Island to Schreiber. Shore □ , river ↗ .

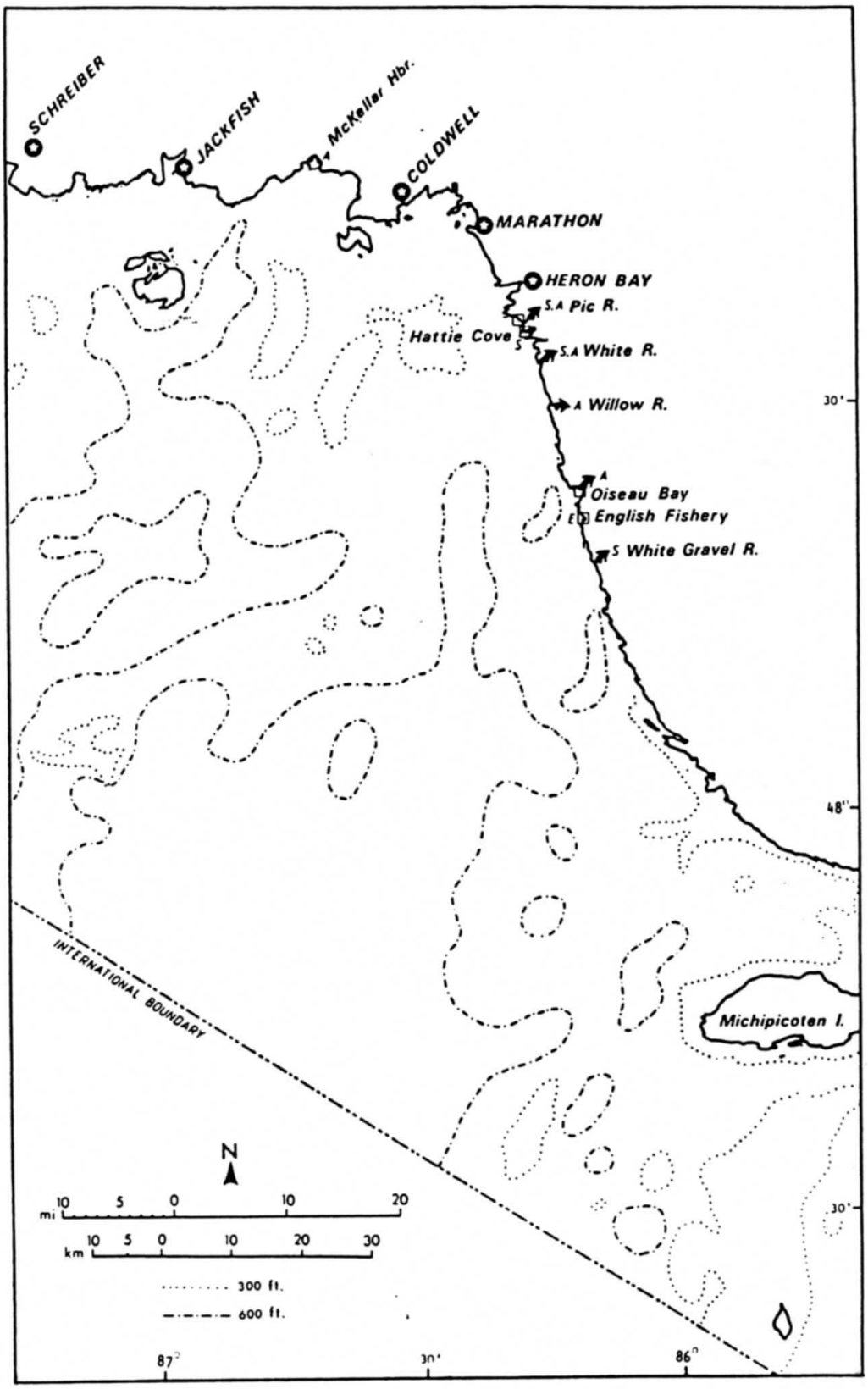
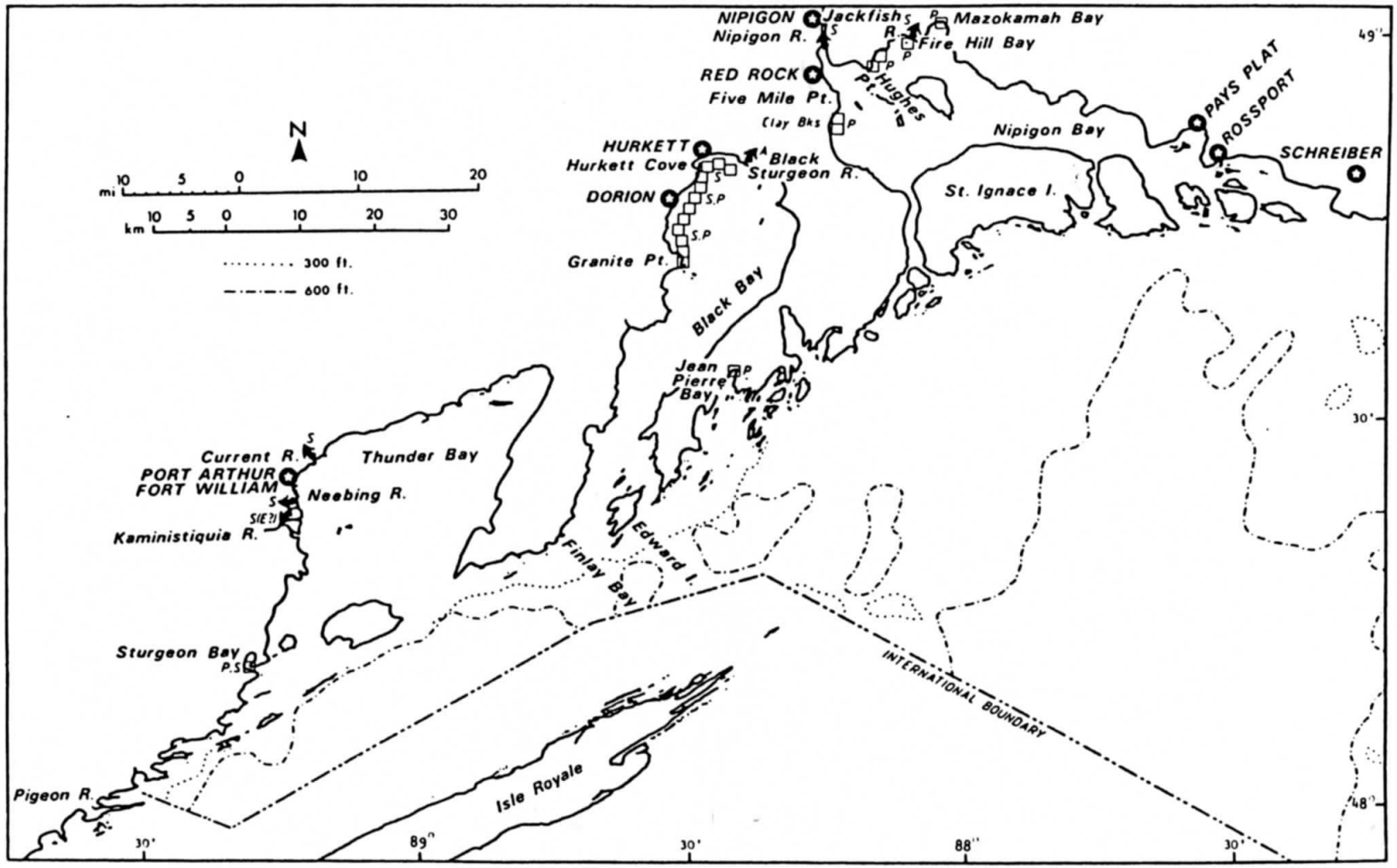

SCHREIBER
JACKFISH
McKeller Hbr.
COLDWELL
MARATHON
HERON BAY
S.A Pic R.
Hattie Cove
S.A White R.
A Willow R.
Oiseau Bay
English Fishery
S White Gravel R.
INTERNATIONAL BOUNDARY
Michipicoten I.
N
10 5 0 10 20
mi
10 5 0 10 20 30
km
300 ft.
600 ft.
87°
30'
86°
30'
48'
30'

Fig. 13. Spawning grounds of walleye (Stizosedion vitreum) *S*, northern pike (Esox lucius) *E*, yellow perch (Perca flavescens) *P*, and lake sturgeon (Acipenser fulvescens) *A*, Schreiber to Pigeon Island. Shore □, river ↗.


NIPIGON
Nipigon R.
Jackfish R.
Mazokamah Bay
Fire Hill Bay
RED ROCK
Five Mile Pt.
Clay Bks
Hughes Pt.
HURKETT
Hurkett Cove
Black Sturgeon R.
DORION
Granite Pt.
Black Bay
Jean Pierre Bay
Nipigon Bay
St. Ignace I.
PAYS PLAT
ROSSPORT
SCHREIBER
Current R.
PORT ARTHUR
FORT WILLIAM
Thunder Bay
Neebing R.
Kaministiquia R.
Finlay Bay
Edward I.
Sturgeon Bay
P.S.
Pigeon R.
Isle Royale
INTERNATIONAL BOUNDARY
N
mi 10 5 0 10 20
km 10 5 0 10 20 30
300 ft.
600 ft.
49°
48°
89°
88°
30'