Severn Sound

Remedial Action Plan

PART 1

Environmental Conditions
and
Problem Definitions

SEVERN SOUND REMEDIAL ACTION PLAN

PART I ENVIRONMENTAL CONDITIONS AND PROBLEM DEFINITION

Environment Ontario

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FOREWORD

This document summarizes environmental conditions and identifies environmental problems in the Severn Sound Area of Concern of Georgian Bay. The document is intended to form the basis of the Stage I submission of the Severn Sound Remedial Action Plan (RAP), as part of the Canada-Ontario commitment to the US-Canada International Joint Commission.

The document also forms the basic technical summary for the Public Involvement Program started in May 1988.

An earlier draft, submitted for preliminary review to Canada/Ontario agencies in February, 1987 identified several gaps in environmental information available on Severn Sound. This report includes updated information and provides a more thorough analysis of the present conditions in Severn Sound. The document will be supplemented with results of field work, analysis and the Public Involvement Program components to be conducted during 1988.

Activities scheduled for 1988 include:

- Updating the calculated total annual nutrient supply to Severn Sound and selected bays through the inclusion of additional data to be collected on supply from land drainage, sediments and point sources.

- Deployment of additional current meters and development of a water budget for the Sound.

- Continuation of the yearly water quality monitoring program initiated in 1973.

- Fish community studies to examine historical trends and changes in fish species continuing in 1988 with an integrated program of netting and Ceel census.

- Undertaking the first two phases of the public consultation program. The first phase involves informing and educating the public regarding the RAP process and the current environmental status of Severn Sound. This will be initiated in the spring of 1988 and completed by late summer. The second phase involves obtaining the views and priorities of the public with respect to desired use options. This phase will be initiated in the fall of 1988 and is expected to be completed early in 1989.

Additional field studies to assist in the development of nutrient budgets, and to assess the bioavailability of nutrients may be initiated as deemed necessary by the RAP Team.

RAP Timetable

Activity	Date
RAP Development:	
Public consultation framework	September 1987 (completed)
Identification of use options	November 1988
Preferred remedial action and implementation schedule	March 1989
Draft RAP (Part II) for review	September 1989
Final RAP review	January 1990
Submit RAP to IJC's Water Quality Board	July 1990

ACKNOWLEDGEMENTS

This document was prepared by the Severn Sound Remedial Action Plan Team under the guidance of the Provincial/Federal RAP Steering Committee. RAP Team membership included:

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SEVERN SOUND REMEDIAL ACTION PLAN PART I
ENVIRONMENTAL CONDITIONS AND PROBLEM DEFINITION

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EXECUTIVE SUMMARY

The Severn Sound is a complex of shallow bays in the south-east part of Georgian Bay. The Sound presently supports a warmwater and a migratory coldwater fishery. A resident coldwater fishery is reported to have existed in the deeper areas of Severn Sound prior to the 1960's. The bays are nutrient enriched or eutrophic and exhibit varying degrees of aquatic plant growth. The shoreline development includes the Towns of Midland and Penetanguishene, as well as rural land and cottages.

Excessive algal growth in Severn Sound, particularly in Penetang Bay, has been of public concern since the mid 1960's. The algae growth forms unsightly scums and layers of turbid water that discourage recreational uses such as swimming. The algae growth may also relate to recent changes in the fish caught from the Sound to species more tolerant of nutrient enrichment. Historically, the collapse of the resident coldwater fishery may also have been related to changes in water quality conditions. Boating is adversely influenced in some areas of Severn Sound where heavy growths of rooted aquatic plants occur (for example in Sturgeon Bay).

Restriction of human consumption of sport fish populations (restricted consumption of walleye and smallmouth bass due to mercury contamination) in Severn Sound appears similar to other areas of Southern Georgian Bay and was not related to any localized source of contamination.

Phosphorus is a key nutrient that limits the growth of algae in Severn Sound. The water quality response of Severn Sound to reduced phosphorus loadings from municipal point sources has been positive. Total phosphorus levels have declined approximately 50% between 1969 and 1986 in Midland and Penetang Bays, which receive the largest discharges from sewage treatment facilities. However, phosphorus levels are still high enough to promote nuisance algal growths, particularly in the southern portion of Penetang Bay. The density of algae in Severn Sound has not shown a decline similar to phosphorus concentration over the same period.

Factors which may account for the limited algae response to reduced municipal effluent phosphorus loadings in comparison to other similarly affected areas include:

- non-point sources (e.g. urban runoff, shoreline development, additional nutrient supply from agricultural runoff in the immediate watershed to the Sound) may have remained or increased as another important source of phosphorus supply;

- continued upgrading and expansion of existing sewage facilities throughout the monitoring period rather than at one point in time may have masked the response;

- extensive water circulation and exchange of Severn Sound with the open waters of Georgian Bay may lead to a greater dispersion and dilution of nutrient gradients (Penetang Bay is a notable exception to this generalization as the Bay has limited circulation and exchange);

- seasonal changes in the availability of nutrients for algal growth in the Sound;

- shifts in the fish community may have adversely affected the zooplankton community grazing or cropping algae in the Sound.

The annual total phosphorus supply to Severn Sound has been estimated. However, additional information on water exchange is required to calculate a nutrient budget. Further clarification of the relationship between nutrient supply and nutrient availability to the algae growths in the Sound as well as the effect of cropping of algae by zooplankton is also required before further remedial measures can be planned.

Available information indicates only minor localized contamination of sediments has occurred. Confirmation of the influence of point source discharges on trace contaminant levels in biota must be obtained. The results of juvenile fish analyses strongly supports the absence of any significant sources of trace contaminants.

1. INTRODUCTION

Since 1973, the U.S./Canada International Joint Commission (IJC) has identified "Areas of Concern" throughout the Great Lakes and their connecting channels where IJC, Provincial or State water quality objectives have been exceeded and uses of the areas have been disrupted.

Severn Sound, a group of bays including Penetang Bay, Midland Bay, Hog Bay and Sturgeon Bay, is a heavily used recreational area in the southeast corner of Georgian Bay. Increasing public concern during the mid-1960's regarding excessive algal growths, particularly in Penetang Bay, had led to a number of water quality surveys of Severn Sound by the Ontario Ministry of the Environment. In 1973 the IJC identified Severn Sound as an Area of Concern which has been included in reviews of all such areas in the Great Lakes Basin (IJC, 1985). The IJC Water Quality Board recommended that a Remedial Action Plan (RAP) be developed for each Area of Concern which would outline a "systematic and comprehensive approach to restoring beneficial uses ... consistent with an 'ecosystem approach' to the protection of the Great Lakes" (IJC, 1985). When completed, the RAP will provide: a description of the area location and extent of environmental problems and use impairment; description of pollution sources leading to the problems; the remedial action(s) proposed to restore beneficial uses with scheduling and tracking procedures. The 1978 Great Lakes Water Quality Agreement (revised with 1987 Protocol) requires the RAP to be submitted to the Great Lakes International Joint Commission at three stages:

1. when the definition of environmental conditions and problems is complete;

2. when remedial and regulatory measures have been selected;

3. when beneficial uses have been restored.

The purposes of the following report are to:

1. describe the Area of Concern;

2. outline what is known about the past and present environmental conditions in Severn Sound;

3. summarize known environmental concerns in Severn Sound.

The report will serve as a basic technical summary of the water quality and aquatic community status of Severn Sounds. The report does not fulfill all aspects of a completed RAP because:

1. the environmental information available to assess the sources of identified water quality problems is not complete; and

2. the public information plan to obtain a consensus on desired beneficial uses, water quality objectives and to evaluate and select remedial options has not been fully implemented.

2. DESCRIPTION OF THE AREA

2.1 Location and Geographic Extent

Severn Sound is located in southern Ontario. This body of water is the southeastern arm of Georgian Bay, but is largely separated from the main Bay by an island archipelago formed in past glacial times by flooding of land along the margin of the Canadian Shield. The Sound has a peculiar shape (Figures 1 and 2), as it incorporates a variety of smaller bays and harbours including Penetang Harbour, Outer Harbour, Midland Bay, Hog Bay, Sturgeon Bay and Matchedash Bay. The distance between Pinery Point on the west side of the Sound, and Long Point on the east side of the Sound, is approximately 18km. Water depth generally decreases from west to east: from 20 m off Pinery Point, to 8 m at mid-Sound, to less than 5 m through Waubaushene Channel to Long Point.

The study area is made up of four physiographic regions each with several physiographic features (Figure 3); the Georgian Bay Fringe region, north of the Severn River; the Simcoe Uplands region, comprising most of the area south of Severn Sound; the Carden Plain region; and the Simcoe Lowlands region in the more southerly section of the study area (Chapman and Putnam, 1984). The Georgian Bay Fringe is characterized by very shallow soil and bare Precambrian granitic rock knobs and ridges. Occasionally, some sedimentary materials such as sandstone, conglomerate, shale and limestone are found lying on top of the ancient Precambrian surface. Bare rocks and shallow soil have contributed to a scrubby growth of red oak, jackpine, hemlock and hardwoods.

The Simcoe Uplands comprise a series of broad, rolling, till plains separated by flat valleys with very steep sides. The till is generally coarse-textured and consists of a mixture of boulders, cobbles, gravel, and sand, with little silt and clay. Outcroppings of Precambrian rock are present towards the north-east. The Uplands are divided by several sand and gravel ridges that appear to be ancient shoreline deposits. The topography ranges from gentle- to steeply-sloping. Soils are well-drained but may be stony (Figure 4). Because of the texture and slope, the soil is highly erodible if exposed.

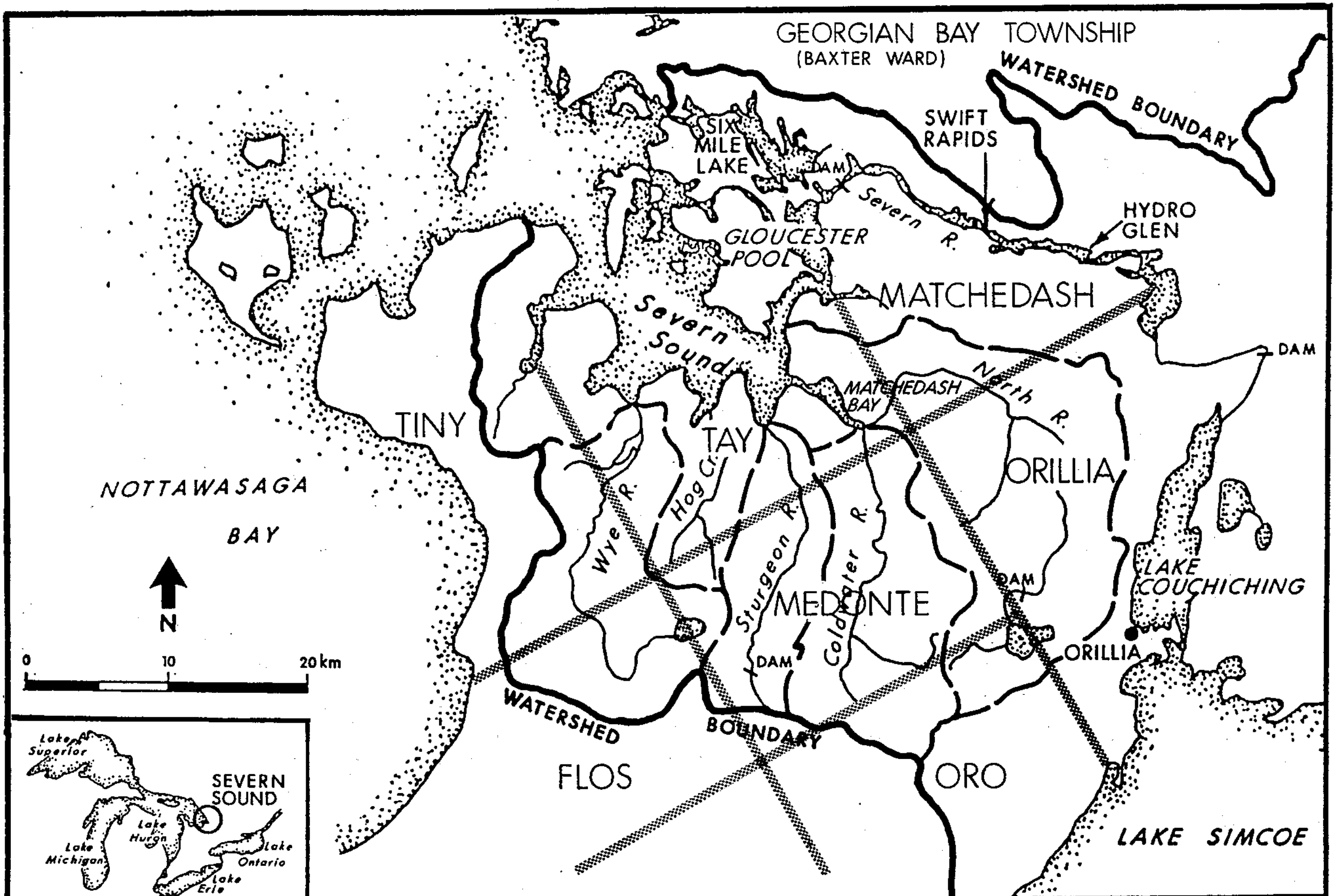


FIGURE 1: Severn Sound and drainage area.

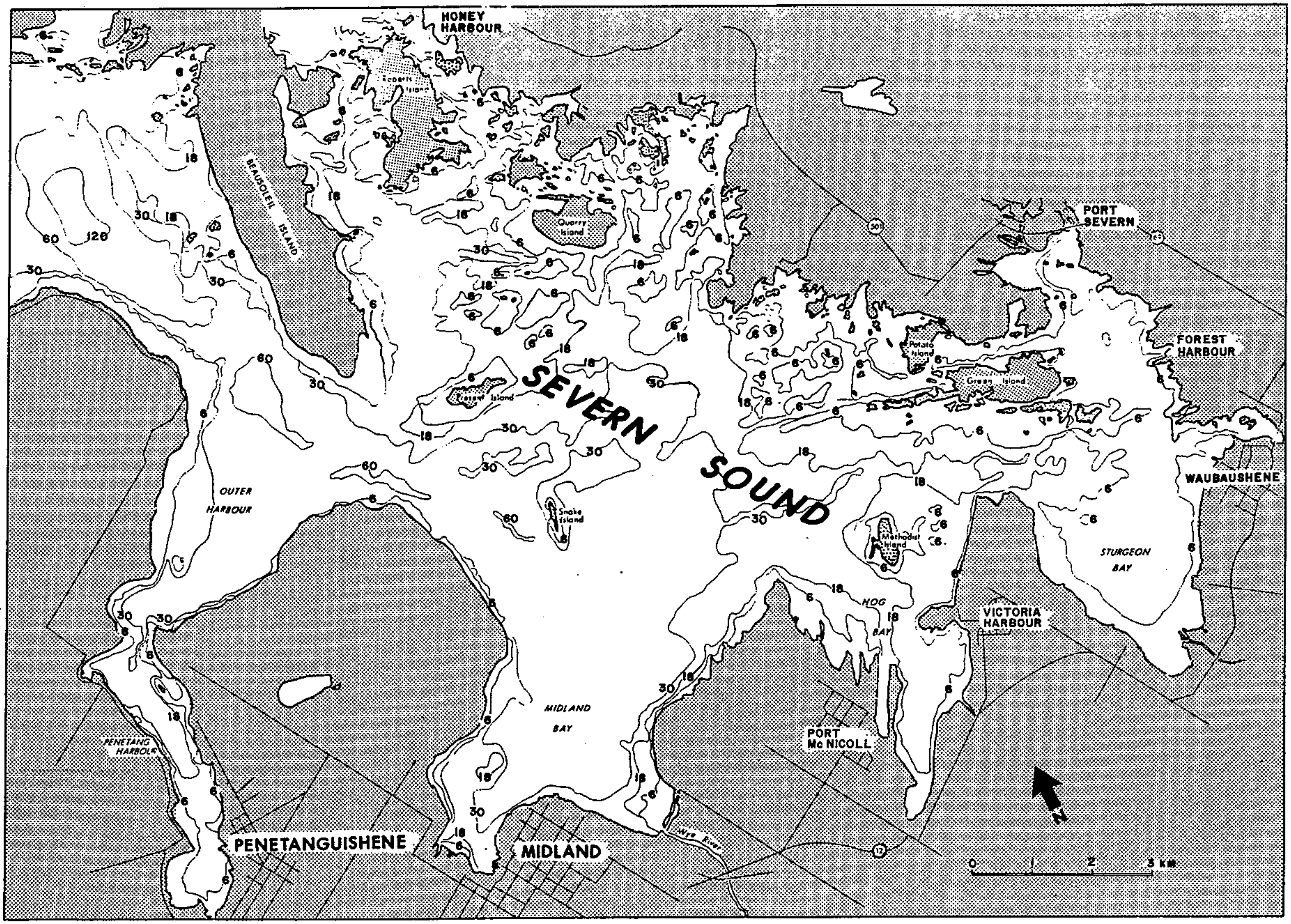


Figure 2: Severn Sound depth contours (feet)

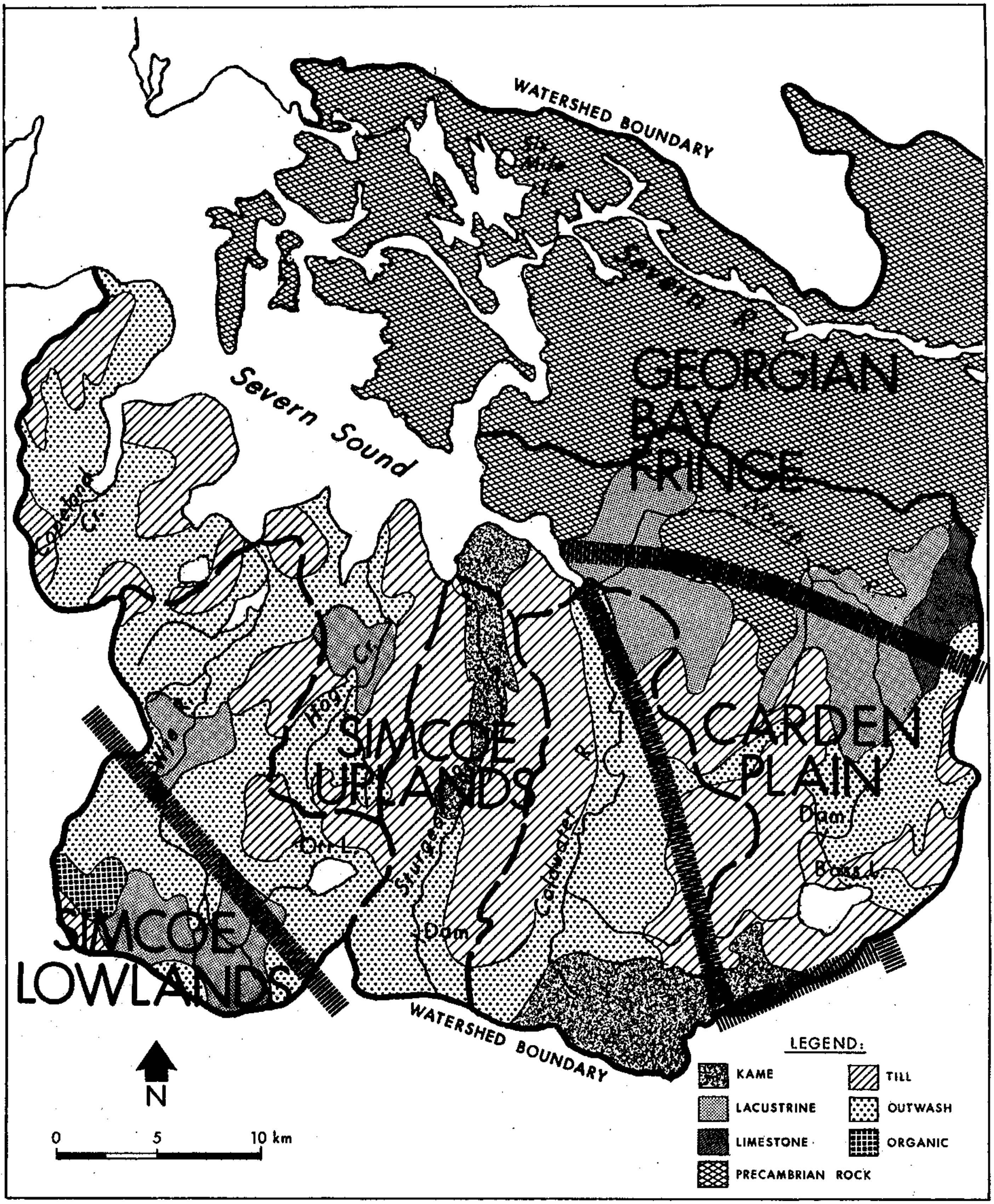


FIGURE 3: Physiography of Severn Sound drainage area. (based on Hoffman et al. 1962)

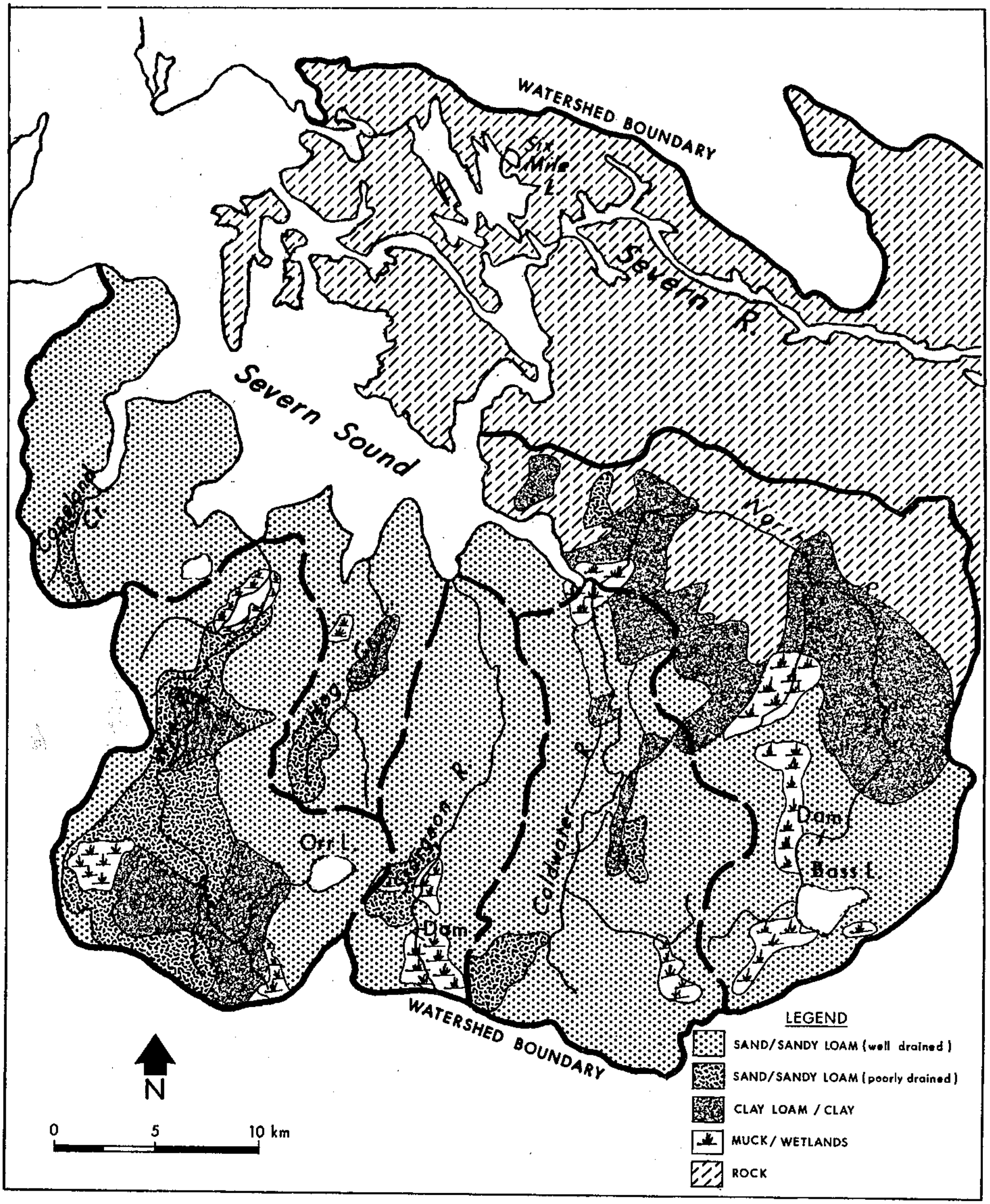


FIGURE 4: Soil texture groups in Severn Sound area.

During the retreat of the last glacier, the Simcoe Lowland regions were submerged under prehistoric Lake Algonquin. The two largest such areas are near Elmvale and Coldwater. Soil texture ranges from silt loam to clay. The soil is generally free from stones, but internal drainage ranges from imperfect to poor.

2.2 Hydrology and Watershed Characteristics

The study area lies within the broad belt of the Humid continental climate: cool summers and cold winters, and no dry seasons. Average temperatures vary within the study area, with the southern region being slightly warmer than the more northerly areas. Recorded mean annual temperatures at Environment Canada's Midland station are about 7°C, with an extreme range between -36° (February) and +33.5°C (July). Recorded mean annual precipitation (snow and rain) is 1035mm, and is fairly evenly distributed throughout the year. Rain and snow fall approximately 100 days and 63 days, respectively, each year. Georgian Bay is directly responsible for the snow squall effect generated in late fall and early winter each year; the heat stored in Lake Huron and Georgian Bay encounters cold, moisture laden westerly winds which, in turn, causes heavy snowfalls in the study area of approximately 344cm a year. Records show that about 161 days annually are frost free, generally between 02 May and 11 October.

Severn Sound receives tributary drainage from the Severn River, North River, Sturgeon River, Wye River, Coldwater River, Hog Creek and Copeland Creek (Figure 1). The principal tributary to the Sound is the Severn River, which has a 3800 square kilometre drainage area. The largest lake in the Severn River Basin is Lake Simcoe. Between Lake Simcoe and Georgian Bay the Severn River is controlled by a series of dams and locks which form part of the Trent-Severn Waterway system. The river flows through Sparrow Lake to the Big Chute Head pond, through Gloucester Pool, and reaches Georgian Bay at Port Severn. Copeland Creek, Sturgeon River, Wye River, Coldwater River and Hog Creek occupy the flat-floored valleys which separate the upland masses of the Penetang Peninsula. These five tributaries appear to be fed largely by springs along the valley sides, with the uplands being practically devoid of streams because of the vertical drainage in the sand till (Chapman and Putnam, 1984).

The study area lies within the Great Lakes - St. Lawrence Forest Region, which contains a mixture of both coniferous (white pine, red pine, and white spruce) and deciduous trees (sugar maple, beech, red oak, and red maple).

2.3 Water Uses

The waters of Severn Sound and its tributaries are used to satisfy many water-based needs including domestic and industrial water supply, treated sewage disposal, sport fishing, fish and wildlife habitat, swimming (and other water/body contact sports), boating and navigation, flood control, and hydro power.

2.3.1 Water Supply and Sewage Treatment:

Severn Sound serves as a source of domestic water for Victoria Harbour and Port McNicoll, the hamlet of Waubaushene and two subdivisions in the Township of Tay (Table 1, Figure 5). At these locations, five water treatment and distribution systems have a combined design capacity of 7 x 10 m^3/day, with the 1985 water consumption averaging 1.3 x 10 m^3/day for approximately 3,000 people. There have been no taste or odour problems associated with water supplied by either of these two treatment plants. Other communities in the study area, including Midland and Penetanguishene, obtain their raw water from groundwater supplies.

TABLE 1 - WATER FILTRATION PLANT INFORMATION

PLANT	TYPE	DESIGN CAPACITY 1000 M^3	AVG. DAILY FLOW 1000 M^3	POPULATION SERVED 1985
Victoria Harbour WTP	Surface source Physical & chemical treatment Chlorination	3.977	0.433	1,094
Port McNicoll WTP	Surface source Chlorination	3.201	0.873	1,932
Waubaushene WTP	Surface source Physical & chemical treatment Chlorination	1.231	0.347	1,100
Midland Bay Woods Subdiv. Tay Twp. WTP	Surface source Physical & chemical treatment Chlorination	0.268*	0.089	338
Rope Subdiv. Tay Twp. WTP	Surface source	0.020*	0.017	30

* Expansions under consideration.

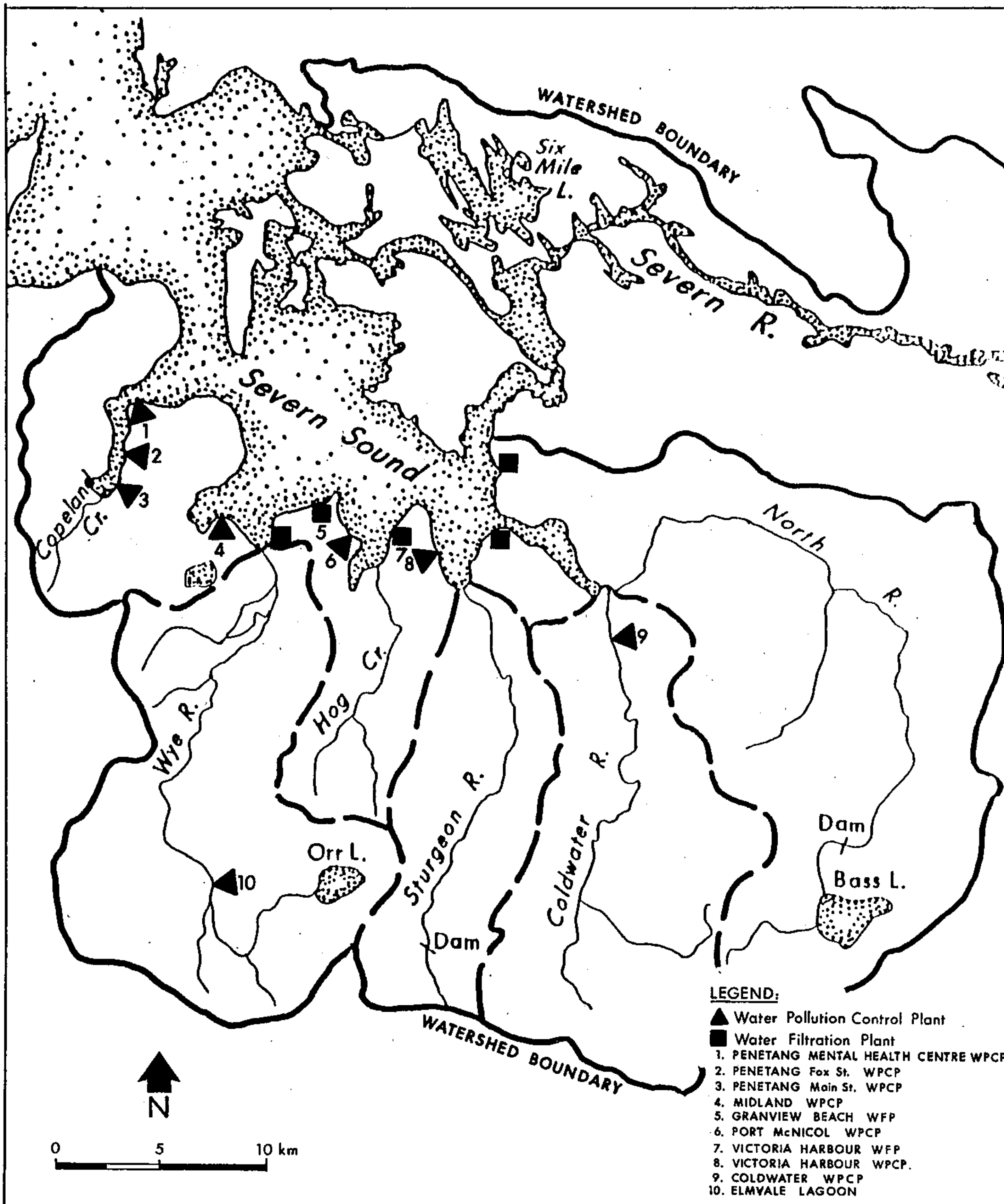


FIGURE 5: Locations of Water Pollution Control Plant outfalls and Water Filtration Plant intakes.

Communities in the study area are serviced by nine water pollution control plants (Table 2, Figure 5). These systems have a combined design capacity of 23 x 10 m^3/day, with the 1985 sewage treatment averaging 18 x 10 m^3/day, for approximately 22,166 people. Waubaushene and Port Severn are both serviced by private sewage disposal systems.

2.3.2 Fishing:

Commercial Fishery

Severn Sound is presently closed to commercial food fishing except for one licence issued to catch carp only. In 1986, about 3700 kg were caught. In addition, five licences are issued to catch commercial baitfish. About 1400 kg of minnows are caught annually consisting mainly of emerald shiners, spottail shiners and logperch. Emerald shiners have declined in the catch during recent years.

Historically, an intensive commercial food fishery took place in the Sound. The main port of operation was Midland. The following from "A Story of Early Midland and Her Pioneers" by G.R. Osborne, 1939, described the extent of the fishery. "The Yates brothers arrived in Midland in 1882 when they established a fish business. They had a fleet of 35 fishing smacks, each 33 feet long and carried their fish from the different fishing stations to Midland. They handled from 25 - 35 tons of fish a week, which were shipped all over Canada and to the United States. It is said that it was not uncommon to see six or seven hundred fishermen fishing through the ice of the Sound."

Sturgeon, lake trout, whitefish and herring were the most important species. Some warmwater species were also caught, including walleye, bass and catfish. By the 1940's, lake trout, whitefish and herring had also declined significantly and most fisheries had all but ceased operations. Shortly after, the Sound was closed to commercial fishing.

TABLE 2 - WATER POLLUTION CONTROL PLANT INFORMATION

PLANT	TYPE	DESIGN CAPACITY 1000 M^3	AVG. DAILY FLOW 1000 M^3	POPULATION SERVED
Penetanguishene WPCP #1	Contact stabilization Phosphorous removal Continuous discharge	3.000	3.038	4,000
Penetanguishene WPCP #2	Contact stabilization Phosphorous removal Continuous discharge	1.500	N/A*	
Penetanguishene Mental Health Unit WPCP	Conventional Activated Sludge Phosphorous removal Continuous discharge	0.568	0.388	950
Midland WPCP	Conventional Activated Sludge Phosphorous removal Continuous discharge	13.638	11.012	12,000
Port McNicoll WPCP	Contact Stabilization Phosphorous removal Continuous discharge	1.045	1.168	1,400
Victoria Harbour WPCP	Extended aeration Phosphorous removal Continuous discharge Effluent polishing	2.363	0.444	1,455
Coldwater WPCP	Extended aeration Continuous discharge	0.545	0.466	761
Elmvale Lagoon	Conventional lagoon Continuous discharge	0.750	1.380	1,200

Sport Fishery

During the early 20th century, as sport fishing gained in popularity in Severn Sound, lake trout, walleye, smallmouth bass, northern pike and muskellunge were important species. Lake trout contributed to the fishery for the first half of the century but declined and, with the invasion of sea lamprey, were ultimately extirpated during the 1950's.

Fishing effort averages 138,000 rod-hours during the 1970's (Table 3) and dropped to about 124,000 rod-hours in 1987. Total weight of fish caught averaged 22,000 kg during the 1970's and was 19,000 kg in 1987.

Walleye were common in the fishery during the 1970's (Table 3). Fish up to 9 kg were caught and fish 4 - 5 kg were common in catches. Walleye were caught in late winter and spring in Sturgeon Bay and the Port Severn area. In the 1980's, however, walleye numbers declined resulting in local game and fish clubs and a chamber of commerce approaching fisheries managers requesting help for the walleye. In 1986 volunteer groups reared and released into the Sound 10,000 walleye fingerlings. In 1987 they stocked 3000 fingerlings in an attempt to bolster the population.

Smallmouth bass and northern pike have contributed significantly to the summer fishery for many years. During the 1970's, smallmouth bass were the most important sport fish caught by anglers during summer months. Northern pike numbers declined during the 1970's, probably the result of low water levels during the 1960's but as water levels rose in the 1980's, pike have again increased and are contributing to the sport fishery.

Muskellunge have always provided a trophy fishery in Severn Sound. For many years, anglers travelled from distant points across the U.S. and Canada to hire local guides in hopes of catching a new record sized muskie. In the 1980's though, angler groups are reporting lower catches and smaller muskellunge in the fishery. They are concerned about the future of Georgian Bay muskellunge.

TABLE 3 - SUMMARY OF SUMMER CREEL SURVEYS CONDUCTED ON SEVERN SOUND

Selected Species	YEARS Numbers of Fish				
	1975	*1976*	*1977*	*1979*	*1987*
Walleye	1414	1445	1300	744	64
Black Crappie	11673	19348	17160	20243	8794
Northern Pike	10161	4945	4512	1855	5910
Total weight caught (kg)*	23201.2	28119.2	20570.7	14735.8	19357.6
Total effort (rod-hrs)	165058	161804	119596	105402	123537

From MNR, Huronia District

*Total weight for all sport fish species caught.

During the 1950's, the black crappie was relatively unknown in Severn Sound waters. Although crappies were present in low numbers, the sport fishery was dominated by large predators such as walleye. This changed in the 1960's and 1970's when area anglers began to catch crappies in ever increasing numbers (Table 3). The catch declined by more than 50% in 1987.

Until the 1950's whitefish and herring were important to the winter fishery of Midland Bay but as their numbers declined, the associated sport fisheries collapsed. Today, a few herring are reportedly being caught in Penetang Bay. Although whitefish populations have rebounded to former numbers in Nottawasaga Bay to the west, no resurgence is being experienced in Severn Sound. Rainbow trout were introduced into Georgian Bay in the late 1800's and provide angling opportunities as they ascend area streams to spawn. Major runs occur in the Sturgeon and Coldwater Rivers. In recent years two other introduced species, chinook and pink salmon, have also become established in Severn Sound. These species are angled for in the fall of the year as they migrate towards spawning but are generally not available the rest of the year as they migrate out of the Sound for most of their life history.

In summary, the fisheries have experienced the complete collapse of native coldwater species and the reduction of sturgeon to very low levels. Warmwater species increased initially and a large, diverse sport fishery developed but populations of the most desired species, walleye, have declined recently. Northern pike and smallmouth bass have remained important to the fishery and black crappie numbers have exploded so that this species has become dominant in the sport fishery. Rainbow trout, chinook and pink salmon have become established and also contribute to local fisheries during certain seasons.

2.3.3 Fish and Wildlife Habitat:

Severn Sound provides numerous and varied fish and wildlife habitats scattered along its shores (Figure 6). Critical habitats for fish include spawning and nursery areas. This is most critical to species such as walleye that concentrate their spawning in only a few locations. Walleye spawn at two locations near Port Severn where water exits from Gloucester Pool. Muskellunge spawning sites are also limited to small discrete locations but are scattered along the north shore of the Sound between Waubaushene and Honey Harbour.

Other warmwater species spawn in numerous locations around the Sound. Most sites are associated with shallow protected locations and healthy aquatic macrophyte communities.

Wetlands have been inventoried and classified along the south shore of the Sound using "An Evaluation System for Wetlands of Ontario, South of the pre-cambrian shield" (1984 Environment Canada and Ontario Ministry of Natural Resources). A total of six wetlands have been identified and are significant provincially.

All these wetlands provide significant areas for warmwater fish spawning and nursery activities. Several provincially significant birds feed and/or breed in these wetlands including Caspian terns, common terns and marsh wrens. Many more common species also inhabit these wetlands. Habitat is also provided for several fur bearers including muskrat, beaver and mink. Many recreational pursuits are associated with these wetlands too, such as waterfowl hunting, boating, fishing and nature appreciation.

Many wetland areas are also located along the north shore of the Sound but have not been inventoried or classified. Northern pike and muskellunge as well as largemouth bass, black crappie and other warmwater species spawn and use these areas for nursery habitats. Waterfowl such as mallard, wood ducks and blue-winged teal nest, raise young and gather before migration in these wetlands. Some aquatic furbearers are also associated with most of these wetlands.

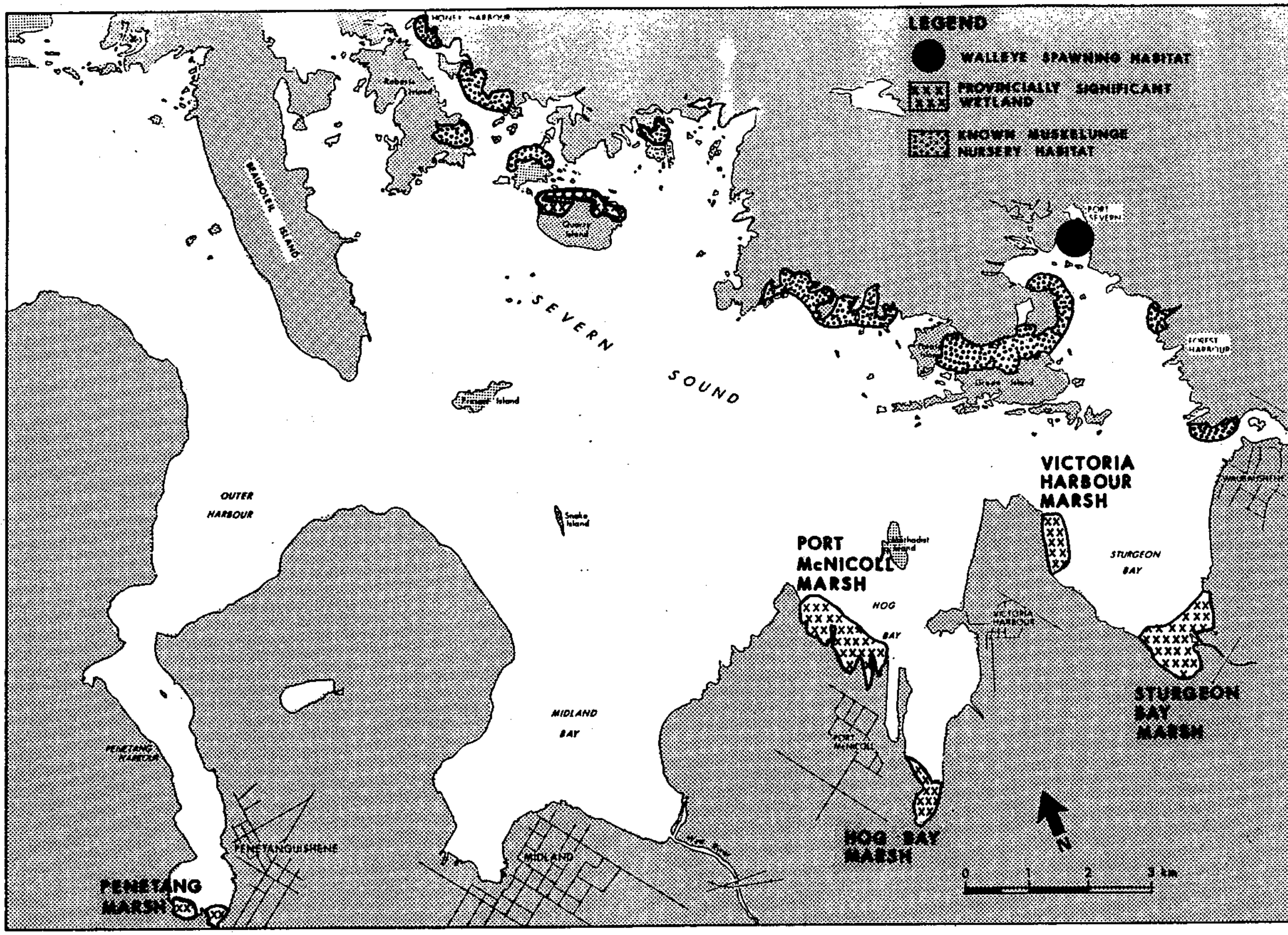


Figure 6: Significant wetlands and fish spawning areas and nursery habitat in Severn Sound.

The offshore area from Sturgeon Bay to Severn Sound was once used during spring and fall migrations by large numbers of greater and lesser scaup and other diving ducks for resting and feeding. The birds fed mainly on tape grass shoots but in recent years, the numbers of birds stopping off in this area has dropped off significantly. The changes in the aquatic macrophyte community to one dominated by Eurasian milfoil may be important in this decline in use.

2.3.4 Swimming (and other water/body contact sports):

The Sound is used for summer water-based recreational uses such as swimming, waterskiing and sailboarding. There are several beaches and swimming areas within the area of concern. Bacteriological sampling, by the local health units occurs at selected locations and at the end of each concession line that terminates along the shoreline. None of the areas sampled were closed to swimming in 1985 and 1986 due to high bacteria densities. Aesthetic problems due to nuisance algae have been reported to make swimming unpleasant in areas such as Penetang Bay.

2.3.5 Water Controls:

The water level of Georgian Bay has fallen approximately 2.5 metres in the last 300 years, as is indicated by investigations at old Fort Ste. Marie on the Wye River near Midland. Recently (1980 to 1986) summer water levels as indicated at Collingwood (Station 02ED012, Water Survey of Canada) have been at least 0.5 m above long-term mean water levels for summer months.

An important water based need on the Severn River is flood control. Flooding has been a serious problem through the years, and there has been a continuing endeavour to control lake levels and flows between Lake Simcoe and Port Severn so as to minimize detrimental effects of flooding. A flood control structure at Big Chute determines the flow release entering Gloucester Pool directly and the amount being diverted through Pretty Channel into Six Mile Lake. The main control structure at Six Mile Lake is at White's Portage, with flows being discharged directly into Gloucester Pool. There are two smaller outlet structures from Six

Mile Lake: at Six Mile Lake dam, and at Crooked Bay. The main control for Gloucester Pool is at Port Severn, but there is also a very small outlet from Go Home Bay. Control procedures at Swift Rapids are designed to maintain reasonable levels in Sparrow Lake (further upstream) as well as to satisfy navigational requirements at Swift Rapids (Dept, Indian and Northern Affairs, 1976).

There are two hydro-electric power plants on the main stem of the Severn River: Swift Rapids Power Plant (owned by Orillia Water, Light and Power Commission), and Big Chute Power Plant (located a few miles downstream and owned by Ontario Hydro).

2.3.6 Boating and Navigation:

Boating (pleasure cruising, and for sports fishing) is a major recreational attraction to Severn Sound and the Severn River. Small craft navigation is generally not a problem in the Sound, with two exceptions. A small craft route is maintained by the Canadian Coast Guard to guide boaters safely through the many islands in the north part of the Sound. In the shallow bays and harbours of the southern parts of the Sound, nuisance aquatic plants can at times make small craft navigation difficult.

Severn Sound boaters have access to the Trent-Severn Waterway, which is part of the Rideau-Trent-Severn inland waterway system administered by Parks, Environment Canada. Parks' records reveal that annually there are approximately 113,000 vessel movements up and down the 12 locks in the northern reaches of the Canal locks, extending between Fenelon Falls and Port Severn. Only the northern-most Canal lock, at Port Severn, lies in the RAP study area. Annually, there are approximately 10,000 vessel movements through the Port Severn lock. It is not known how many of these boaters originate or terminate their journey in Severn Sound (pers. comm., J. Garlow, Parks, Environment Canada, 1988).

Twenty-four (24) private marinas, five (5) federal Small Craft Harbour facilities and two (2) ports are located in the study area (Figure 7).

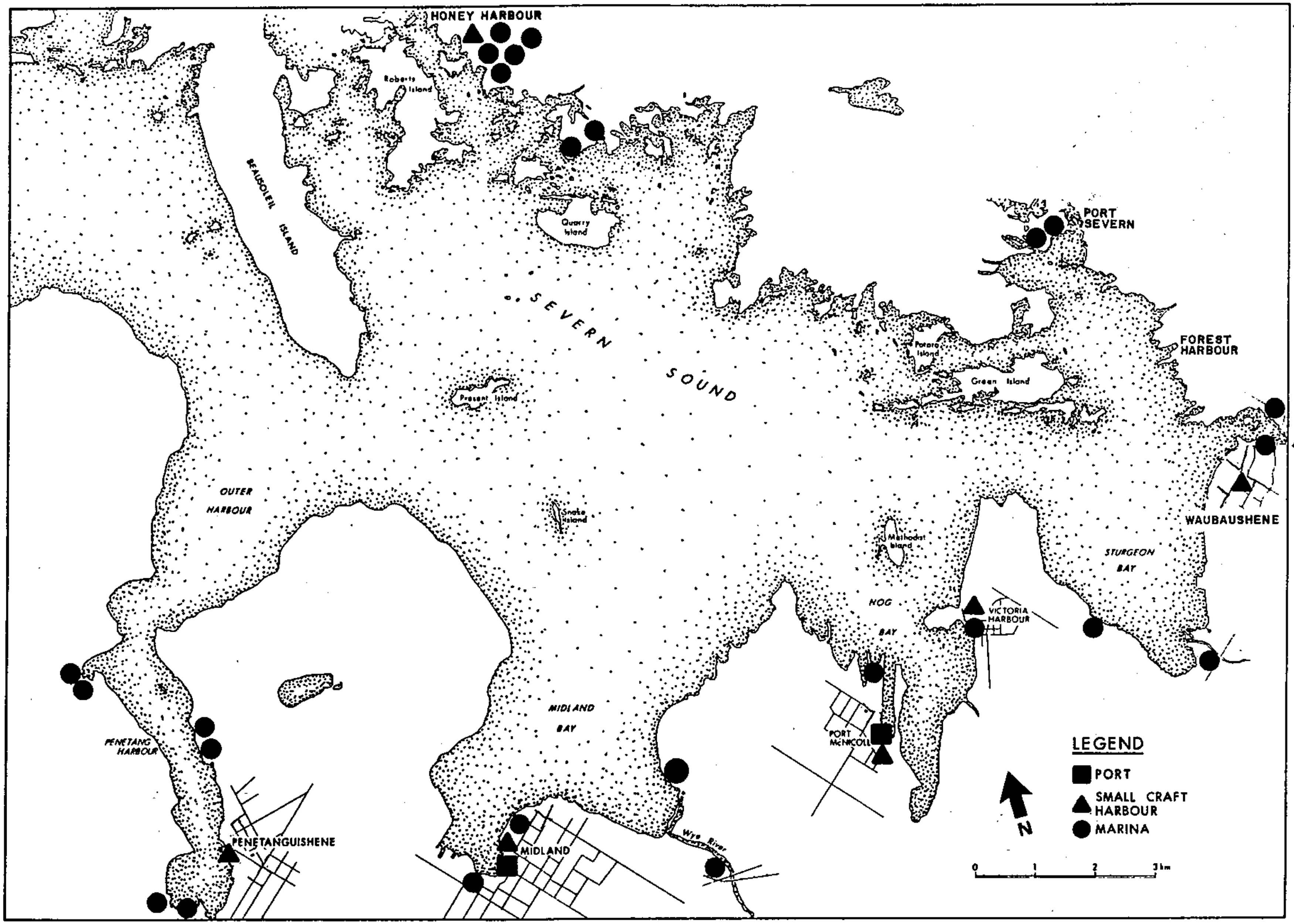


Figure 7: Harbours and marinas in Severn Sound area.

2.3.7 Marine Construction:

Twenty-four private marinas are concentrated in clusters throughout Severn Sound, at Penetanguishene, Midland, Port McNicoll, Victoria Harbour, Waubaushene, Port Severn and Honey Harbour. The smallest of the marinas has only 30 slips. One marina in Midland Bay has 1100 slips, making it the largest private marina on the Great Lakes. Dredging and expansion applications for marine construction projects ranging from new marina basins to shoreline stabilization of cottage frontage are considered by the Canadian Coast Guard with comments on environmental concerns from the Ministry of Natrual Resources (MNR), the Ministry of the Environment (MOE) and Environment Canada (EC).

Federal Small Craft Harbour facilities are located at Penetanguishene, Midland, Victoria Harbour, Waubaushene and Honey Harbour. To date, dredging has not been necessary at any of these facilities (pers. comm., D. Blanchard, Department of Fisheries and Oceans, 1988).

Two ports are maintained in the Sound, one at Midland, and the other at Port McNicoll. The Canadian Coast Guard maintains a shipping channel into the Sound during the normal navigation season from approximately April 15 to December 15. In addition, the Coast Guard routinely breaks ice to these ports during winter months to allow local (Georgian Bay) shipping prior to the normal navigation season.

Midland is an important grain handling port. The movement of quartz accounts for other major commercial port traffic. Transport Canada owns five port facilities in the harbour; however, they are presently inactive. The main wharves in the harbour have charted depths of 6.1 - 7.3 m. In the past, dredged channels have included Midland Harbour and Tiffin Basin; however, there have been no dredging expenditures since 1973. There are no applications on file to dredge or expand the existing facilities (pers. comm., D. Mattingley, Transport Canada, 1986). The approach to the harbour is well marked by ranges and buoys. A natural hazard to shipping, the Midland Bay Shoal, is situated 1.6 km SW of Midland Point.

Port McNicoll consists of an artificial basin which was dredged inward from the original shoreline for a distance of 1,371 m and width of 182 m. This is a grain transfer port and terminal for the Canadian Pacific Railway. The depth in the harbour varies from 5.8 - 8.5 m. The channel has been dredged in the past; however, there has been no dredging activity since 1973. There are no applications on file to dredge or expand the existing facilities (pers. comm., D. Mattingley, Transport Canada, 1986).

2.4 Land Uses

The area surrounding Severn Sound and the Severn River is a multi-use basin incorporating urban, industrial, agricultural, waste disposal and recreational land uses (Figure 8).

2.4.1 Urban:

Tiny, Tay and Matchedash Townships have a combined population of 38,000 in the winter and 150,000 in the summer. The largest population centres -- Penetanguishene (5,449 in 1986), Midland (12,049 in 1986), Port McNicoll (1,950 in 1986), Victoria Harbour (1,198 in 1986) and Waubaushene (750 in 1985) -- are all located on the south shore of Severn Sound. The hamlets of Port Severn and Honey Harbour are located on the north shore of Severn Sound.

2.4.2 Agriculture:

The soil types present throughout much of the study area place severe restrictions on the type of farming operations that can be carried out. Much of the land is too steep, too stony, too wet or too rocky to be farmed (Figure 9). Across the region south of Severn Sound generally, between a third and a half of the land is used for crop production or pasture. Essentially, no agricultural activity is carried on in the Georgian Bay Fringe.

On the Simcoe Uplands, farming on much of the land is limited by either the slope or the stoniness. This includes most of the area drained by Copeland Creek, Hog Creek and the Sturgeon River, as well as the upper reaches of the Coldwater and North Rivers. A large proportion of the land (half or more) is forested or is

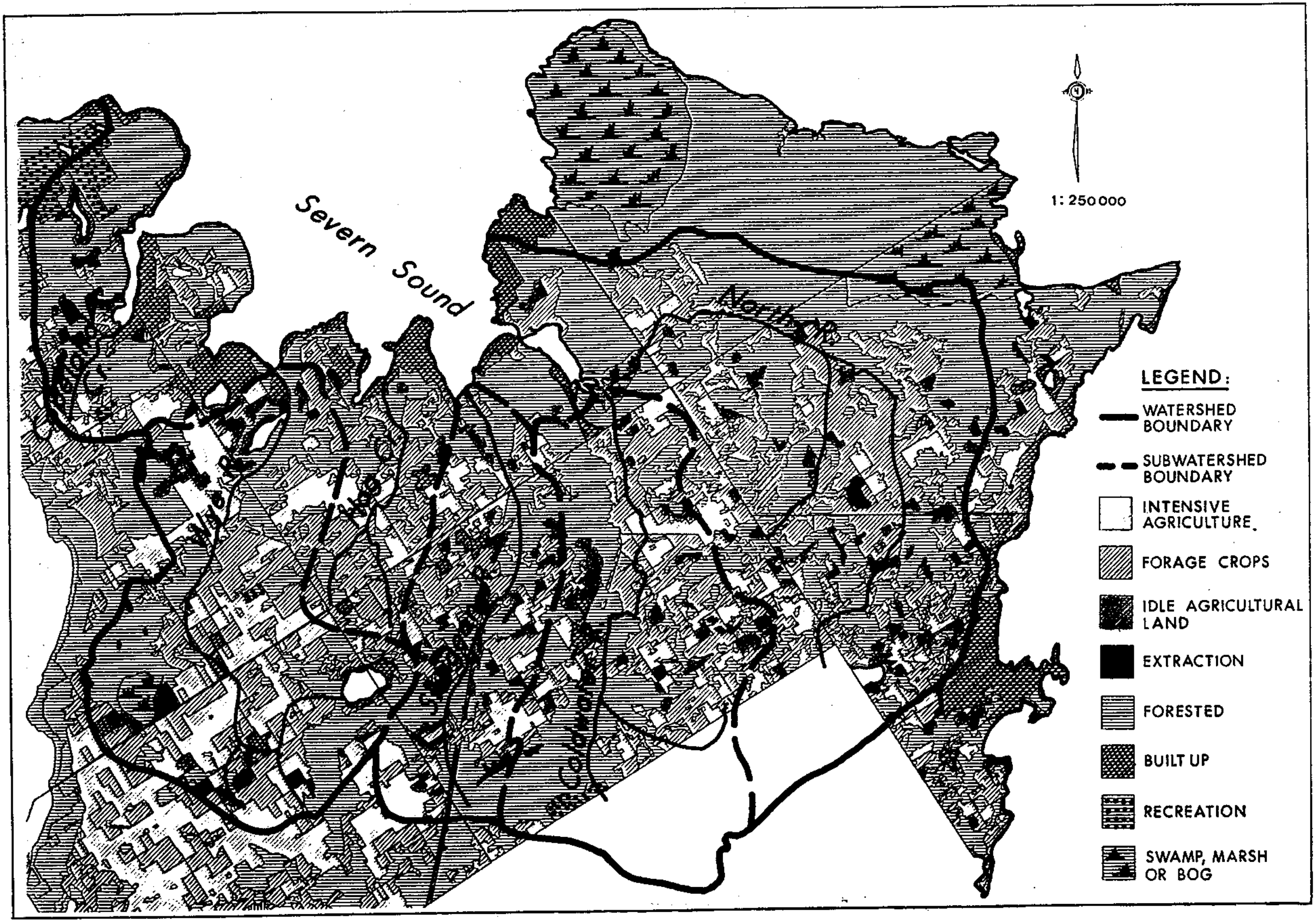


FIGURE 8: Land use in the Severn Sound area.

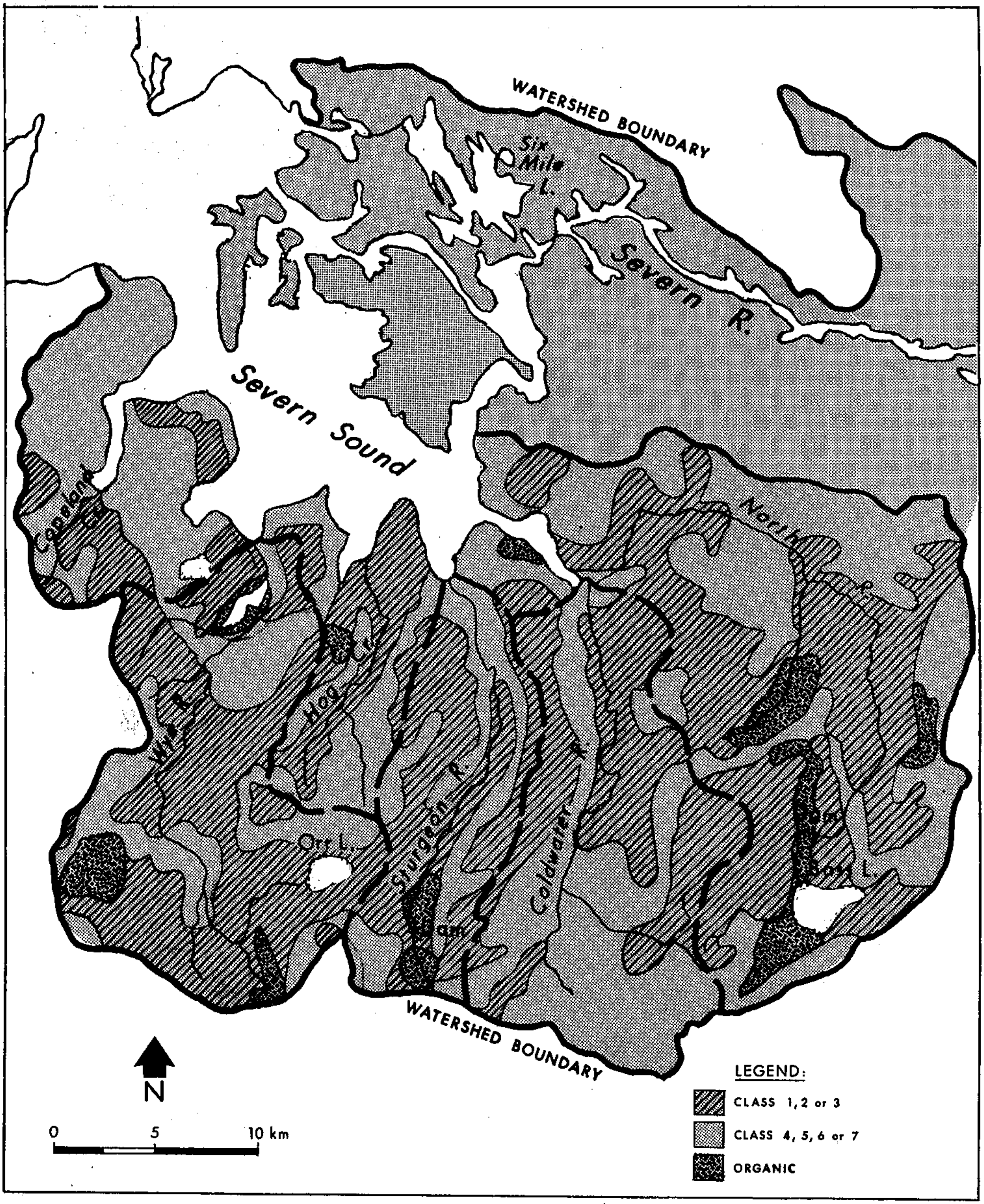


FIGURE 9: Soil capability for agriculture.

farmland that has been abandoned (Appendix I). Farming is limited to the smoother, less stony areas. Mixed farming systems predominate, with 50 to 60 percent of the farmland being devoted to hay and pasture (Appendix I). Row crops such as corn or soybeans are grown on only 5 to 10 percent of the farmland; cereal grains are grown on 10 to 20 percent.

The clay plain bordering the Wye River near Elmvale is the most intensively farmed portion of the study area. Although the internal drainage of the soil is naturally imperfect, much of the improved farmland has been tile drained. This has made it possible to produce crops such as corn, soybeans, field beans and canola, in addition to forages and cereal grains. A similar, but less intensively farmed area exists adjacent to the Coldwater River, near Coldwater.

Extensive woodlands, interspersed with swamps, marshes or bogs are common along the Severn River, and around Matchedash Bay. Moving west across the study area, the percentage of woodland decreases.

2.4.3 Industrial:

The geographic situation of Midland and Penetang, relative to major market areas, has made them particularly attractive to a variety of industries. There are no large industries in Port McNicoll and Victoria Harbour; here, the major employers are the government and local services.

2.4.4 Waste disposal sites:

Within the study area, there are nine certified waste disposal sites (Figure 10). Three of these sites are active; six others have been closed. There are numerous, closed, uncertified waste disposal sites in the Severn Sound area (Figure 10, Appendix II).

2.4.5 Recreation/Forestry:

Severn Sound is a major recreation area, especially for the heavily populated areas of Southern Ontario. Swimming, boating, and the scenic surroundings are the main attractions to the area during the summer. The heavy snowfall and the unsettled topography attracts cross-country skiers and snowmobilers in the winter.

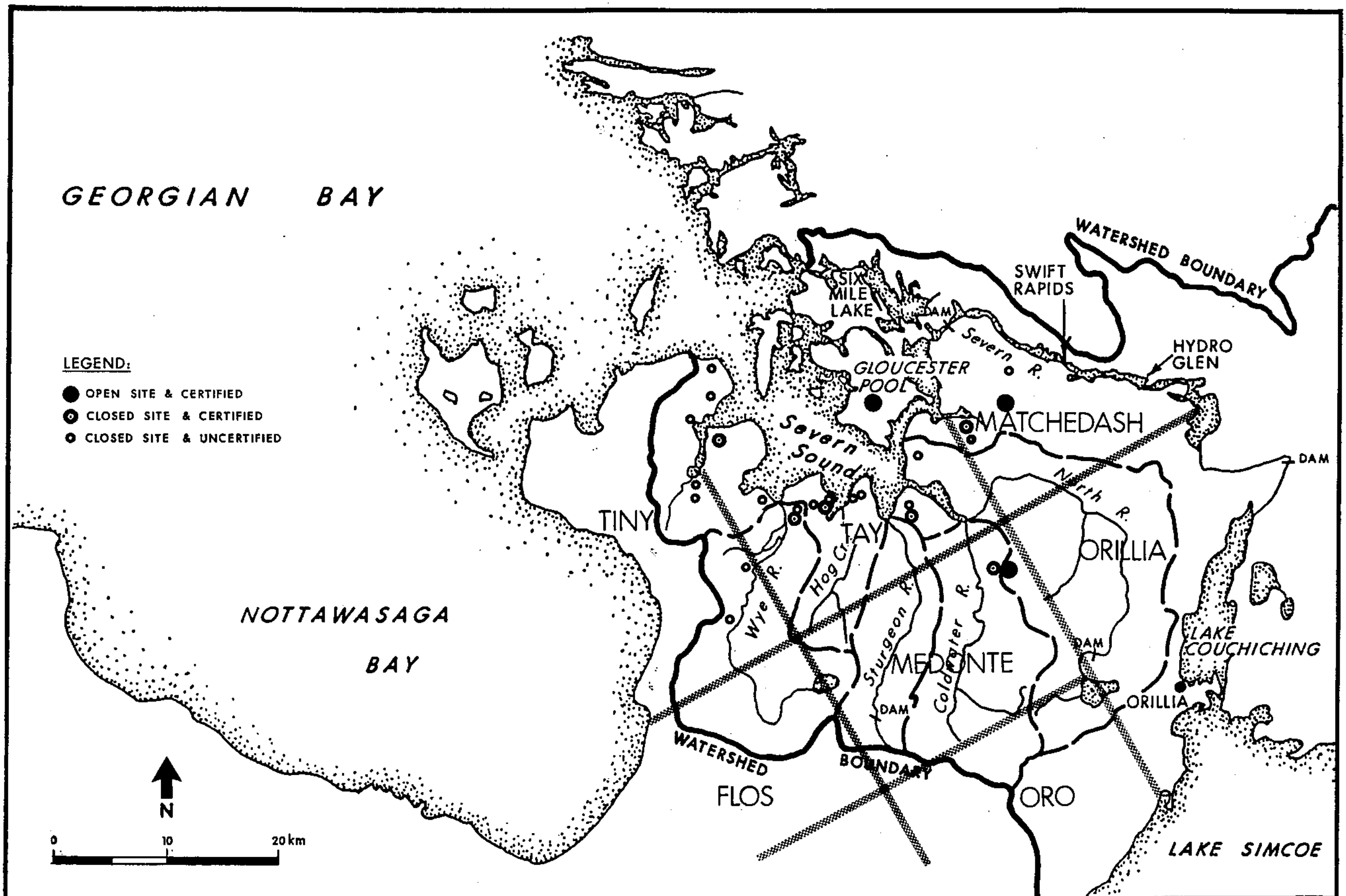


FIGURE 10: Waste disposal sites within the Severn Sound RAP drainage area.

Georgian Bay Islands National Park, one of only two island parks in Canada, is in the study area. Difficult access has resulted in environmental components, both living and non-living, being preserved in a more pristine and untouched condition.

The Trent-Severn Waterway, discussed earlier in this report, is an important recreational and tourism resource in the Severn Sound area.

The Ministry of Natural Resources manages three Provincial Wildlife Areas and one Resources Management Area within the Severn Sound watershed. The four wildlife areas include 3471 ha of varying amounts of marsh and upland habitats. Numerous provincially significant and common wildlife inhabit these areas. Hunting, trapping, nature appreciation and outdoor education are the major activities that occur on the properties.

Forestry activities in the watershed include selective harvesting and planting on both private and public lands. Forest products include pulpwood, pinewood, saw logs, Christmas trees and maple syrup. Limited planting of mainly conifers occurs throughout the watershed where appropriate.

3. DESCRIPTION OF ENVIRONMENTAL CONDITIONS

3.1 Currents and Water Movement

Gradients in water quality and water clarity between the open waters of Georgian Bay and Severn Sound have been noted since the earliest studies in 1969 (Veal and Mickalski, 1971). The gradients are a result of water movement and exchange between the relatively clear waters of Georgian Bay and the more turbid waters of Severn Sound. The water movement and exchange is caused by a combination of local and lakewide currents. In order to understand the implications of any water quality management activities, it is necessary to define the water exchange taking place between two bodies of water. The mechanisms responsible for the exchange are documented by Kohli (1979).

Eight self-recording current instruments, two at each of the four mooring sites (Figure 11) were operated from June to December 1985, to provide input data for the Excursion-Episode model (Kohli, 1979). This model was used to estimate the exchange between:

(a) Penetang Bay (PB) and Severn Sound (SS)
(b) SS and Georgian Bay (GB)

PRELIMINARY results from the model are presented in Table 4. The results and the following interpretation are preliminary only and may be changed in the final report.

(a) The net flow from PB to SS ranged between 0.4 and 3.8% volume of PB (16.7×10^6 m^3/d) during September to December. However, the net flow was in the opposite direction, from SS to PB during June and July and accounted for 6.5 and 2.9%, respectively, of the bay volume.

(b) For the SS-GB exchange, Table 4 shows that the net flow remained towards GB (2.1 to 19.4×10^6 m^3/d). For 3 out of 6 months, the net flow out from Severn Sound exceeded the total inflow to Severn Sound from all sources (2.4 to 9.9×10^6 m^3/d - Table 5).

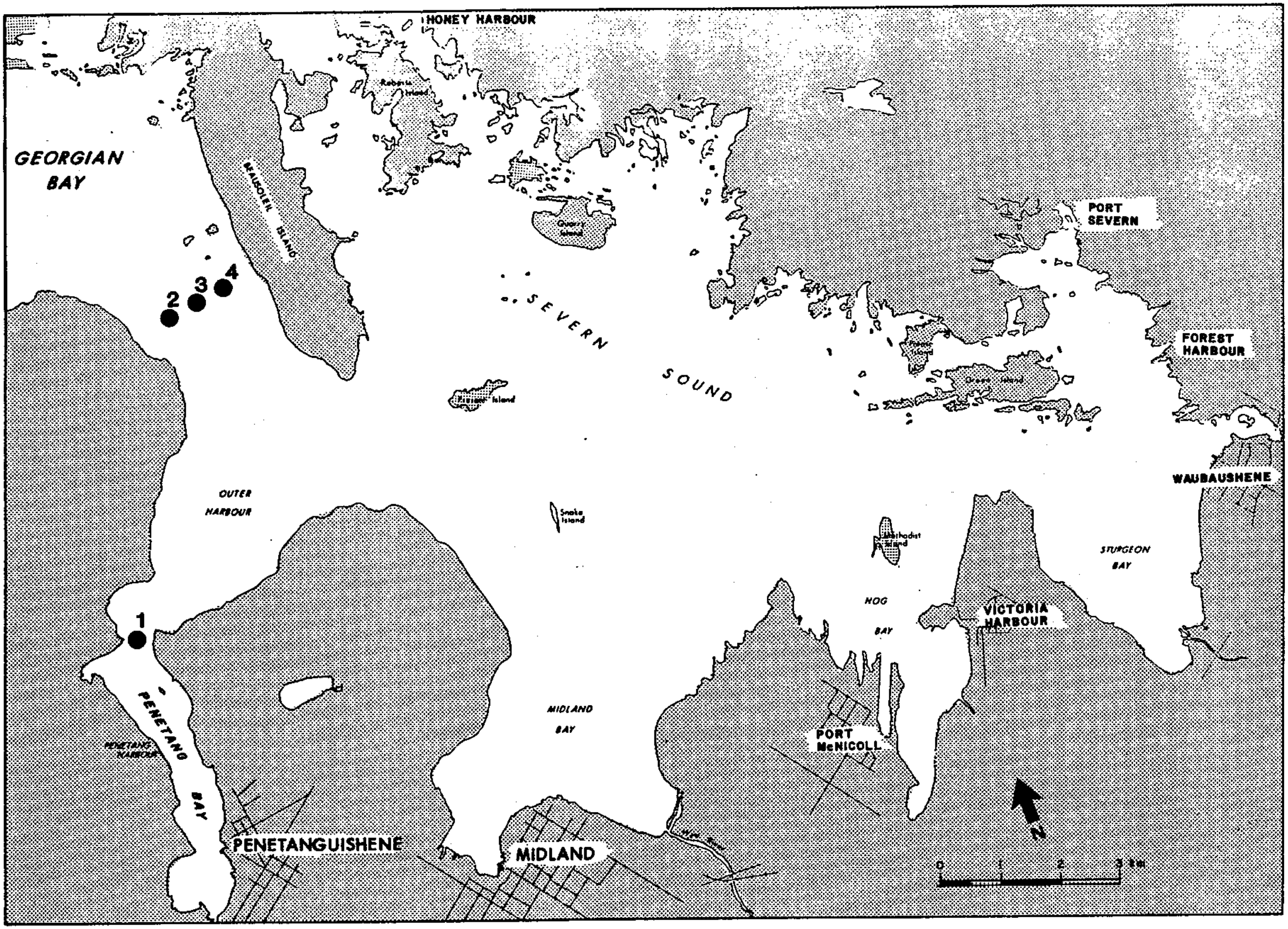


Figure 11: Location of current meter mooring sites, 1985

TABLE 4: SUMMARY OF EXCHANGE FLOWS

PENETANG BAY-SEVERN SOUND-GEORGIAN BAY, 1985

Flow x 1000 m^3/d

	Penetang Bay-Severn Sound			Severn Sound-Georgian Bay			
Month	Penetang Bay	Severn Sound	Net to Severn Sound	Severn Sound	Georgian Bay	Net to Georgian Bay	Total Inflow
June	2012	926	- 1086	-	-	-	3,025
July	1482	1150	- 332	19,371	30,136	10,765	2,378
August				12,436	31,880	19,444	2,835
September	486	549	63	11,944	14,067	2.123	6,542
October	107	467	360	8,446	13,824	5,378	7,249
November	327	966	639	12,166	28,199	16,033	9,862
December	434	840	406	4,855	9,439	4,584	8,564

TABLE 5 : FLOW INPUTS TO SEVERN SOUND, 1985

(flow x 1000 m^3/d)

Month	Two STP's in Penetang Bay	All STP's in Severn Sound	Severn River to Severn Sound (10-yr. avg.)	Non-Point Sources	Total Inflow
June	2.46	13.08	2533	479	3025
July	2.12	12.35	1907	459	2378
August	2.01	12.04	2425	398	2835
September	2.25	12.76	5981	548	6542
October	2.26	13.06	6713	523	7249
November	2.92	14.89	9005	842	9862
December	2.95	14.92	7159	1,390	8564
Mean	2.42	13.30	5103	663	5779

Severn Sound registered a net water gain during July, August and November and a net water loss during September, October and December, 1985 (Table 5). However, a satisfactory water budget could not be estimated from the 1985 data due to the large size of the model grid in the presence of a complex hydrodynamical regime (Kohli, 1988). A smaller grid size with the corresponding number of current meters would provide a better water budget. A detailed study, including 18 current instruments, is planned for the 1988 field season.

3.2 Water Quality

Staff of MOE, Aquatic Biology Section have conducted a program of water quality assessment in Severn Sound from 1973 to present to assess changes in water quality in relation to changes in treated sewage effluent discharges.

Water samples were collected bi-weekly from early May until October at five to thirteen stations in Severn Sound (Figure 12). Stations P1 and P4 near Penetanguishene, M1 near Midland, PM2 near Port McNicoll and BS in Sturgeon Bay were regarded as the main stations and were sampled each year. The other stations were sampled intermittently. The number of stations was reduced to five because quality was similar to other nearby stations.

At each station, dissolved oxygen concentrations and water temperatures were measured from surface to lake bottom and samples were collected for chemical and biological analyses. Biological results have been discussed elsewhere (Nicholls, Carney and Robinson, 1977; Nicholls, Robinson, Taylor and Carney, 1987).

The following sections summarize key features of the water quality information available for Severn Sound.

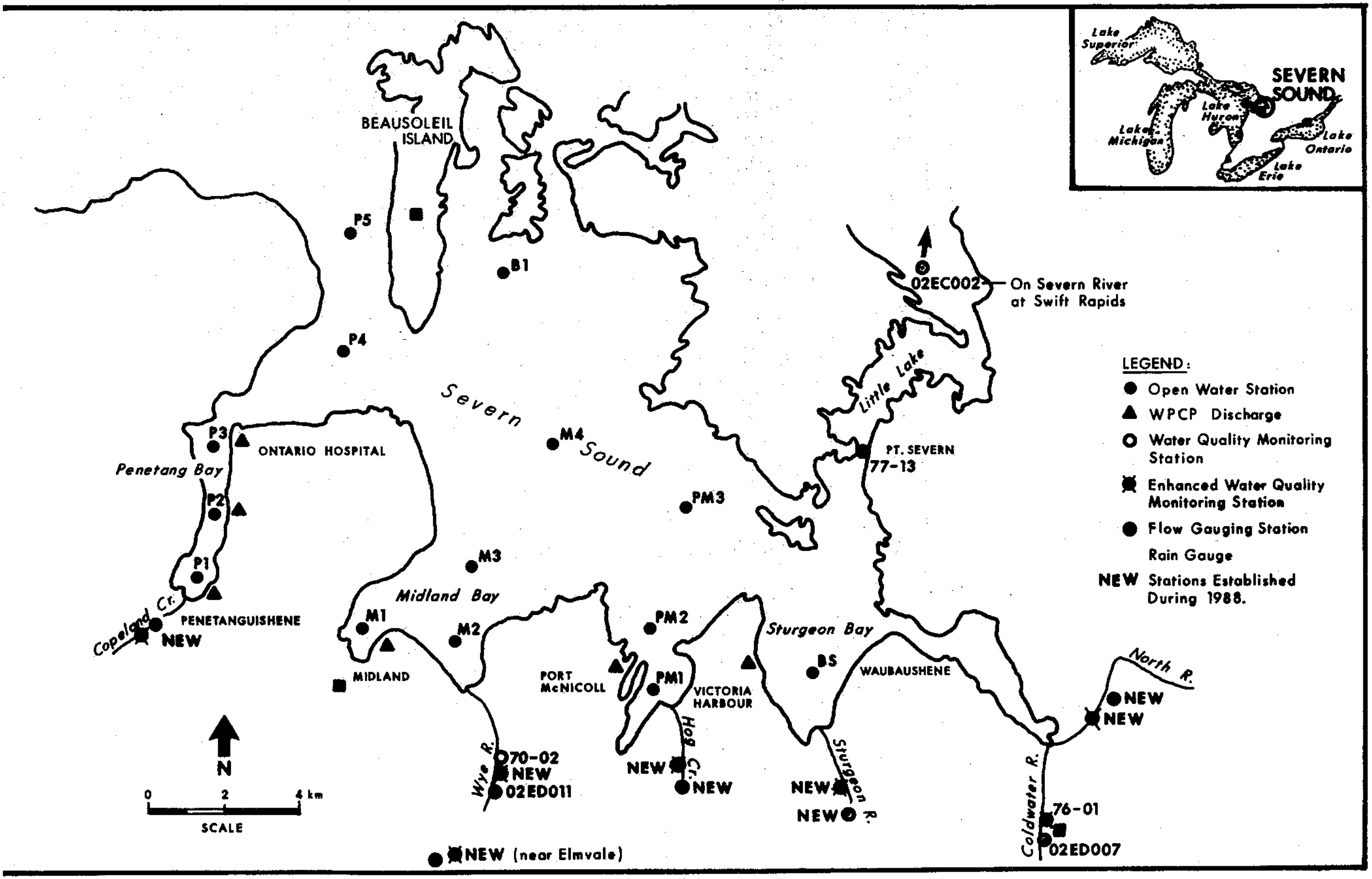


FIGURE 12: Water Quality and flow monitoring stations in the Severn Sound Area.

3.2.1 Temperature and Dissolved Oxygen

The shallow bays in the Sound warm rapidly each spring reaching maximum temperatures by July or August. Temperatures ranging as high as 26 degrees Celsius present no unusual problems for aquatic life. Sturgeon Bay is generally the warmest area due to absorbance of solar radiation by dense aquatic plant growth, warm water inputs from the Sturgeon River, and protection from mixing with the Sound by shoals at its mouth. Open water stations are usually cooler because of cold water mixing from Georgian Bay, especially during windy weather.

Thermal stratification is evident only during brief periods of hot, calm weather.

Dissolved oxygen levels are similar at all depths except during temporary periods of thermal stratification when concentrations are sometimes reduced near bottom. During calm periods in the summer months dissolved oxygen levels drop as low as 2.7 mg/L at Station PM2 - a site with a small localized bottom water area. At typical summer temperatures concentrations below 4-5 mg/L may stress some species of fish (PWQO). Oxygen supersaturation occurred occasionally at all stations which can be harmful to fish. The rapid depletion of oxygen in the localized bottom waters at sites like PM2 and the supersaturation of dissolved oxygen in Severn Sound is an indication of high productivity typical in eutrophic waters. Apart from the localized temporary depletion of oxygen and the possible effect of supersaturation, the oxygen levels met MOE PWQO in Severn Sound.

3.2.2 Basic Chemistry

Measured pH values over 7.0 are consisdered alkaline while values under 7.0 are acidic. Average pH ranged from 7.6 to 8.4 and varied from station to station. These are similar to values observed in other areas of Georgian Bay. Sturgeon Bay is the exception where, because of the influence of a dense plant community seasonal variations are greater, with pH values as high as 9.0 observed in some years.

3.2.3 Water Clarity

The depth at which a black and white metal disc, called a Secchi disc, disappears from view is a measure of water clarity. As expected, Secchi disc readings were highest in the open water areas of Stations P4 and M1 and lowest at Station P1. In the Port McNicoll area Station PM2 had similar water clarity to Station P4, except when wave action resuspended materials, such as sediment into the water column. Similarly, in Sturgeon Bay, aquatic plant growths and suspended material sometimes reduced Secchi disc readings.

Average Secchi disc depths fluctuated from year to year, but there were no apparent trends towards improved water clarity (Figure 13).

3.2.4 Phosphorus

Phosphorus (total and soluble reactive) are important nutrients utilized by plants and algae. Normally found in nature in short supply, it generally limits plant growth in Georgian Bay waters. However, high concentrations of phosphorus can promote nuisance levels of algal and plant growth. Veal and Michalski (1971) reported a gradation in total phosphorus concentration in Penetang Bay. Highest concentrations were measured at Station P1 at the southern end of the Bay, and lowest concentrations were found at Station P4 (Figure 14). This gradient was a result of imcomplete mixing with the open water areas.

The 1986 total phosphorus concentrations were approximately 50% of those measured in 1969 at Stations P1 and M1; there were no significant changes at Stations PM2 or BS. Penetanguishene (Station P1) and Midland (Station M1) represent waters near the largest population centres in the area and are influenced more directly by WPCP discharges than PM2 or BS. The pronounced decreases in TP observed at P1 and M1 were presumed to be due to improved operating efficiency at the Penetang and Midland WPCPs, and to detergent phosphorus control. Since the initial drop in 1973, TP levels have fluctuated considerably (Figure 14).

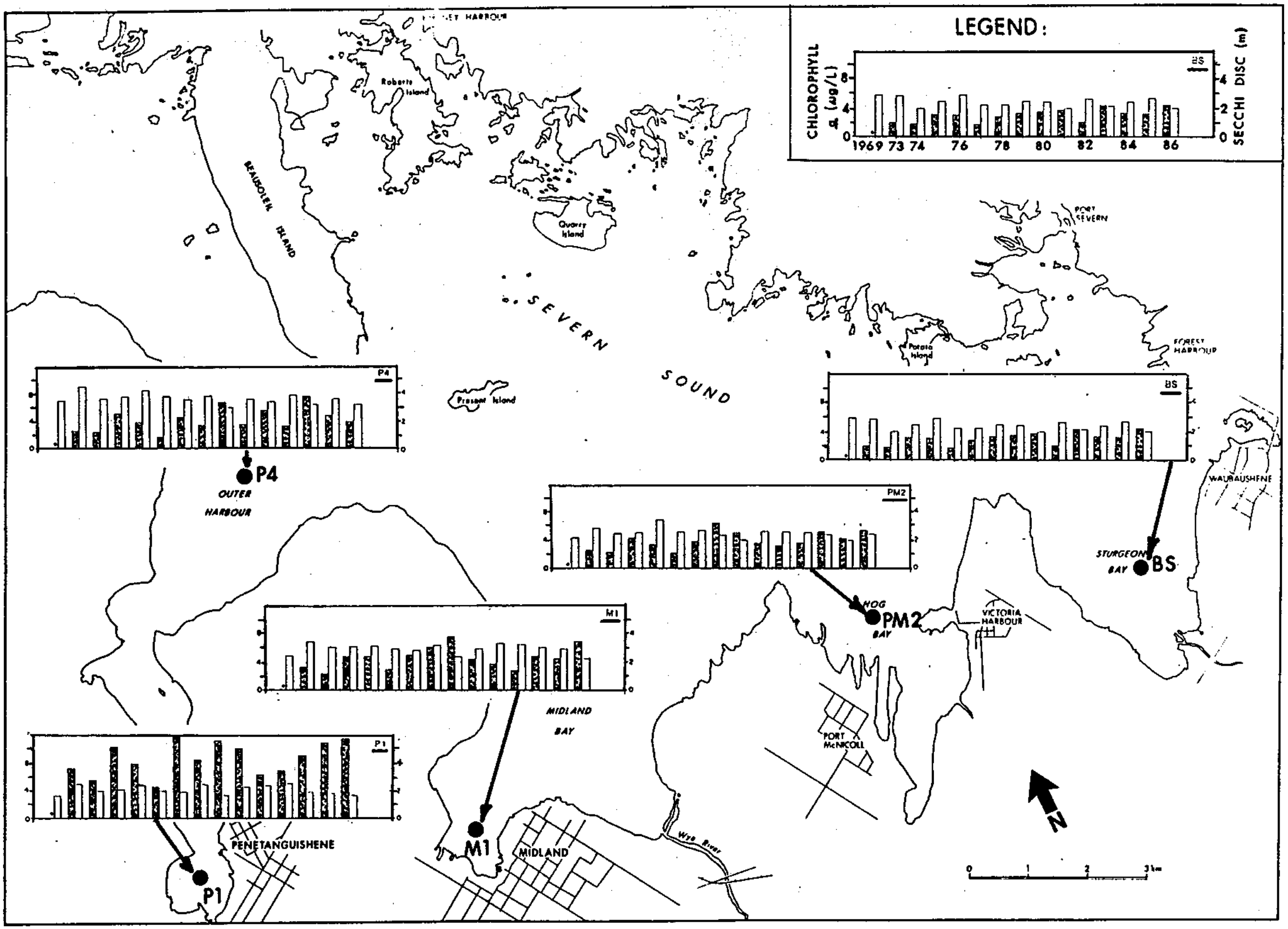


FIGURE 13: Mean euphotic zone chlorophyll a concentrations (µg/L) and mean Secchi disc readings (m) at the five main Severn Sound stations, during the ice free periods of 1969, 1973-1986.

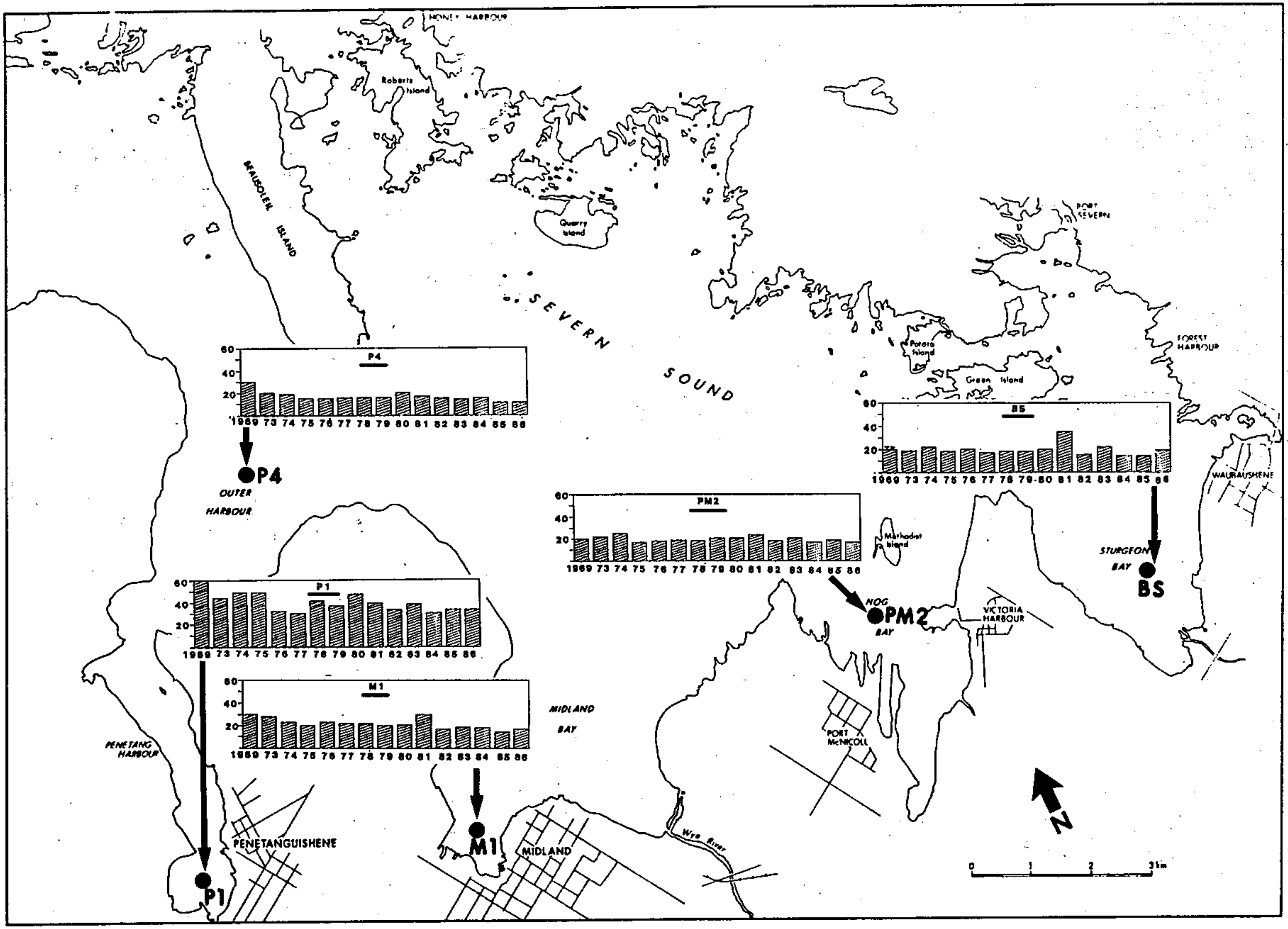


FIGURE 14: Mean annual total phosphorus concentrations at the five main Severn stations 1969, 1973-1986.

In Severn Sound, WPCP facilities have been constructed, modified, or expanded throughout the entire study period. Consequently, any real reductions in TP concentrations from these sources have been difficult to interpret. It is therefore understandable that Severn Sound as a whole did not respond immediately to the individual improvements to facilities along its shores. TP levels at P1 and M1 though significantly lower than at the beginning of the study, are still high enough to support nuisance algal growths, particularly in the southern part of Penetang Bay.

Soluble reactive phosphorus (SRP) is considered to be more readily used by algae than other forms of phosphorus. Mean SRP concentrations were highest at Station P1 and lowest at Station PM2. The other three main stations were not significantly different from Station PM2. Year-to-year variations appear to be more important than station-to-station differences since, until 1984, there was no discernible trend toward lower mean SRP levels at any station. The gradation observed in TP levels from Station P1 to Station P4 was also evident for SRP concentrations.

No seasonal patterns or trends could be established for SRP. Factors such as weather and water exchange influence SRP concentrations. The lowest SRP concentrations were measured in the Sound in 1979. This corresponds exactly with observations of low concentrations in the Bay of Quinte (Robinson 1986). In both cases, the record low levels were followed by substantial increases in 1980.

3.2.5 Nitrogen

Mean total nitrogen (TN) concentrations were highest at Station P1 and lowest at Station P4. Stations M1 and PM2 were similar to Station P4 since all three stations are exposed to wind-induced mixing. TN levels were slightly higher at Station BS but because of the plant community the nitrogen was mostly in the organic form. In recent years, Total Inorganic Nitrogen (TIN) levels have been higher suggesting less demand for nitrogen by the algal and plant communities in Sturgeon Bay.

This increase in TIN in the last few years was also evident at the other four main stations. The shift from organic to inorganic forms of nitrogen was most pronounced at Station P1. This is probably due to partial nitrogen removal at the STP and to an increase in nitrate nitrogen, generally occurring throughout the Great Lakes.

3.2.6 Nitrogen to Phosphorus Ratios

High Nitrogen-to-Phosphorus(N:P) ratios, greater than 20:1, generally indicate good water quality; not conducive to nuisance algal blooms. Low ratios of less than 10:1 indicate a potential for nuisance algal blooms to develop.

Since the general decrease in Severn Sound TP concentration was greater than the decrease of TN concentration, N:P ratios increased at all five stations, indicating an improvement in water quality. The apparent improvements since the beginning of the study were greatest at Stations P4, M1 and PM2. Only a minor increase in N:P ratio was seen at Station P1.

The improvement in N:P ratio at Station BS may not be as relevant in Sturgeon Bay as in other areas studied in Ontario because of the dominating influence of the aquatic plants which obtain much of their nutritional requirements from the sediment (Appendix III).

3.2.7 Algal Biomass

Chlorophyll *a* is the photosynthetic green pigment present in most plants and algae. Measured concentrations of chlorophyll *a* indicate the amount of suspended algae or phytoplankton in the water. Chlorophyll *a* levels are highest at Station P1, with levels as high as 27.9 ug/L recorded in 1986. This station is in close proximity to the Penetang water pollution control plant (WPCP) discharge which contributes nutrients promoting algal growth. The constricted entrance to Penetang Bay also serves to restrict mixing with the rest of the Sound resulting in the more eutrophic conditions at Station P1.

Although average chlorophyll *a* levels have been low at times, there has been no obvious trend towards lower concentrations despite the implementation of improved phosphorus treatment at the WPCP's. In fact, there has been a recent rise in chlorophyll *a* concentrations similar to those of 1978 and 1980 (Figure 13). Some of the variation may be caused by natural factors such as rainfall, water level changes, winds and currents. But other factors such as sewage treatment facility expansion, as well as WPCP operational problems may have had an effect.

Similar to the gradient observed for phosphorus, a gradient also exists for chlorophyll a in Penetang Bay, with higher concentrations at Station P1 and lower concentrations by Station P4. Concentrations greater than 30 ug/L occur when algal blooms are present. Algal blooms can screen available sunlight from reaching the lake bottom. This hinders the development of a healthy aquatic plant community which in turn can potentially eliminate productive fish habitat.

In Midland Bay, despite the close proximity of Station M1 to the STP, chlorophyll a concentrations were generally low and similar to those at Station PM2, but less than those at Station P4. In the Port McNicoll area average chlorophyll a levels were consistently low. The highest mean value recorded was 6.1 ug/L. Consequently, this area of the Sound enjoys some of the better water clarity in the area.

In Sturgeon Bay, dense growths of aquatic plants are able to out-compete algae for available nutrients, as such, chlorophyll a levels were generally low, from year to year.

3.3 Contaminants in Water

There are no routine trace contaminant monitoring data available for open waters of the Sound, but limited data is available for four water quality monitoring stations located on inflows (Figure 16). The concentration of metals analyzed from water samples were generally below the Provincial Water Quality Objectives (PWQO). Cadmium, arsenic, lead and nickel levels were usually below Ministry detection levels. Initially, measured copper levels were above the PWQO, but a change in analytical techniques in 1983 has increased precision, and copper levels have subsequently been within the PWQO guidelines. Iron levels were frequently above the PWQO at station #76-01 in the Coldwater River (0.14 - 2.995 mg/l), but were within acceptable limits at the other monitoring stations.

All organic contaminants concentrations analyzed were below Ministry detection levels.

A 1985 water quality study was also available for Penetang Harbour and Midland Bay, using the same sampling sites as for the sediment data (see Figure 15). Water samples were taken 1m off the bottom, and the parameters analyzed are listed in Table 6.

In Penetang Harbour, copper levels generally exceeded the PWQO (see Table 6). Mercury levels also exceeded the guidelines at station 524, as did iron at stations 528 and 530, zinc at stations 524 and 525, and aluminum at stations 526, 528, 529 and 530. All other metals concentrations analyzed were within the PWQO, and all organic contaminants concentrations analyzed were below Ministry detection levels.

Copper levels in Midland Bay also generally exceeded the PWQO (see Table 6). Iron levels also exceeded the guidelines at station 519, as did zinc at stations 517 and 519, and aluminum at stations 516, 517 and 519. All other metals analyzed were within the PWQO, and all organic contaminants analyzed were below Ministry detection levels.

3.4 Sediment

There is limited surficial sediment data (grab samples) available for the Severn Sound area. Data from 1985 is available for Penetang Harbour and Midland Bay (MOE, *Aquatic Biology Section, In-Place Pollutants Program*), and 1980 data is available for Sturgeon Bay (MOE, Great Lakes Section, unpublished). Samples were collected from 10 stations in each of Penetang Harbour and Midland Bay, and from 15 stations in Sturgeon Bay. (See Figure 15 for station locations.)

In Midland Bay, levels of copper, chromium, lead, zinc and solvent extractables generally exceeded the MOE Open-water Disposal Guidelines (Table 7). Mercury concentrations at stations 517 and 518 also exceeded the guidelines, as did nickel levels at stations 512, 519 and 521. PCB levels were within MOE guidelines.

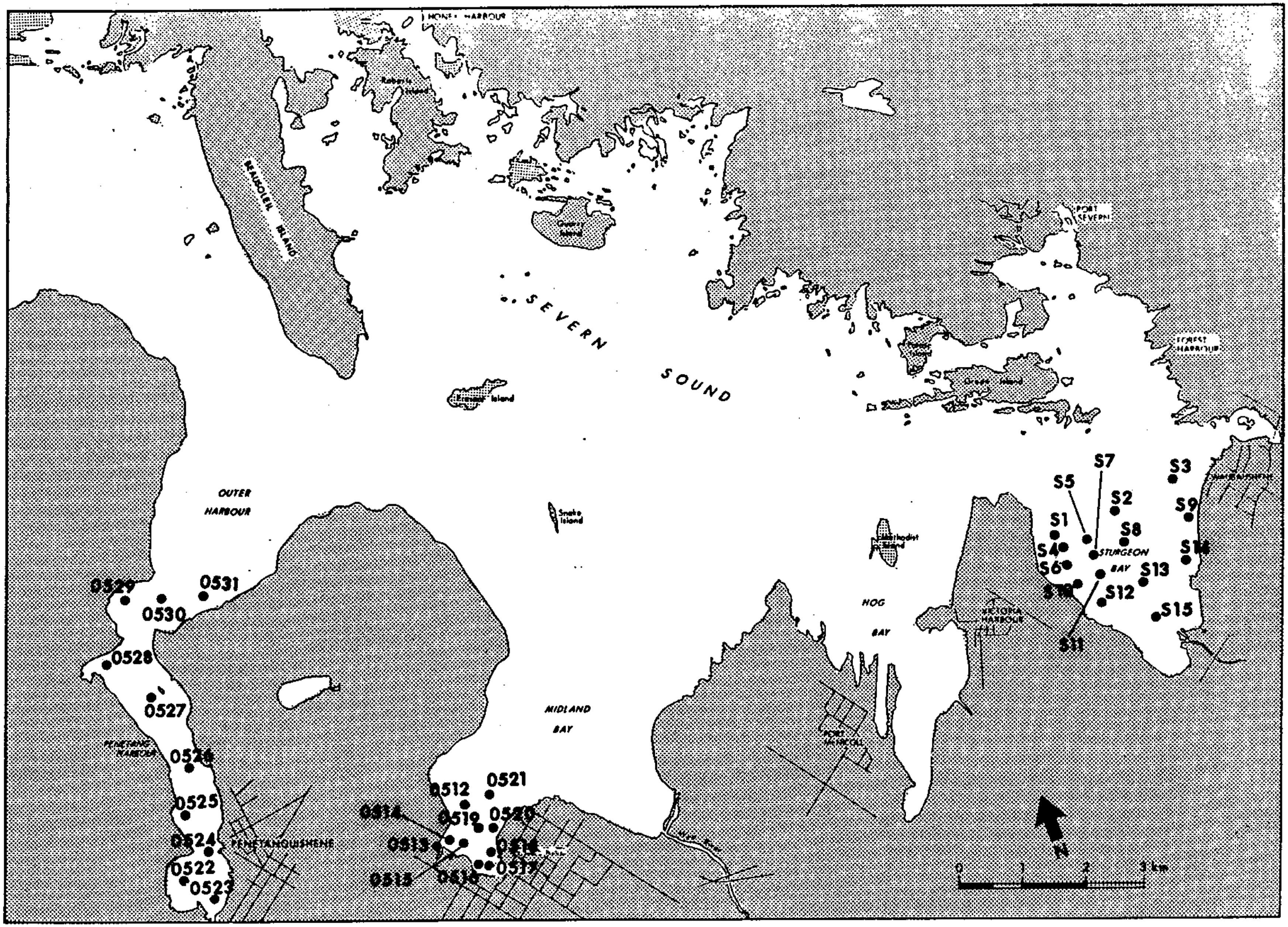


FIGURE 15: Sediment sampling locations, 1980 & 1985

TABLE 6 - SUMMARY OF 1985 WATER QUALITY MONITORING DATA FROM 1 M OFF BOTTOM AT STATIONS SHOWN IN FIGURE 15

Parameter	Range		M.O.E. Guidelines	Stations exceeding guidelines	
	Penetang Harbour	Midland Bay		Penetang Harbour	Midland Bay
Copper (mg/l)	0.001 - 0.054	0.001 - 0.023	0.005	524,25,26,27, 28,29,30,31	512,13,14,15, 17,20,21
Chromium (mg/l)	< 0.001 - 0.001	< 0.001 - 0.021	0.100	None	None
Mercury (g/l)	< 0.010 - 0.700	0.010 - 0.080	0.500	524	None
Cadmium (mg/l)	< 0.0002 - < 0.0003	< 0.0003	0.002	None	None
Iron (mg/l)	0.069 - 0.990	0.066 - 0.390	0.300	528,30	519
Lead (mg/l)	< 0.003 - 0.008	< 0.003 - 0.004	0.020	None	None
Zinc (mg/l)	0.004 - 0.056	0.008 - 0.064	0.030	524,25	517,19
Arsenic (mg/l)	< 0.001	< 0.001	0.100	None	None
Manganese (mg/l)	0.011 - 0.045	0.009 - 0.022	None currently exist		
Aluminum (mg/l)	0.036 - 0.770	0.044 - 0.330	0.100	526,28,29,30	516,17,19
Nickel (mg/l)	< 0.001 - 0.002	< 0.002 -	0.025	None	None
Calcium (mg/l)	20.000 - 27.000	24.000 - 25.000	None currently exist		

TABLE 7 - SUMMARY OF SURFICIAL SEDIMENT DATA 1980, 1985

Parameter	Range			M.O.E Guidelines (Control)	Stations exceeding guidelines		
	Penetang Harbour	Midland Bay	Sturgeon Bay		Penetang Harbour	Midland Bay	Sturgeon Bay
Copper (ug/g)	3.00 - 49.00	15.00 - 66.00	5.00 - 21.00	25.00 (21)	522,23 24,29,30	512,13 14,15,17 18,19,21	None
Chromium (ug/g)	4.10 - 85.00	19.00 - 74.00	11.00 - 49.00	25.00 (66)	522,23 24,25,28 29,30	512,14 15,16,19 21	S2,3,4,7 8,9,10,11 13
Mercury (ug/g)	< 0.01 - 0.24	0.05 - 1.00	< 0.1 - 0.06	0.30 (0.10)	None	517,18	None
Cadmium (ug/g)	0.20 - 1.40	< 0.20 - 0.81	< 0.3 - 0.72	1.00 (<0.3)	522,29,30	None	None
Iron (ug/g)	6300 - 48000	14000 - 36000	8600 - 56000	10000 (51600)	522,23 24,25,28 29,30,31	All	All except S14
Lead (ug/g)	< 2.00 - 130.00	30.00 - 260.00	< 3.00 - 28.00	50.00 (27)	522,23 24,29,30	512,13 14,15,17 18,19,21	None
Zinc (ug/g)	9.40 - 200.00	60.00 - 160.00	27.00 - 130.00	100.00 (195)	522,23 24,29,30	512,13 14,15,18 19,20	S2,8
Arsenic (ug/g)	0.46 - 6.75	1.45 - 4.97	-	8.00 (4.5)	None	None	-
Manganese (ug/g)	69.00 - 850.00	230.00 - 640.00	-	None currently exist			
Solvent Extractable (ug/g)	115.00 - 3483.00	903.00 - 2891.00	-	1500.00	522,23 29,30	512,13 14,15,16 17,19,21	-
Aluminum (ug/g)	1600 - 25000	5900 - 23000	-	None currently exist			
Nickel (ug/g)	2.00 - 39.00	14.00 - 46.00	-	25.00	522,29 30	512,19, 21	-
PCB (ng/g)	< 20.00 - 120.00	< 20.00 - 50.00	-	50.00 (24)	524	None	-

- No data
- Control = sediment off Beausoleil Is. for sediment bioassay controls

Levels of chromium, lead, zinc and solvent extractables exceeding M.O.E. guidelines were found at stations 522, 523 and 524 in the southern end of Penetang Harbour, and at stations 529 and 530 in the northern portion of the harbour. Samples taken from stations near the middle of the harbour were generally within the guidelines. PCB levels were within the MOE guideline except for station 524.

Sediment data from Sturgeon Bay shows mercury, lead, copper, cadmium, and zinc levels to be generally within MOE open-water disposal guidelines. Zinc and chromium levels exceeded the guidelines at specific stations, as shown in Table 7. The levels of chromium in this bay probably reflect background concentrations.

Iron levels for all three sampling areas generally exceeded MOE guidelines, due to natural background concentrations.

3.5 Biology

3.5.1 Phytoplankton

Phytoplankton are microscopic photosynthetic plants (algae) that are present in all natural water bodies. They form the base of the natural food chain.

Average phytoplankton biomass at the five main stations in Severn Sound was on average about 10-20 x higher than for sites in adjacent Nottawasaga Bay. No significant long-term trend in the total phytoplankton present was noted (Figure 16). Over the 1973 to 1985 period, levels of total phosphorus and total phytoplankton were 1.5 to 3 X higher at Station P1 than at the other four stations. The five sites also demonstrated significant differences in the species of algae present. Diatoms contributed most to the total phytoplankton biomass (Appendix IV).

It is significant that no clear trend in phytoplankton densities has emerged since the implementation of phosphorus loading controls in 1973.

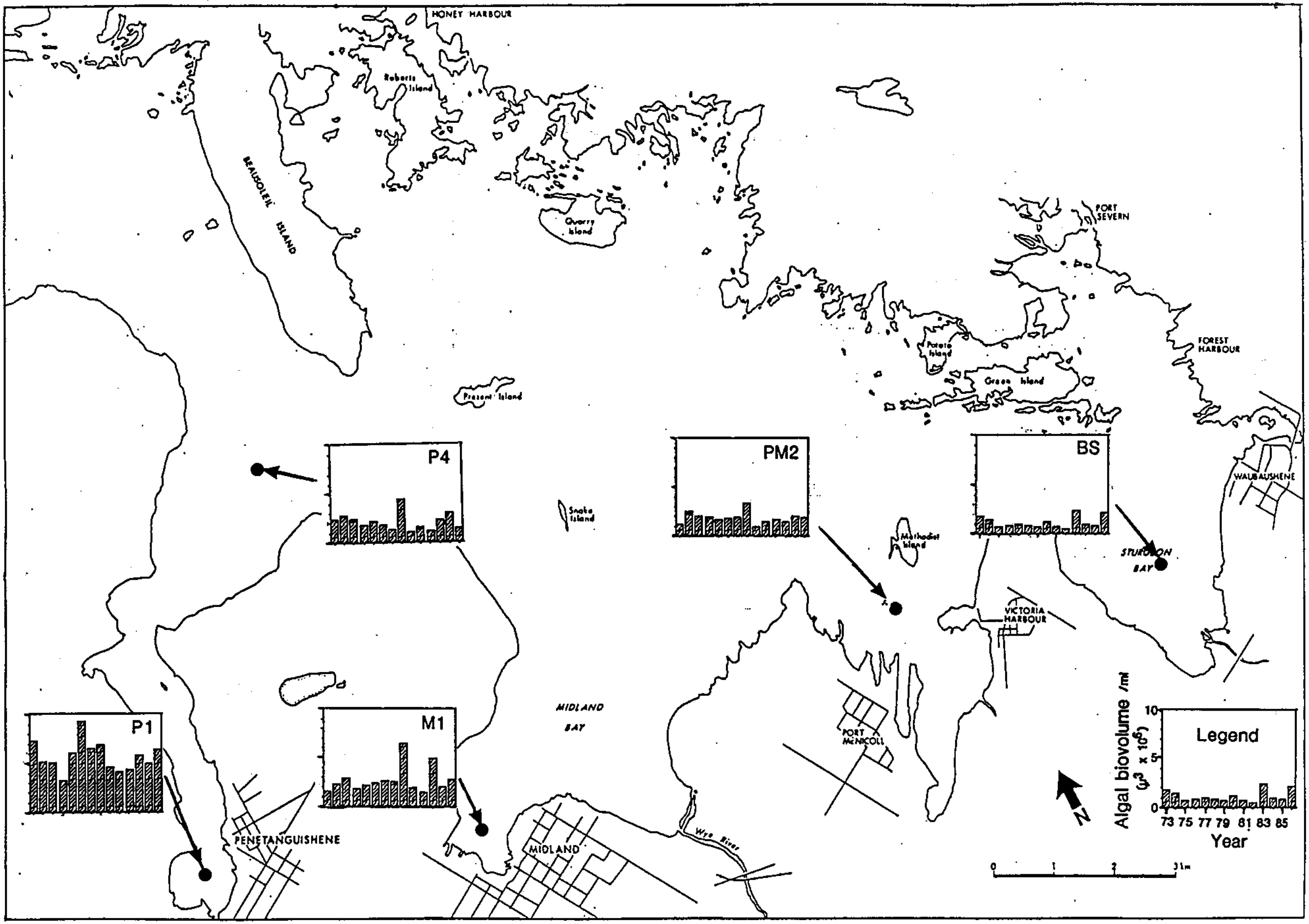


FIGURE 16: Annual changes in algal levels, 1973 to 1986, at the five main Severn Sound stations.

Data from Severn Sound show significant relationships between total phosphorus and phytoplankton and between phytoplankton and water clarity. There is no reason to suspect that the phytoplankton of Severn Sound has been limited by any nutrient other than phosphorus. Nitrogen has been shown to be limiting in some Great Lakes phytoplankton communities; however, total N:P ratios in Severn Sound over the 13-year period do not suggest N limitation.

Reductions in phytoplankton biomass and improvements in water clarity can be expected in Severn Sound if reductions in phosphorus loadings achieve lower lakewater phosphorus concentrations. Because phytoplankton densities were 10-20 times higher within Severn Sound than in adjacent Nottawasaga Bay, it is suggested that considerable improvement in water clarity is potentially achievable.

Growth incubation studies of phytoplankton were carried out during 1985 and 1987 (Nicholls and Heintsch, 1987; Heintsch, 1988) at Penetang Bay and off the Severn River. The results suggested that phosphorus in the vicinity of the Main St. WPCP outfall in Penetang Bay was more available for growth of phytoplankton than at the mouth of the Severn River. Moreover, much of the phosphorus contributed by the Severn River was not available for growth during the summer of 1987 (a low flow year).

3.5.2 Macrophytes

Several investigations of larger aquatic plants or macrophytes have been conducted in individual bays within Severn Sound (MOE, 1973; MOE, 1977; MNR, 1979; MOE, 1980, 82). Table 8 lists those species of floating and submerged plants found in Sturgeon Bay and Penetang Bay. The table also classifies plants based on growth "behaviour" or growth zone. Many species of submerged plants (e.g. Isoetes, Ranunculus) grow in an innocuous manner so that most people making use of the water would be unlikely to notice them. Other plants (e.g. Myriophyllum spicatum) grow to the surface in dense beds that can be a nuisance for navigation or swimming.

TABLE 8: LIST OF SUBMERGED AND FLOATING AQUATIC MACROPHYTES ENCOUNTERED IN STURGEON BAY (1980, 1982) AND PENETANG BAY (1982)

SPECIES	COMMON NAME	OVERWINTERING FORMS	GROWTH ZONE	STURGEON BAY 1980,1982	PENETANG BAY, 1982	PREVIOUS RECORD
Chara spp	Stonewort	U	C	+	+	73 77 79
Isoetes sp			C	+		
Potamogeton amplifolius	bass weed	R	S,T	+	+	73
P. bicuspulatis	narrow-leafed pondweed	?	S,C	+		
P. crispus	curly-leafed pondweed	WB, R	T		+	73 79
P. foliosus			S			73 79
P. friesii	narrow-leafed pondweed	WB	S	+	+	
P. gramineus	variable pondweed		IS, FL	+	+	73
P. hillii			S			73
P. natans	floating leafed pondweed		IS, FL	+		
P. pectinatus	sago pondweed	T	S,C	+	+	73 79
P. perfoliatus		R	S,T	+		
P. praelongus	whitestem pondweed	R	S,T	+	+	73 77 79
P. pusillus		WB	S,C	+	+	73
P. richardsonii	Richardsons pondweed	R	S,T	+	+	73 77 79
P. robbinsii	Robbinsons pondweed	R	D,C	+	+	73 77 79
P. spirillus					+	
P. strictifolius	narrow-leafed pondweed		S,T			77
P. zosteriformis	flat-stemmed pondweed	R, WB	S,T	+	+	73 77
Najas flexilis	bushy pondweed	-	D,C	+	+	73 79
N. guadalupensis	bushy pondweed	-	D,C	+	+	77
Sagittaria rosettes	arrowhead	U, WB	S,C	+		
Elodea canadensis	Canada waterweed	U, WB	D,C	+	+	73 77 79
Vallisneria americana	tapegrass	T,R	D,T	+	+	73 77 79
Eleocharis acicularis	needle rush	R	S,C	+	+	
Lemna trisulca	star duckweed	U	F		+	
Eriocaulon sp			S,C	+	+	73
Pontederia cordata	pickerel weed		D,E			79
Heteranthera dubia	water stargrass	R	D,T	+	+	73 77
Ceratophyllum demersum	coontail	T	F,T	+	+	73 77 79
Nuphar sp	yellow waterlily	R	F,L			79
Ranunculus sp	water buttercup	U	S,C	+	+	73
Myriophyllum alterniflorum	milfoil	T	S,C	+	+	77
M. excelbascens	milfoil		D,T			77
M. heterophyllum	milfoil		D,T			79
M. spicatum	Eurasian milfoil		D,T	+	+	73 77 79
M. verticilatum			S,T			79
Megalodonta beckii	water marigold		S,T	+	+	77

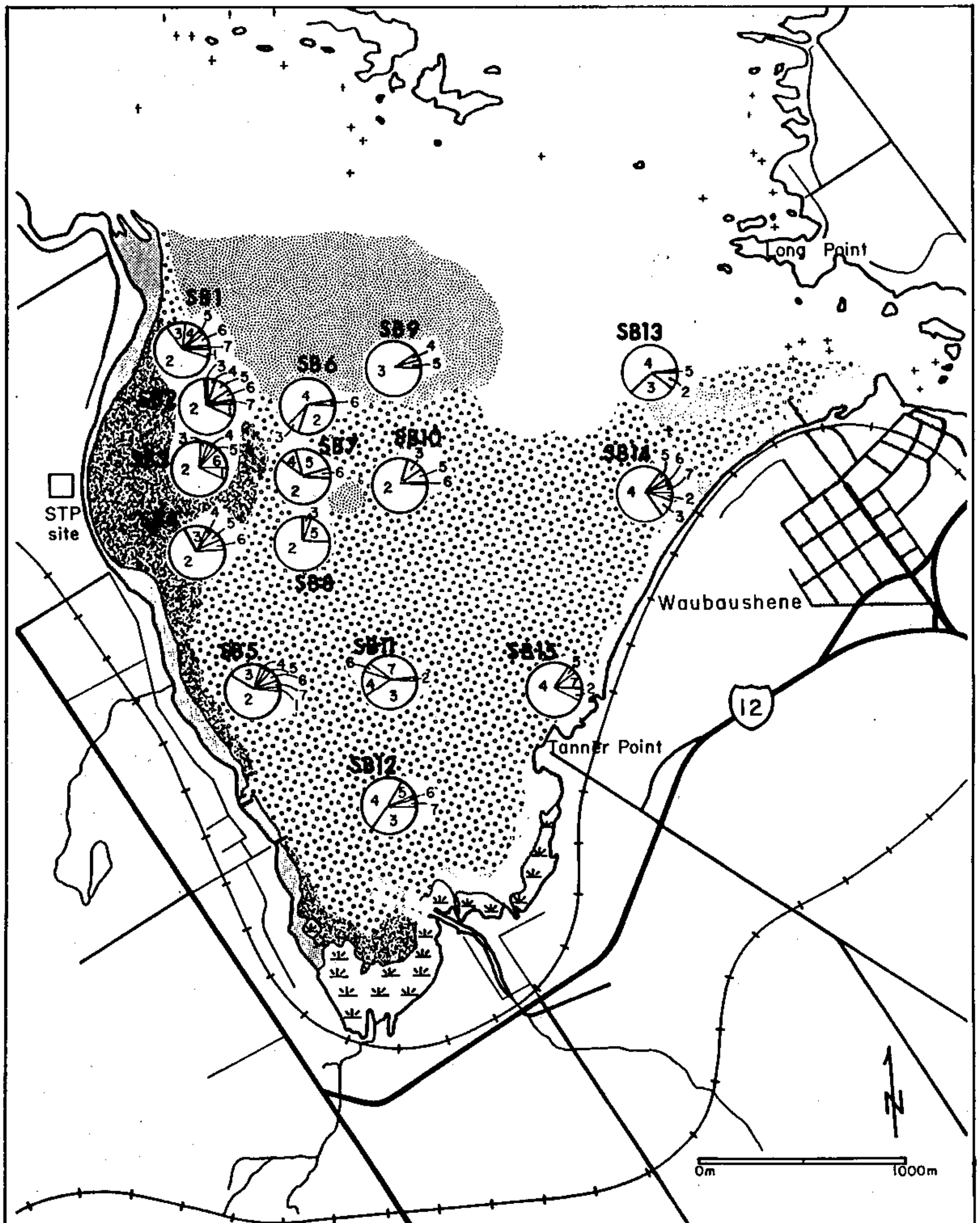
Overwintering forms: U = unchanged, R = rhizone, T = turion, WB = winter bud
Growth Zone: D = dense beds, T = tall (bottom to surface in deep water), F = free floating, FL = floating leaves, IS = inshore (1m), S = solitary, C = close to bottom, E = emergent.
Previous records: 73 = MOE Survey of Penetang Bay 1973
77 = MOE Survey of Sturgeon Bay 1977
79 = MNR Survey of Sturgeon Bay 1979

Two important factors influencing the growth and distribution of plants are substrate and light penetration. Phosphorus concentration in the Severn Sound water column is not generally limiting to rooted plant growth. Rooted plants such as Myriophyllum spicatum obtain most required nutrients from the sediments (Bristow and Whitcome, 1972; Carignan and Kalff, 1980). Kalff (1986) has shown that plant biomass peak and the maximum depth of distribution is related to water transparency in lakes.

In Sturgeon Bay, the heaviest growths of macrophytes occur on the west side of the bay in 1.5 to 2.5 m depth (Figure 17). The bay is relatively shallow and sufficient light penetrates to allow plant growth across the bay. Sparse growths were found near the shoreline due to sandy and/or rocky substrate. An extensive shoal area in the bay was also very sparse in plant growth. The west side of Sturgeon Bay was dominated by the Eurasion milfoil Myriophyllum spicatum (Figure 17), while tape grass, Vallisneria americana dominated the east side. A balanced diversity of plant species was found at all sites.

Penetang Bay coverage in 1973 (Figure 18) was very similar to that observed in 1982 with the exception that deeper areas had an even lower percent cover in the south end of the bay. Poor water transparency was thought to limit plant distribution generally, while the presence of bark deposits from past logging practices limited growth in localized areas. The south end of Penetang Bay, near the eastern shore, was dominated by water stargrass, Heteranthera dubia (Figure 18). This plant is known to grow well in nutrient enriched waters. The remaining areas tended to have a more even species composition. Of special note was the predominance of Myriophyllum excelbescens (a native species) in comparison with Myriophyllum spicatum. The reverse was true in Sturgeon Bay.

In summary, the macrophyte community in Penetang Bay and Sturgeon Bay was typical of shallow, hard-water areas of Southern Ontario (c.f. Miller, 1976). A nutrient control strategy for Severn Sound would not directly affect the rooted plants as their main nutrient source is from the sediments. However, control of phytoplankton growths could result in increased areas of nearshore water available for rooted plants to colonize.



LEGEND: Distribution of Aquatic Plant Growth in Sturgeon Bay 1980

- Sparse — sandy areas or sparse plant growth
- + Rocky or cobble bottom with few rooted plants, attached algae
- Emergent vegetation
- Moderate growth — confined largely to mud areas greater than 2 m deep
- Heavy growth — plants growing to surface, or near surface, mostly *Myriophyllum spicatum*

LEGEND: Aquatic Plant Community Composition in Sturgeon Bay 1980

1. All Pondweeds
2. *Myriophyllum spicatum* *M. exalbescens*
3. *Najas, Megalodonta, Heteranthera*
4. *Vallisneria americana*
5. *Ceratophyllum demersum*
6. *Elodea canadensis*
7. Other *Chara, Ranunculus*

FIGURE 17: Distribution of aquatic plant growth and composition in Sturgeon Bay 1980.

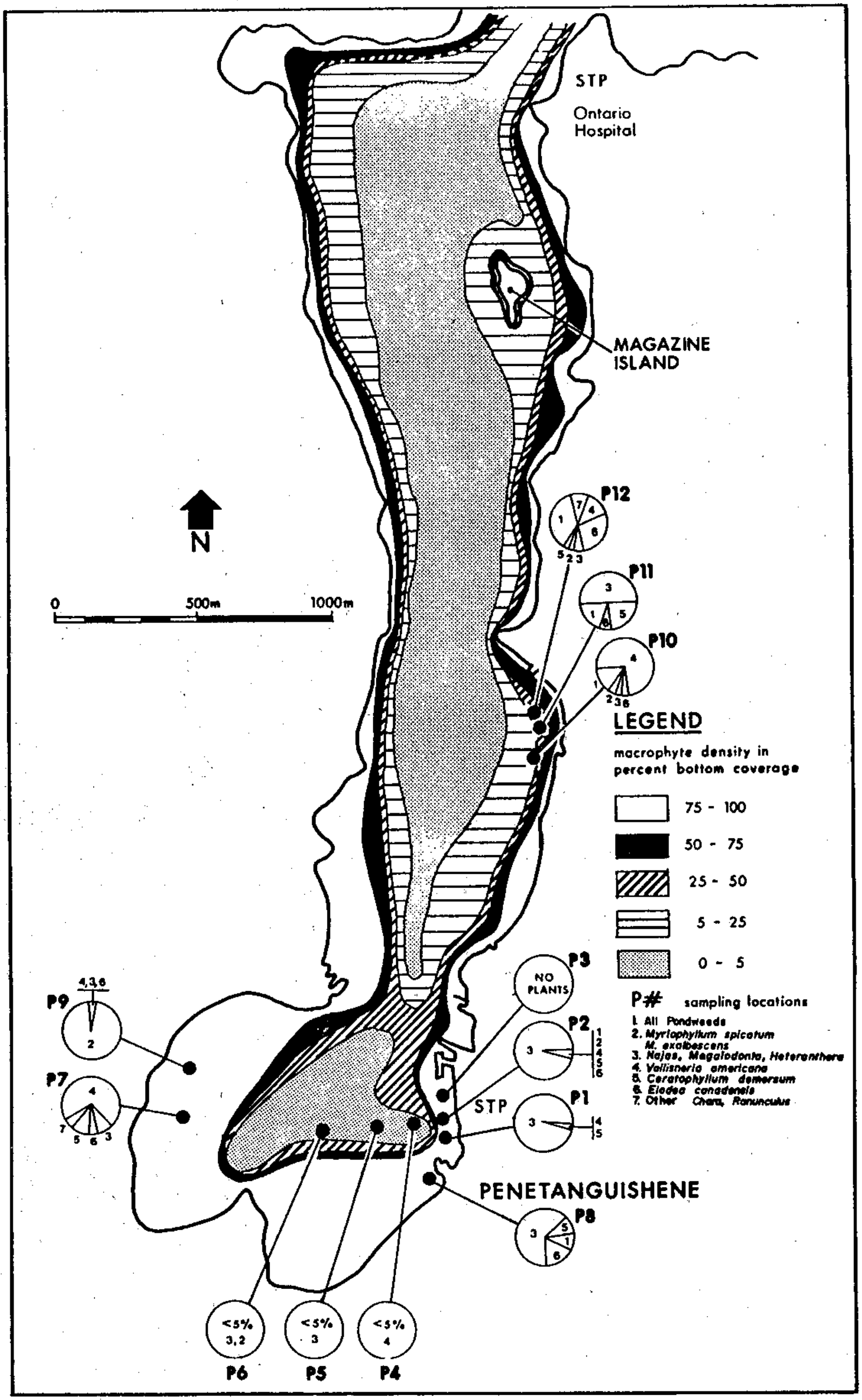


FIGURE 18: Diagram representing the approximate densities of aquatic macrophytes in Penetang Bay during 1973 & Survey of aquatic plant community composition in 1982.

3.5.3 Benthos

Benthic macroinvertebrates integrate and reflect the quality status of a water body. The presence/absence of species with known requirements, their abundance and the species composition can all provide an indication of nutrient enrichment and/or the presence of toxic factors contributed by discharges.

There are many factors that influence the relative abundance of the benthos in shallow bays such as the Severn Sound. These can include the following:

1. The presence of aquatic plants can influence the community by favouring those species that live in direct association with aquatic plants (epiphytic invertebrates).

2. The nature of the bottom substrate can influence relative abundance of the benthos. For example, fine-grained, softer sediments favour a dominance of oligochaetes and larger chironomids.

3. The degree of exposure to waves and strong currents influences the community composition.

4. Nutrient enrichment or eutrophication tends to increase the abundance and decrease the diversity of benthic organisms, especially near a nutrient-rich point source.

5. The presence of toxic contaminants in sufficient concentrations or toxic conditions in the water column can have the effect of decreasing or eliminating the abundance and diversity of organisms even though other conditions, such as substrate, are suitable for a variety of animals.

Studies of Sturgeon Bay benthos (Barton, 1981; 1983) concluded that the community in the mud was typical of a shallow, weedy bay with both species tolerant of nutrient enriched conditions (such as worms and large midge larvae) and those associated with cleaner water (such as caddisfly larvae Figure 19). Tolerant organisms tended to be more abundant toward the west side; more because of shelter from wind and wave action than because of nutrient

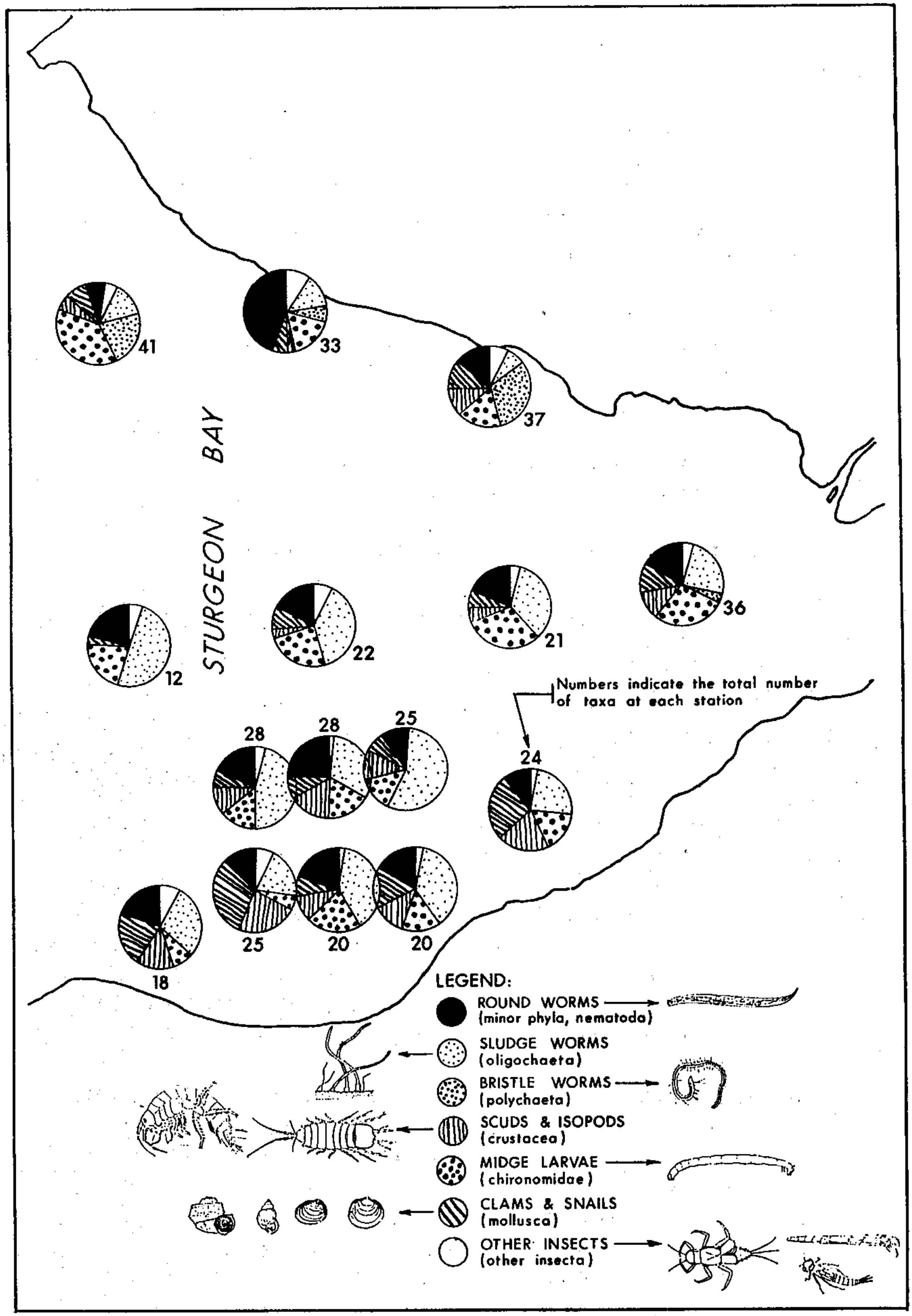


FIGURE 19: Species composition of benthic organisms in Sturgeon Bay in 1980

enrichment. Areas with aquatic plant beds supported a more diverse community (Figure 20). Milfoil was found to support a wide variety of organisms with abundance significantly correlated with size of plants. The purpose of the work during 1980 and 1982 was to document conditions in the bay, prior to operation of the Victoria Harbour WPCP. Since the WPCP started operation in 1985, no follow-up study of the benthos has been done.

Barton (1983) and Jaagumagi (1986) studied benthos in Penetang Bay. Barton's results (Figure 21) indicated a pattern of decreased abundance and diversity near the old Penetanguishene WPCP (Main St.) increasing with distance out into the south portion of the bay. Highest diversity was found in the mid-bay area off the site of the then-proposed Penetang Fox St. WPCP. This pattern suggested that some toxic factor was influencing the community near the Main St. WPCP outfall. Jaagumagi (1986), in a sample close to the same WPCP outfall, also concluded that some form of toxicity was influencing the community. No follow-up benthic study has been conducted as the new plant has just been completed.

Jaagumagi (1986) also studied benthos in Midland Bay. He found, in general, that the benthic community was typical of good water quality but that the community at sites in the inner harbour indicated moderately enriched water quality.

The benthos of the open areas in Severn Sound, as well as Hog Bay, have not been studied.

3.5.4 Fish:

Coldwater Community

Prior to 1950 lake trout, lake whitefish and lake herring occupied the deep, cold waters between Midland and Beausoleil Island. Since then lake trout have become extinct in the Sound and throughout all of Georgian Bay. Lake whitefish and lake herring have all but disappeared from the Sound but are still found throughout other areas of Georgian Bay. The probable causes for these declines include over-exploitation, changes in water quality and the invasion of sea lamprey. Today, Severn Sound is occupied only by migratory

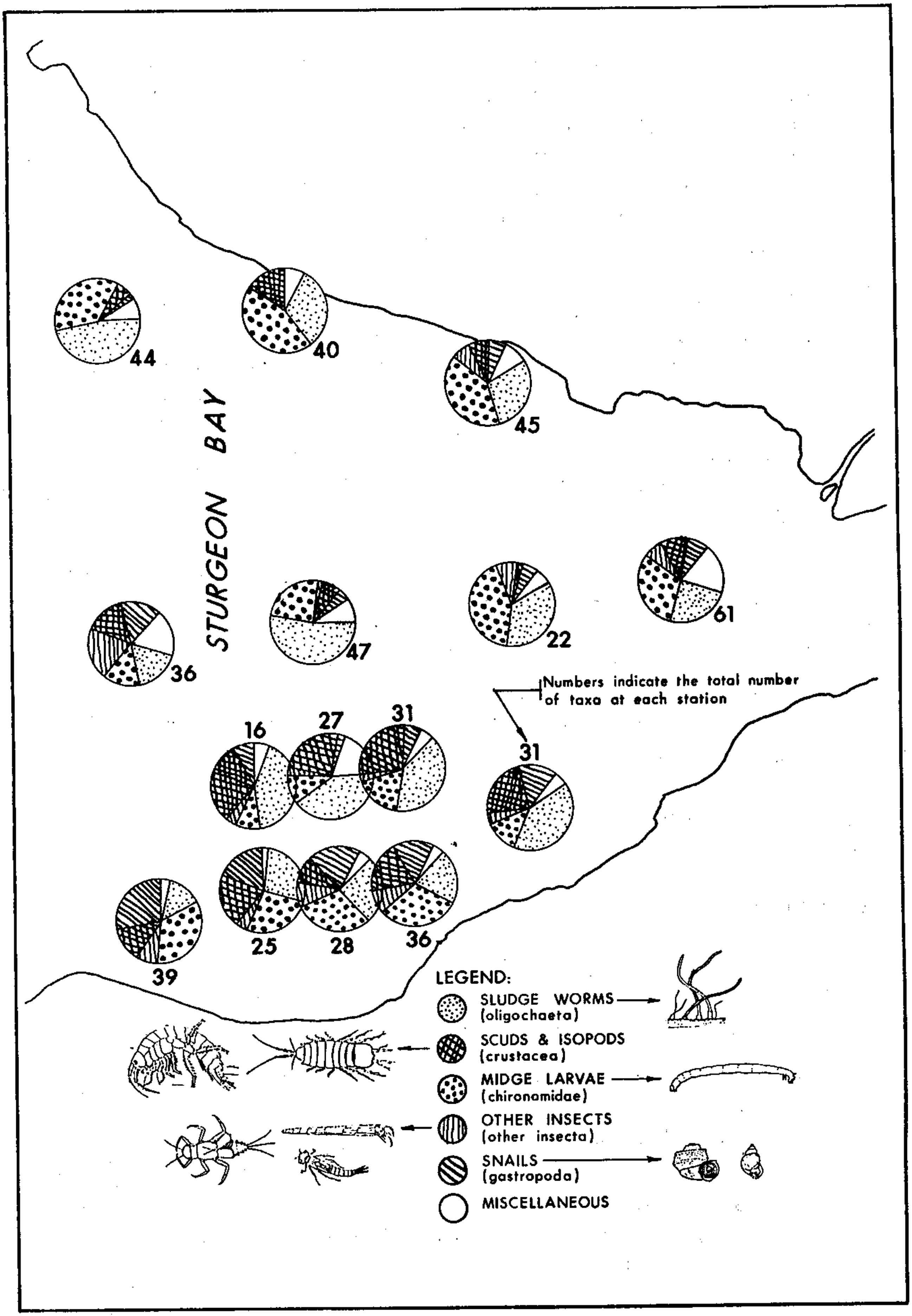


FIGURE 20: Species composition of epiphytic organisms in Sturgeon Bay in 1980.

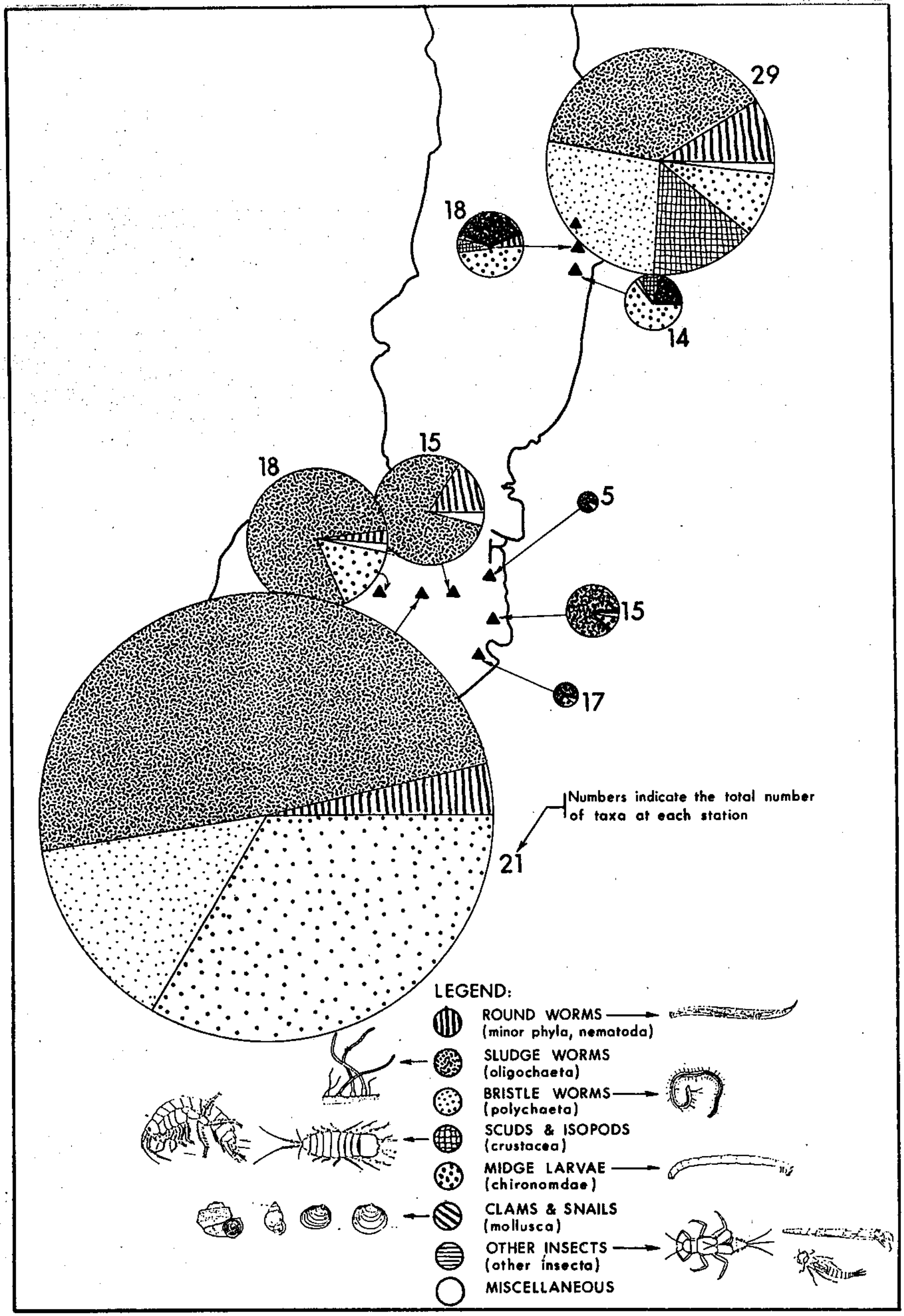


FIGURE 21: Species composition of benthic organisms in Penetang Bay in 1982.

coldwater species that travel through the Sound to and from inflowing spawning streams. Species include rainbow trout, brown trout, pink salmon and chinook salmon.

Warmwater Community

Lake sturgeon were once common in Severn Sound but by 1900 they had declined significantly. Over-exploitation and damming of spawning rivers are the most likely causes. Most warmwater communities benefited in the first 50 years of this century as the Sound became culturally enriched. Production of percids, centrachids and esocids likely increased initially. Walleye populations were good into the mid 1970's but have declined, while black crappie, which were relatively unknown during the 1950's, have exploded throughout the Sound (Table 9). Smallmouth and largemouth bass have remained strong. White bass populations were never large but have declined in recent years. Northern pike populations have fluctuated over the years but have generally remained good while muskellunge appear to be reduced. Little is known about trends in populations of other species except that emerald shiners are generally declining in littoral areas throughout the Great Lakes. Table 10 provides a list of fish species known to be present for all or part of their life histories.

TABLE 9 - COMPARISON OF WALLEYE AND BLACK CRAPPIE TRAP NET RESULTS 1975-1985

A. Catch of Walleye and Black Crappie per Night of Spring Trap Netting - 1975-85

	1975	1976	1980	1981	1982	1983	1984	1985
Walleye	11.5	14.9	14.6	3.7	5.0	2.9	3.9	2.7
Black Crappie	9.4	-	263.2	247.7	163.2	145.3	104.9	67.5

B. Catch of Black Crappie per Walleye per Night of Spring Trap Netting - 1975-85

1975	1976	1980	1981	1982	1983	1984	1985
0.8	-	18.0	66.9	32.6	50.1	26.9	25.0

TABLE 10 - FISH SPECIES OF SEVERN SOUND

lampreys - Petromzontidae
sea lamprey - Petromyzon marinus
silver lamprey - Ichthyomyzon unicuspis
sturgeons - Acipenseridae
lake sturgeon - Acipenser fulvecens
bowfins - Amiidae
bowfin - Amia calva
catfishes - Ictaluridae
tadpole madtom - Noturus gyrinus
brown bullhead - Ictalurus punctatus
eels - Anguillidae
american eel - Anguilla rostrata
trout-perch - Percopsidae
trout-perch - Percopsis omiscomaycus
smelts - Osmeridae
rainbow smelt - Osmerus mordax
salmons and trouts - Salmonidae
lake trout backcross - Salvelinus namaycush X S. fontinalis
rainbow trout - Salmo gairdneri
brown trout - S. trutta
pink salmon - Oncorhynchus gorbuscha
chinook salmon - O. tshawytsha
whitefishes and ciscoes - Coregoninoe
lake whitefish - Coregonus clupeaformis
lake herring - C. artedii
gars - Lepisosteidae
longnose gar - Lepisosteus osseus
killifishes - Cyprinodontidae
banded killifish - Fundulus diaphanus
pike - Esocidae
northern pike - Esox lucius
muskellunge - E. masquinongy
mudminnow - Umbridae
central mudminnow - Umbra limi
suckers - Catostomidae
northern hog sucker - Hypentelium nigricans
white sucker - C. commersoni
redhorse - Moxostoma sp.
quillback - Carpiodes cyprinus
minnows - Cyprinidae
carp - Cyprinus carpio
golden shiner - Notemigonus chrysoleucas
emerald shiner - N. atherinoides
spottail shiner - N. hudsonius
blackchin shiner - N. heterodon
mimic shiner - N. volucellus
brassy minnow - Hybognathus hankinsoni
herrings - Clupeidae
alewife - Alosa pseudoharengus
gizzard shad - Dorosoma cepedianum
Sculpins - Cottidae
mottled sculpin - Cottus bairdi
cods - Gadidae
burbot - Lota lota
perches - Percidae
walleye - Stezostedion vitreum
logperch - Percina caprodes
Iowa darter - Etheostoma exile
johnny darter - E. nigrum
temperate basses - Perchichthyidae
whitebass - Morone chrysops
sunfishes - Centrarchidae
largemouth bass - Micropterus salmoides
smallmouth bass - M. dolomieui
black crappie - Pomoxis nigromaculatus
pumpkinseed - Lepomis gibbosus
rock bass - Ambloplites rupestris
sticklebacks - Gasterosteidae
brook stickleback - Culaea inconstans
silversides - Atherinidae
brook silversides - Labidesthes sicculus

3.6 Biomonitoring

Common aquatic plants and animals have been used to monitor concentrations of nutrients or trace contaminants throughout the Great Lakes. The reasons for selecting plants or animals for analysis include:

- the plant or animal has widespread distribution;
- it accumulates the contaminant in the tissues to allow consistent measurement of tissue levels while water concentrations are non-detectable;
- an individual animal or plant does not move far from the collection site, reflecting localized conditions.

Several plants and animals or biomonitors have been used in the Severn Sound and are discussed below.

3.6.1 Filamentous Algae

Nutrient levels in the filamentous alga fringing Cladophora in Severn Sound (Jackson, 1985) suggested conditions typical of enriched areas in Georgian Bay (Appendix V). Seasonal variability in the growth condition and environmental conditions of the alga affect the uptake of nutrients (Painter and Jackson, 1986). The late sampling period for fringing Cladophora (August, 1980) may have resulted in lower than normal tissue concentrations.

Metal uptake by the alga was comparable to other sites in Georgian Bay (Appendix V) with the exception of elevated levels of Zn, Pb, Cu and Cr. Lead (Pb) concentration was highest in Midland Harbour and Penetang Bay.

Values for submerged Cladophora (Jackson, 1985) indicated a similar pattern but with lower zinc (Zn) concentration than that of fringing Cladophora or submerged Cladophora from other sites in Georgian Bay.

3.6.2 Aquatic Plants

Tissue levels of submerged aquatic plants or macrophytes were also used as an indicator of nutrient conditions and heavy metal accumulation (MOE Central Region 1980, 82, unpublished).

Nutrient levels in plant tissues were generally higher than sediments indicating luxury uptake in both Penetang Bay and Sturgeon Bay. A series of stations in Penetang Bay show a trend in tissue phosphorus concentrations for the common water stargrass Heteranthera dubia. N:P ratios for tissues were lower near the outfall (P1) reflecting the increased availability of phosphorus over nitrogen (low N:P ratio) near a treated sewage effluent (Figure 22). The ratios increase further from the outfall to values comparable to moderately enriched lakes not influenced by point source discharges (Wile and Hitchin, 1977).

Values for tissue lead concentrations in Heteranthera dubia in southern Penetang Bay (Figure 23) indicated a clear increasing trend in lead with proximity to the WPCP outfall and the most concentrated urban area. Other metals (arsenic, copper, nickel) did not show a similar trend.

3.6.3 Benthos and Young Fish

Preliminary results of tissue analysis of chironomids (WRB 1985, unpublished) from Penetang and Midland Bays indicated little uptake of metals and persistent organic chemicals is taking place (Appendix VI). The burrowing mayfly, Hexagenia limbata, is typically collected from Severn Sound near Beausoleil Island for sediment toxicity testing. The organisms are used as controls indicating their very low concentrations of trace contaminants (Appendix VI).

A preliminary single composite sample of juvenile emerald shiners from Penetang Bay (Suns, 1985 unpublished) indicated some uptake of of polychlorinated biphenyl (PCB) and pDDE (a breakdown product of the pesticide DDT). The PCB value of 110 ng/g exceeds the IJC Aquatic Life Guideline of 100 ng/g. However, additional samples were required to confirm this result. In 1987, juvenile fish were collected from 18 locations within the Severn Sound (Appendix VII). Results are summarized as follows:

1. Mercury levels were found to be low, ranging from 11-40 ng/g, much below the IJC Aquatic Life Guideline (500 ng/g) considered to be detrimental to the consumers of forage fish.

2. PCB residues in the Midland Bay collection (164 ng/g) exceeded the IJC Aquatic Life Guideline (100 ng/g), and quantifiable accumulations of PCB's were also found in collections from Penetang Bay Tannery Point, Midland WPCP, Grandview Beach and Hog Bay. The remainder of the spottail samples had non-detectable PCB residue levels.

3. Low concentrations of DDE were found in all the collections and near-detection limit residues of hexachlorobenzene in some. Heptachlor, aldrin, mirex, BHC, chlordane, octachlorostyrene and tohaphene were not detected in any of the shiner collections (Appendix VII).

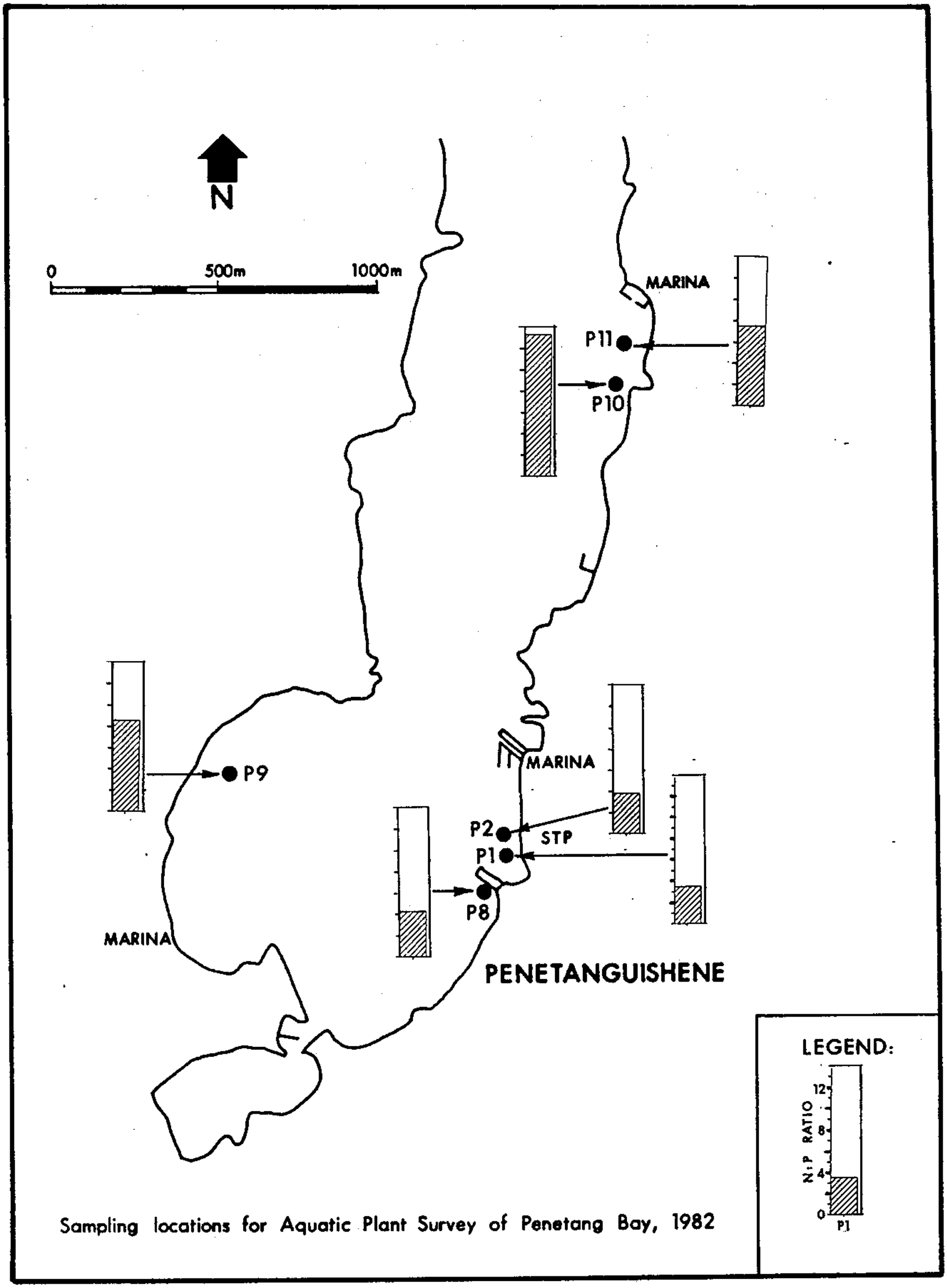


FIGURE 22: Ratio of tissue nitrogen to phosphorus in H.dubia a plant from Penetang Bay, 1982

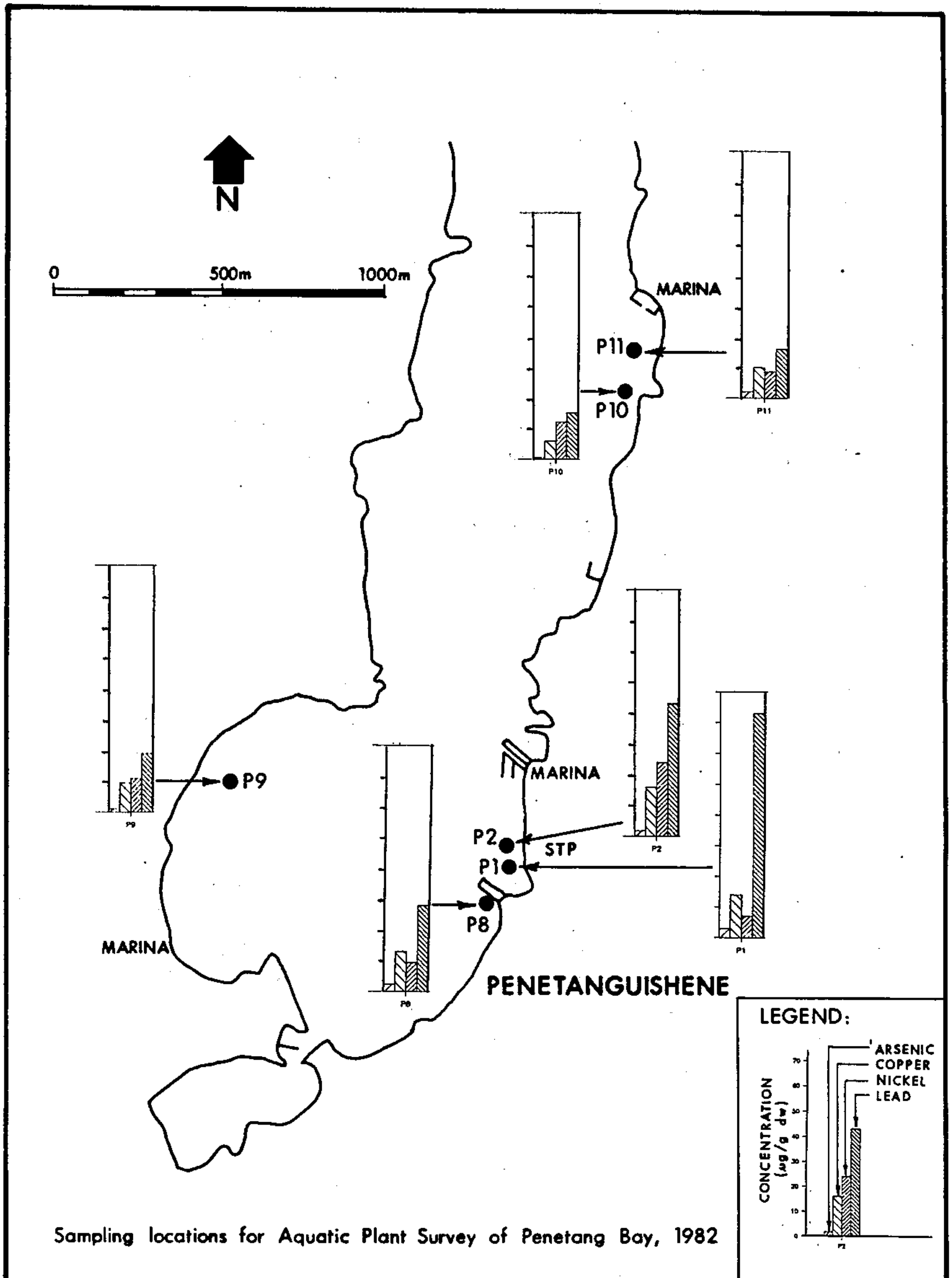


FIGURE 23: Concentration of tissue arsenic, copper, nickel, lead in <u>H.dubia</u> a plant from Penetang Bay, 1982

3.6.4 Contaminants in Sport Fish

Available contaminant data for sport fish is reported as consumption advisories in the publication Guide to Eating Ontario Sport Fish (MOE/MNR, 1987). The MNR/MOE Sport Fish Contaminant Program provides a consumption guideline for selected fish species from areas throughout Georgian Bay. The guidelines for the Severn Sound area have a similar pattern to those of other areas in Georgian Bay. For example, walleye from all four sectors of Georgian Bay have similar restrictions on consumption due to mercury contamination (fish larger than 45 or 55 cm). This suggests that the cause of the contamination is due to general factors affecting all Georgian Bay walleye rather than some specific contamination in Severn Sound. The MNR district plan for Severn Sound calls for fish collections for carp, northern pike, walleye, black crappie, smallmouth bass, pink salmon and yellow perch over the period 1988 to 1992 (Appendix VIII).

3.7 Water Quality Status of Severn Sound

The present water quality status of the Severn Sound is summarized as follows.

Despite some improvements in phosphorus concentrations, the eutrophication problem in Severn Sound persists. There are still nuisance levels of algae with frequent algal blooms especially in Penetang Bay.

Total phosphorus concentration does not meet the provincial guideline of 20 ug/L in the open waters of Severn Sound, with the exception of the area off Beausoleil Island. Nutrient ratios in water, nutrient ratios in plant tissues and algae bioassay results suggested that phosphorus is more available near water pollution control plant outfalls than off river mouths. Highest densities of algae were found in Penetang Bay with lowest densities found in weedy Sturgeon Bay.

Dense, widespread growths of rooted aquatic plants occur only in Sturgeon Bay although localized growths occur in other areas (e.g. Penetang Bay). Based on the limited benthos sampling available, the benthic community appeared typical of good water quality conditions with the exception of the localized area off the Penetang Main St. WPCP.

The fish community within Severn Sound has apparently experienced a dramatic shift in recent years. The most desireable warm water sport fish in Severn Sound, the walleye, has declined and the panfish, black crappie, has become abundant. The shift in community may be related to the persistent eutrophication.

With respect to trace contaminants, Severn Sound, in general, does not appear to be experiencing any problems. There are localized areas adjacent to larger urban centres where some trace metals (such as lead) are elevated. However, organic contaminants are noticeably low or absent from sediments and biota near these same areas. The contaminant levels in Severn Sound sport fish appear similar to those of other collections within Georgian Bay and relate to general mercury contamination not specific to Severn Sound. The best evidence of the lack of any widespread trace contaminant problems in Severn Sound is the routine use of sediments and biota from off Beausoleil Island as control material in sediment bioassay tests conducted by MOE.

4. DESCRIPTION OF POTENTIAL SOURCES

4.1 Nutrient Supply

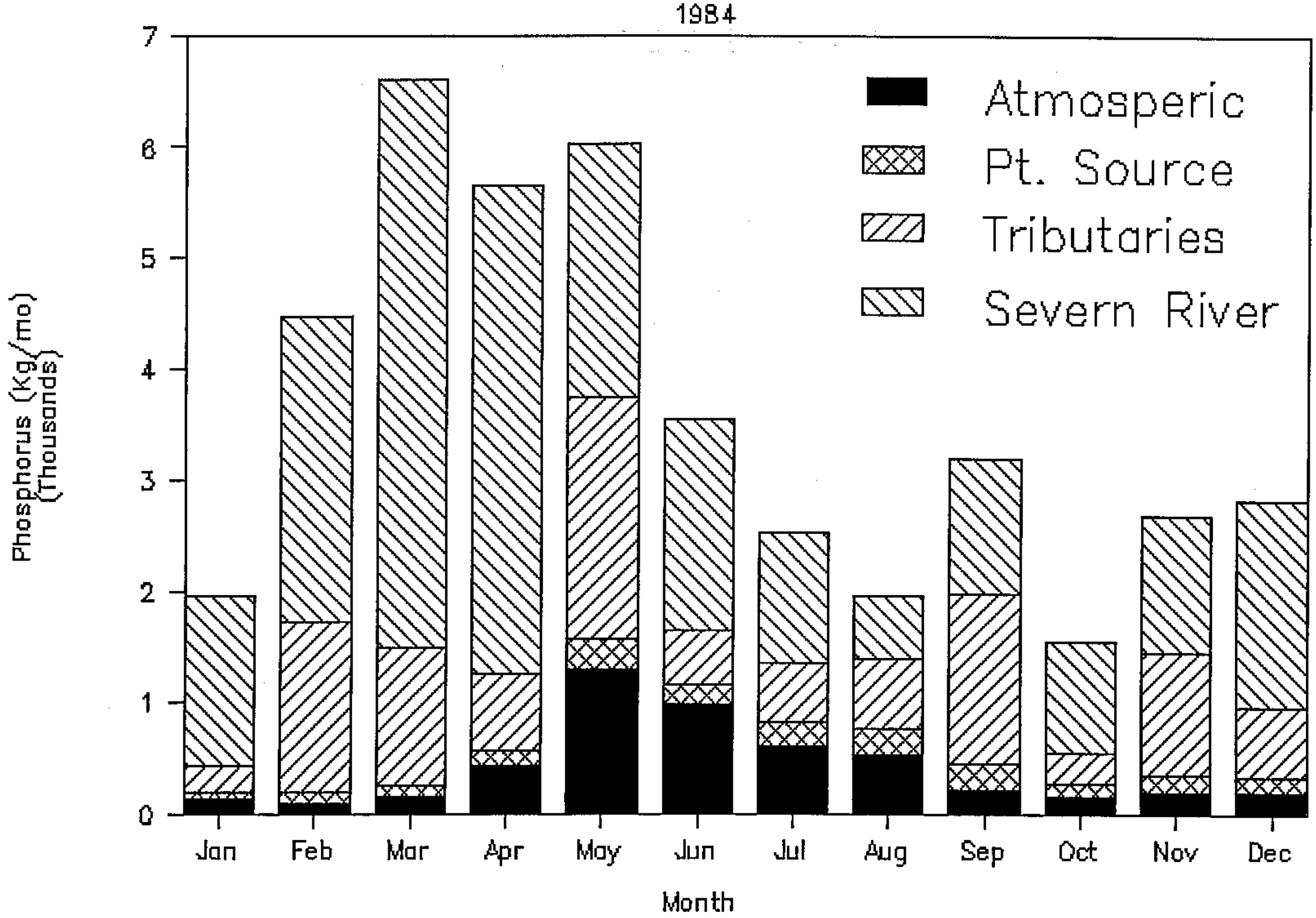
A nutrient budget, which can be used to predict water quality, is a powerful tool used to evaluate the effect of nutrient controls on water quality. The first step in constructing a nutrient budget for a water body is to calculate the supply from various sources. Phosphorus has been shown to be a key nutrient limiting algae growth in Severn Sound (see Sections 3.2 and 3.6.1; also see Nicholls et al., 1988). As a first step in the evaluation, phosphorus supply will be considered, with a view to predicting phosphorus concentration in part or all of Severn Sound open waters.

Enhanced monitoring of Severn Sound WPCP's and the Severn River at Port Severn was conducted during 1984. A preliminary calculation of nutrient supply to the Sound was made for the year 1984, which required estimation of supply from tributaries and atmospheric input (MOE, 1984). Assumptions and methods for the analysis are found in Appendix IX.

Figure 24, the calculated supply for Severn Sound, shows that the supply of total phosphorus from the Severn River is the largest component of the inputs in spring and remains significant through the year. It must be noted that the total phosphorus concentrations of the Severn River through most of the year are diluting relative to the concentrations in the open bays of the Sound. The Severn River passes through Glouchester Pool and Little Lake prior to discharge over the dam at Port Severn. The lakes would provide a great deal of equalization of concentrations and flow. The unregulated smaller tributaries would be expected to vary much more in supply over a year.

The supply from WPCP effluents represents a small portion of supply. Other tributaries with much smaller drainage relative to the Severn River provided a proportionately greater supply of phosphorus due to the higher estimated export of phosphorus from the local watersheds. The smaller tributaries drain land which contributes more phosphorus due to factors such as less control over flows, a greater proportion of cleared land and a sedimentary rather than pre-Cambrian geology.

Fig. 24 Severn Sound Phosphorus Supply



The supply for Penetang Bay was also calculated and provides an example for a smaller bay within Severn Sound (Figure 25). The Bay, for calculation purposes, was treated as tributary to the rest of Severn Sound. The major sources of the supply were the Penetang WPCP and land drainage from Copeland Creek and land surrounding the Bay. Precipitation and changes in storage in the Bay represented minor components of supply.

Nicholls & Heintsch (1987) have cautioned that "the relative importance of land drainage vs WPCP sources of phosphorus (to phytoplankton growth) is determined not by the absolute quantity of nutrient but indirectly by their influence on nutrient concentration in the receiving waters." They also found that the bioavailability of phosphorus from the Severn River varied seasonally. For example, bioavailability of phosphorus supplied by the Severn River in August was only 2-3% of that contributed during April (studied during 1985 and 1987).

Experience with other shallow nutrient enriched bays in the Great Lakes (Minns et al; 1986- Bay of Quinte) has shown that a significant "internal" supply of phosphorus to the water column can originate from the sediments through physical resuspension, bioturbation and the decay of aquatic plants. The importance of this suspected source of phosphorus to Severn Sound is unknown and should be included in any further nutrient budget studies.

An understanding of the flushing and exchange of Severn Sound water with the open waters of Georgian Bay is crucial. Only when the exchange and flushing of the Sound are understood, can the phosphorus supply and bioavailability information be put into perspective for a nutrient management strategy for Severn Sound.

Nutrient Budget

The estimation of phosphorus supply leads to a model predicting the open water total phosphorus concentration in Penetang Bay or Severn Sound. The model concept used here is based on Dillon's methodology (Figure 26; Dillon & Rigler, 1974; Lakeshore Capacity Study, 1986). Also incorporated are the links between the predicted total phosphorus and the algal biomass or "crop" of

Fig. 25 Penetang Bay Phosphorus Supply

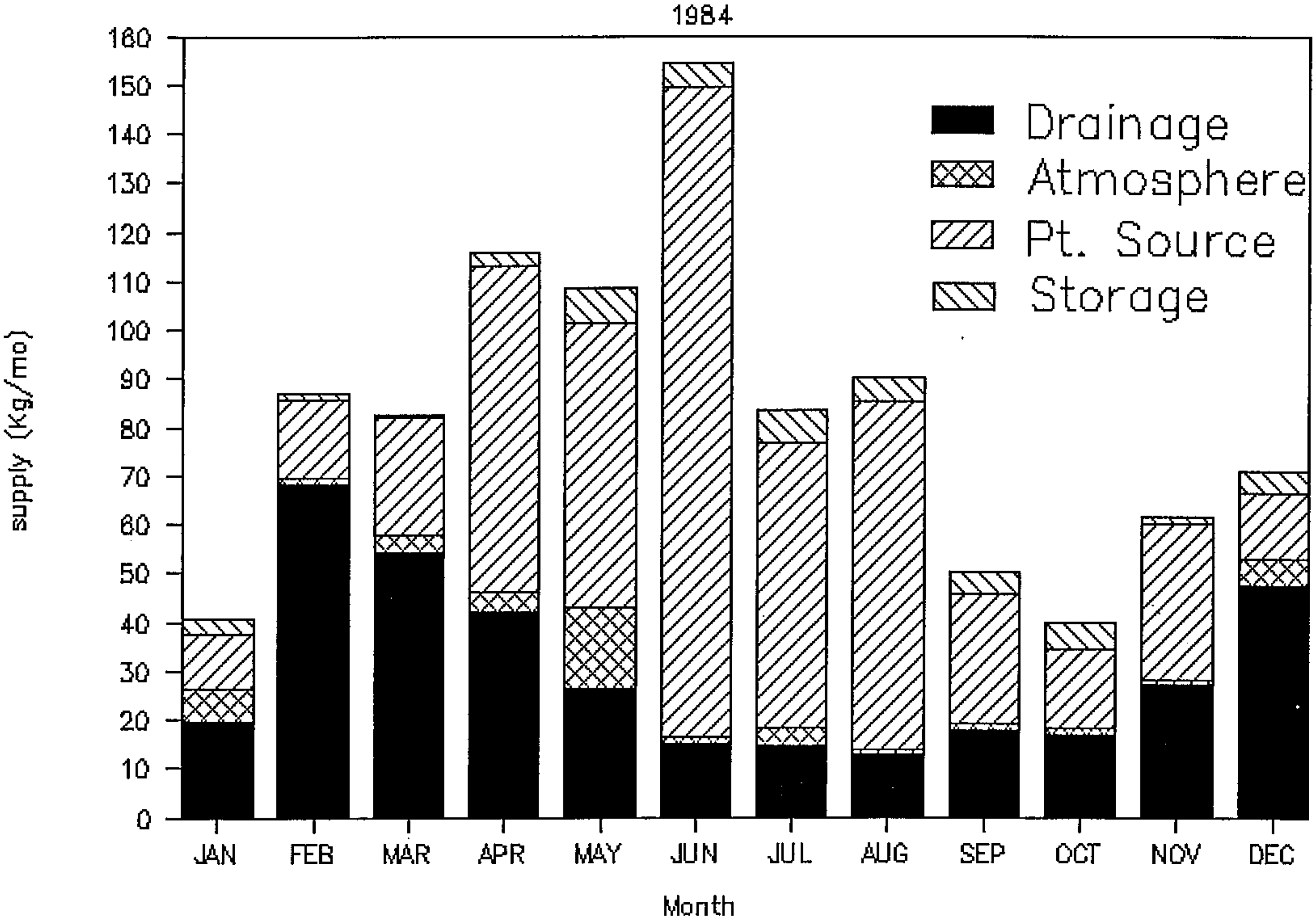
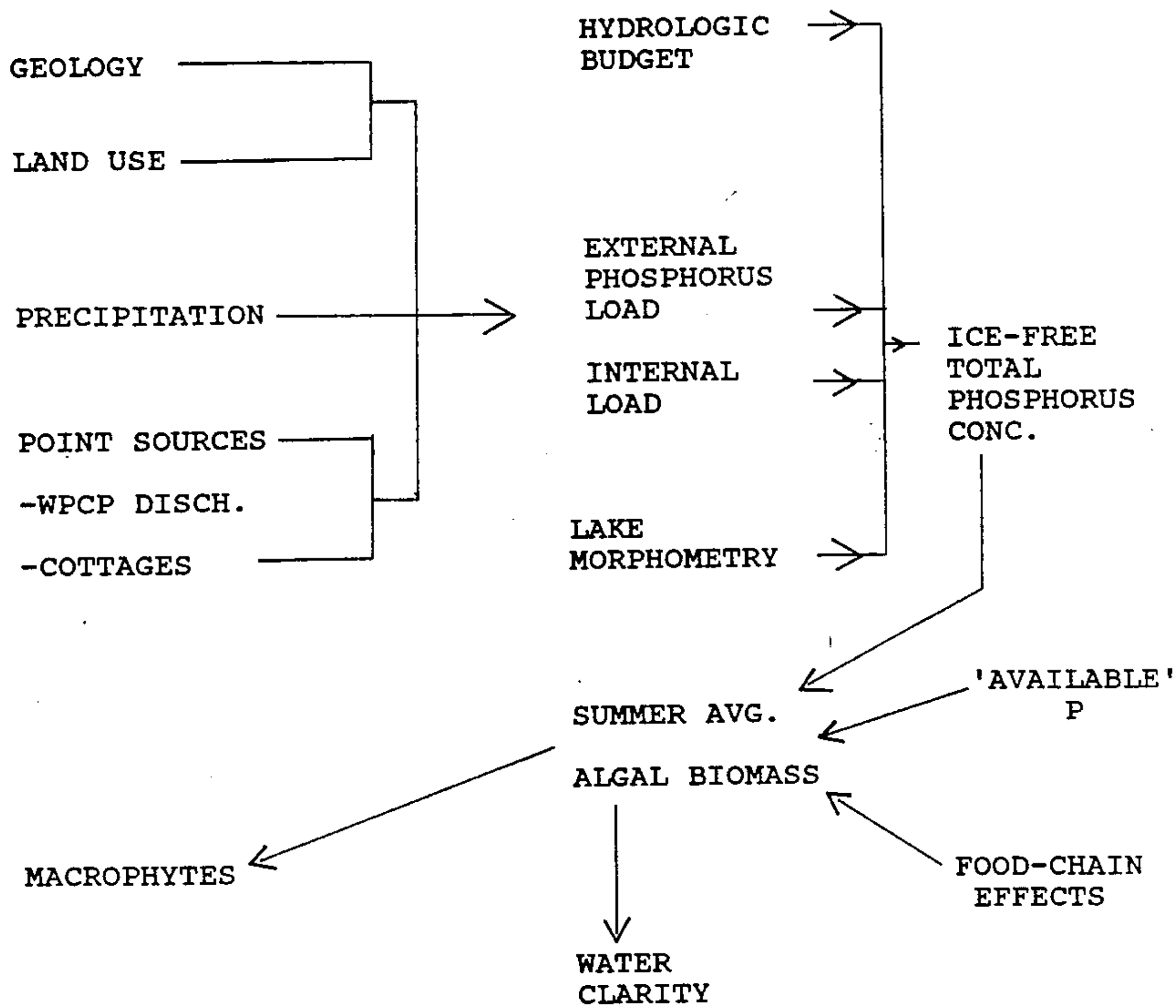


Figure 26 CONCEPTUAL MODEL OF FACTORS INFLUENCING THE PHOSPHORUS CONCENTRATION IN PENETANG BAY



algae produced. Other factors, not directly related to nutrient concentration, can influence algal biomass such as the presence of significant beds of macrophytes or grazing of algae by water fleas or zooplankton. The steps used in calculation are shown in Appendix IX.

Using Penetang Bay phosphorus supply calculations and the excellent long-term water quality monitoring data available, measured and predicted average total phosphorus concentrations were compared for the period 1973 to 1986 (Figure 27). The relatively good agreement of the basic model predictions with the measured values is encouraging and should lead to a useful model for developing a nutrient control strategy for Penetang Bay. The assumptions upon which the estimates are based, however, must be tested and found to be valid prior to further use of the model. The use of the modelling concept for the entire Severn Sound cannot be assessed without reasonable water exchange estimates expected from the 1988 field work.

4.2 Industrial Sources

The only industry within the Severn Sound study area with a Certificate of Approval from the Ontario Ministry of the Environment for a direct discharge is Mitsubishi. The treated effluent is discharged, at a rate of 3.72 x 10^3 m^3/day, into the Wye River, which flows into Midland Bay. The average concentration on chromium in the effluent is 0.103 mg/l, for a loading of approximately 0.4 kg/day. The fluoride concentration is 2.74 mg/l, for a loading of approximately 10 kg/day. The discharge is in compliance with the requirements of the Certificate of Approval.

All other industries in Midland (Table 11) discharge into the municipal sanitary sewer system.

Penetanguishene, Victoria Harbour and Waubaushene have 'dry' industries only, and Port McNicoll has no industries.

Fig. 27 Penetang Bay Phosphorus Budget

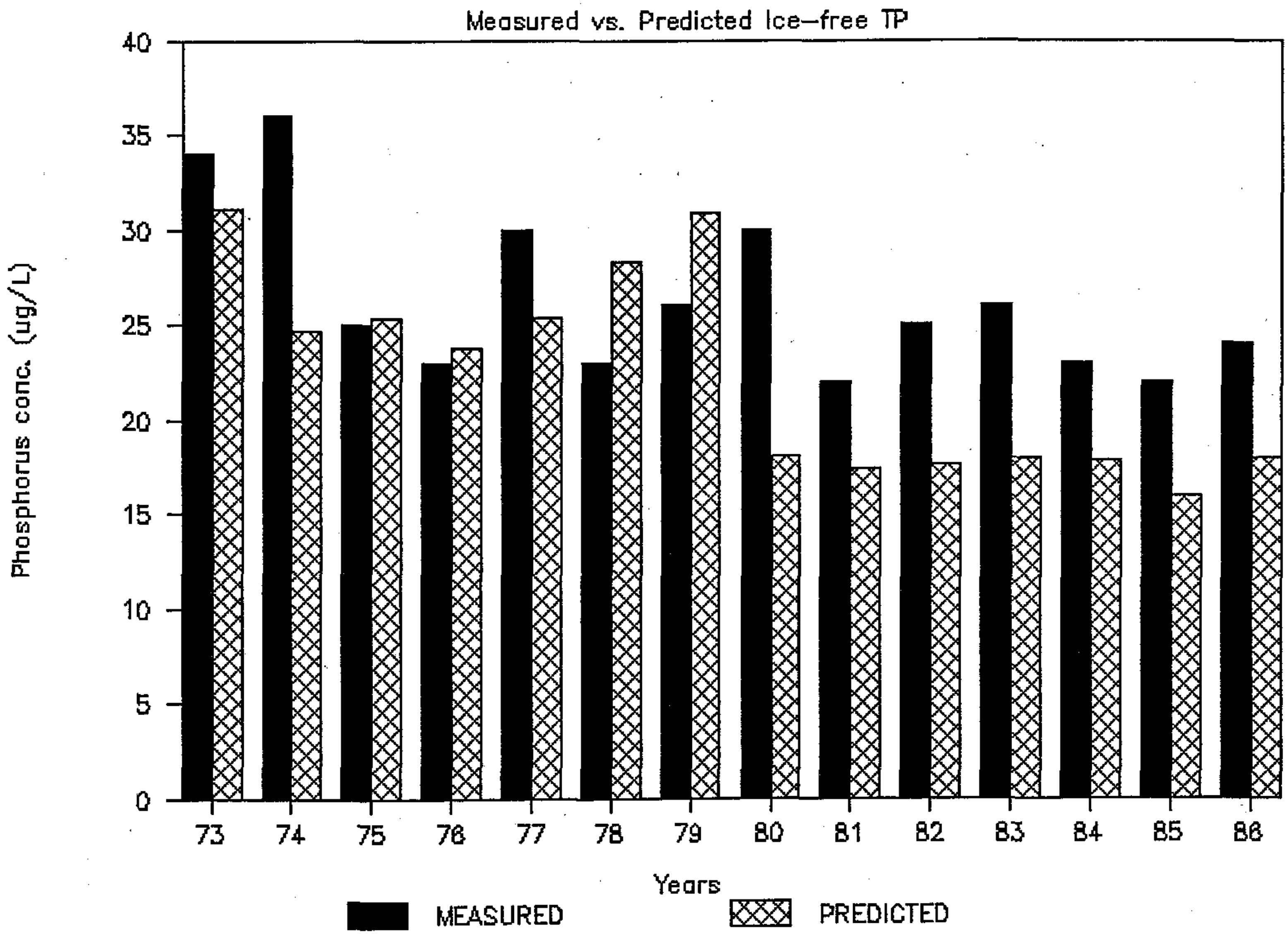


TABLE 11 - INDUSTRIES WITHIN THE SEVERN SOUND STUDY AREA

Company	Product	Discharge
Mitsubishi Electronics Industries Canada Inc.	- electronic components	- direct discharge into Wye River
MIDLAND:		
Bay Mills Ltd.	- industrial fabrics	- into Midland WPCP
TRW (Decor Metals) Ind.	- automotive seatbelts, decorative trim	- into Midland WPCP
Dominion Electroplating	- electroplating	- into Midland WPCP
Great Lakes Boat and Machine Co.	- marine and industrial machine repairs	- into Midland WPCP
Greening, Donald Co. Ltd.	- wire, rope and cable manufacturing	- into Midland WPCP
Indusmin Ltd.	- silica and/or glass industry and cleaner	- into Midland WPCP
Waltec Sinkware	- stainless steel kitchen equipment	- into Midland WPCP
Waltec Plastics	- plastics	- into Midland WPCP
Arthur S. Leitch Co. Ltd.	- pumps, pressure vessels and tube heat exchangers	- into Midland WPCP
Ernst Leitz (Canada) Ltd.	- cameras, lenses and optical instruments	- into Midland WPCP
North Simcoe Tool & Manufacturing	- fixtures and custom built machines	- into Midland WPCP
Rowika Industries	- metal stampings and electroplating	- into Midland WPCP
Scott Printing Service	- commercial printers	- into Midland WPCP
PENETANGUISHENE, VICTORIA HARBOUR AND WAUBAUSHENE :	- dry industries only	
PORT MCNICOLL:	- no industries	

4.3 Municipal Point Sources

There are currently six WPCPs discharging directly into Severn Sound. Three (including the new Penetang Fox St. plant) are located near Penetanguishene, and there is one in each of Midland, Port McNicoll and Victoria Harbour (see Figure 4 for locations, and Table 2 for specifications). In 1984 the effluent discharges from the WPCPs contributed a total of 2119 kg of phosphorus per year to the Sound or 5% of the total phosphorus supply from all sources (see Table 12).

No inorganic or organic trace contaminant data was available for WPCP effluents in Severn Sound. However, an indication of potential concern is provided for trace metals from monitoring results of hauled sludge from each plant (Table 13). Results for Midland WPCP were only available to 1981 since the spreading of sludge on agricultural land was discontinued due to elevated metals levels in the sludge. The elevated levels were the result of input to the WPCP from metal plating industries in Midland. The problem is presently under investigation and confirmation of sludge quality will be obtained during 1988. The elevated values for zinc and copper at Victoria Harbour WPCP are anomalous considering the fact that the plant has no industrial input. The fact that sludge hauled from all WPCPs but Midland WPCP is suitable for use as a soil conditioner on farm fields attests to the low trace contaminant levels found.

4.4 Non-Point Sources

4.4.1 Agriculture

Contamination of water within the Severn Sound watershed from agricultural sources has not been studied in detail. Studies from other regions of Ontario, however, suggest that the contaminants most likely to originate from agricultural activities are phosphorus and sediments. Nitrates and pesticides are also potential contaminants from farming.

The contribution of sediments and phosphorus from farmland depends on the nature of the soil, the amount of runoff, and the management applied to the land, as these contaminants are displaced from farmland largely as a result of soil erosion. Soil texture is a

TABLE 12 - PHOSPHORUS LOAD SUMMARY FROM WPCP's 1984

WPCP	Avg. Daily Flow 1000 M^3/Day	Average Concentration mg/l	Total Annual Load KG/YR
Midland	9.277	0.37	1259
Penetanguishene	2.874	0.54	553
Penetanguishene Mental Health Unit	0.344	0.40	51
Penetanguishene #2 (north-end)	not yet operating		
Victoria Harbour	0.412	0.17	26
Port McNicoll	1.044	0.60	229
TOTAL			2119

TABLE 13 - HAULED SLUDGE CHARACTERISTICS (AVERAGE CONCENTRATIONS (mg/l)) FOR 1985

	Penetang. WPCP #1 1985	Penetang. MHU WPCP 1986	Midland WPCP 1981*	Port McNicoll WPCP 1985	Victoria Harbour WPCP 1985	Coldwater WPCP 1985
Cadmium	0.153	0.58	0.31	0.103	0.195	0.171
Chromium	2.675	3.1	49.0	2.433	3.45	1.071
Copper	12.150	20.5	14.0	25.33	37.25	17.576
Lead	5.60	2.2	52.0	1.2	7.20	2.816
Mercury	0.063	0.045	0.12	0.033	0.055	0.188
Nickel	0.586	0.44	113.0	0.383	1.10	0.61
Zinc	23.250	20.5	67.0	18.0	54.0	14.571
Cobalt	<0.103	<0.1	0.3	0.30	0.29	0.131
Molybdenum	0.265	0.265	0.3	0.256	0.25	0.227
Arsenic	0.145	0.13	0.4	0.15	0.29	0.076
Selenium	0.168	0.21	0.05	0.186	0.275	0.116

*There has been no recent sludge analysis done, since the dried sludge is presently disposed of in a waste disposal site.

major factor in determining erosion potential. The potential for erosion is usually greatest from fine-textured soils because infiltration of water into the soil is reduced; because such soils are easily suspended but settle out very slowly; and because more nutrients are associated with clay particles than other soil particles. Intensity of cultivation (area cultivated, degree of cultivation, proportion of row crops) is also an important factor in determining the amount of pollution from farmland. Characteristics specific to the site also are important. These include the amount and intensity of rainfall, the steepness and length of slopes, and erosion control measures that may have been implemented.

Although there may be specific sites with significant problems, the potential for pollution from cropland within the Severn Sound drainage area is generally considered to be low (Switzer-Howse 1982). Throughout most of the area, the combination of coarse-textured soils (with their reduced potential for runoff), a high proportion of forested or uncultivated land, and extensive use of cereal grains and forages on the cultivated land results in a low risk of erosion. The exceptions to this are the clay plains where the soil texture, higher intensity of cultivation and a higher proportion of row crops combine for a high risk of water contamination (see Figures 4 and 8).

Agricultural drainage activities can also contribute to the sediment load in streams through erosion of the banks of surface drains that have been designed or maintained improperly. Improperly installed outlets for tile drains can also result in streambank erosion. In other respects, however, subsurface drainage should serve to reduce contamination from both sediments and phosphorus. By increasing the amount of water that infiltrates into the soil, subsurface drainage reduces the amount of runoff and hence, the amount of sheet erosion. Because phosphorus is an element that leaches through soil very little, phosphorus concentrations in tile drainage water are significantly lower than those in surface runoff.

Most farms within the area have a livestock operation associated with them. Manure from these animals can enter water courses with runoff from feedlots and manure storage areas or from fields improperly spread with manure. Contamination of water with manure can degrade water quality because of 1) excessive levels of nitrogen or phosphorus; 2) high levels of ammonia; 3) high biological and chemical demand for oxygen; and 4) pathogenic micro-organisms.

Cattle on pasture are frequently allowed free access to streams. This practice results in both direct contamination of the water with manure and degradation and erosion of the streambanks. In this situation, streambank erosion , while adding to sedimentation problems, may not be contributing much available phosphorus because of the very low natural phosphorus levels in many of the soils. The extent of water contamination in the Severn Sound watershed arising from livestock operations has not been evaluated.

4.4.2 Stormwater

Based on the small urbanized area relative to the drainage basin area, stormwater did not appear to be a significant source of nutrients or other contaminants to Severn Sound. There may be localized areas where urban stormwater runoff contributes significantly. The phosphorus contribution of urban stormwater runoff was broadly estimated using two methods (Appendix X). The estimated total supply of 842-1090 KgP/yr from the five main urban areas around Severn Sound was considered a "worst case" estimate, and represents less than five percent of the total phosphorus supply to Severn Sound (see Appendix IX).

4.4.3 Erosion

The contribution of phosphorus and sediment from stream bank erosion is identified in Section 4.4.1 with respect to agricultural practice. To obtain an indication of how important this source is in the immediate drainage area to Severn Sound, Ministry of Natural Resources stream bank erosion information was summarized in Table 13. From these results it appears that the Wye River and Hog Creek are the streams with the highest bank erosion potential. Further work within Hog Creek by MNR staff (Table 14) showed that the

TABLE 14 - STREAM BANK EROSION POTENTIAL IN SEVERN SOUND STREAMS

Stream	Length (km)	% Unstable
Wye River	75	11.3
Hog Creek - mouth-to-confluence of branches (20 km)		17.5
- Main Branch (14 km)		5.4
- Waverley Branch (10 km)		7.5
- Total	44	11.4
Copeland Creek	21	0.9
Sturgeon River	53	2.8
Coldwater River	107	0.9
North River	178	2.2

Source: MNR, Huronia District

mouth-to-confluence reach of the stream had the highest percentage of unstable banks. The proportion of available phosphorus in the eroded bank material is unknown. However, the additional supply could result in a significantly higher total phosphorus export measurement.

4.5 Sediments as a Source of Contamination

Preliminary findings for Penetang Harbour and Midland Bay indicated slightly elevated concentrations of metals and PCBs in localized areas adjacent to the WPCP discharges and built-up shoreline areas (see Section 3.4). These areas may act as low level sources of contamination to the biota when wind and wave action or boat traffic promote fine sediment resuspension. However, available biomonitoring data (Section 3.6) suggest that little uptake into animals and only slight uptake into plants is occurring for these contaminants. Sturgeon Bay, at the time of sampling in 1980, had relatively low contaminant concentrations and was not considered a source to the biota. The area of sediment off Beausoleil Island in the Sound has been shown to contribute little to contaminant levels of mayflies by its use as control for sediment bioassays. There is a lack of sediment quality information on Hog Bay.

5.0 SPECIFIC CONCERNS

Based on the technical review by the RAP Work Team, the following specific concerns for the water quality of the Severn Sound have been identified.

1. Eutrophication

   The continuing growth of nuisance densities of phytoplankton and the resulting degradation of aesthetic quality for recreation is still a concern in Severn Sound. The uncertain relative importance of various sources of nutrients to the phytoplankton growths and the possible relationship of algal density to fisheries through food chain effects make it impossible to show the effect of proposed remedial options on resultant water quality at the present time. The studies planned for 1988 should allow more comprehensive decisions on appropriate remedial options when results are available.

2. Changing fish community

   One factor responsible for the decline in availability of walleye and the rise in availability of black crappie in Severn Sound could be degraded water quality. It is important that an understanding of the water quality factors influencing this change be understood before remedial action and reasonable water quality management options can be considered. Other fish management options are available, such as stocking or habitat improvement, which may be considered in addition to or apart from water quality considerations.

3. Prevention of Contamination

   The water, sediment and biota of Severn Sound appear to be generally free from the effects of trace contaminants, apart from some very localized areas near urban discharges. Existing abatement programs and regulatory controls such as the Municipal-Industrial Strategy for Abatement (MISA) should provide the basis for a sound strategy to prevent any further significant contamination from occurring in Severn Sound.

6. AGENCY GOALS AND OBJECTIVES

The surface waters of Ontario are put to many uses, and each use has specific water quality requirements. Water quality must be managed, preserved, and restored where necessary to permit the greatest number of uses, based on the best interests of the people of Ontario.

The province has agreed that the revised Specific Water Quality Objectives contained in the Great Lakes Water Quality Agreement (1978 as revised 1987) shall be used in environmental programs to achieve and maintain Great Lakes water quality.

Each federal and provincial agency involved in the RAP team have goals and objectives that affect water quality. The following sections summarize those programs, goals and objectives of each agency that have a direct bearing on control of nutrients, especially phosphorus, in Severn Sound.

6.1 Ministry of the Environment

GOAL: To ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation.

OBJECTIVES: Water which meets the water quality criteria for aquatic life and recreation (designated as the Provincial Water Quality Objectives, 1978, Revised 1984 - PWQO), will be suitable for most other beneficial uses, such as drinking water and agriculture. For the few parameters where better water quality is required to protect these other beneficial uses in a given location, the appropriate criteria shall be applied for that location.

The PWQO include specific objectives for water quality parameters to protect aquatic life as well as for swimming and bathing use of water. The PWQO note specifically that the open water total phosphorus concentration necessary to avoid nuisance algae growths is difficult to establish. The guideline suggested is a concentration of 20 ug/L total phosphorus to avoid nuisance algae with a high level of protection against aesthetic deterioration provided by a concentration of 10 ug/L.

MOE Policies

Areas with Water Quality Better than the Objectives

In areas which have water quality better than the PWQO, water quality shall be maintained at or above the Objectives.

Areas with Water Quality Not Meeting the Objectives

Water quality which presently does not meet the PWQO shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives.

Sediment Quality Guidelines

The MOE "Guidelines for Open Water Disposal of Dredge Spoils" (MOE, 1976) have been used to assess the sediment quality of Severn Sound sediment (see Table 7). The guidelines may not give the best indication of the sediment quality where variables can be influenced by natural conditions. For example, an area of the Severn Sound bottom may naturally have a high percentage of clay; or may have elevated phosphorus concentrations due to the presence of a stream discharge.

6.2 Great Lakes International Joint Commission (Great Lakes Water Quality Agreement of 1978 (revised with 1987 Protocol))

Canada and the United States have adopted the following General Objective regarding nutrient enrichment in the Great Lakes System:

- Great Lakes waters should be free from nutrients directly or indirectly entering the waters as a result of human activity in amounts that create growths of aquatic life that interfere with beneficial uses.

Specific Objectives related to phosphorus include the following:

- The concentration should be limited to the extent necessary to prevent nuisance growths of algae, weeds and slimes that are or may become injurious to any beneficial water use.

The goals of phosphorus control as stated in Annex III of the Agreement are:

° Maintenance of the oligotrophic state and relative algal biomass of Lakes Superior and Huron;

° The elimination of algal nuisance in bays and in other areas wherever they occur.

6.3 Environment Canada
Great Lakes Water Quality Working Group of the Federal Government

This interdepartmental working group has adopted the following general objective regarding Great Lakes water quality:

To restore and secure the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem as a multi-use resource with full commitment to renewable resource management principles, to provide for the requirements of society for:

- food and drinking water
- human health
- shelter and energy
- industrial and commercial opportunity
- culture and recreation

Specific objectives include:

° To ensure and preserve an adequate water quality for use by municipal water works.

° To restore and secure the chemical, physical and biological integrity of the waters of the Great Lakes Basin in order to provide healthful and pleasant recreational, cultural and aesthetic benefits to society.

- To restore and secure the integrity of the Great Lakes Basin Ecosystem in order to conserve the health and diversity of wildlife, fish and other organisms, and to ensure the preservation of heritage features reflecting (human) history and interaction within the basin.

- To continue to ensure adequate quantity and quality of water for industrial use.

- To preserve and continue to develop environmental conditions required for a safe navigation system for the Great Lakes, its connecting channels, harbours and ports.

- To ensure the provision of current and innovative programs and facilities for waste treatment and recycling in order to establish and meet the guidelines and criteria for waste management in the Great Lakes Basin Ecosystem for municipal, industrial, urban and agricultural wastes.

6.4 Ministry of Agriculture and Food

Conservation of Ontario's physical resource base is a major component of OMAF's strategic plan. Soil and water sustainability relies on basic research and technology transfer to producers, development of a "stewardship" focus in soil and water management by the industry, and new techniques for proper soil and water management. The goal is to maintain and improve productivity in areas of the province hit hard by soil erosion and degradation, while protecting water resources.

A definite shift away from treating agriculture as a soil resource entire unto itself has occurred in recent years. OMAF has taken increasing responsibility for delivery of both soil and water programs and for providing technical advice to farmers on these topics.

OMAF programs are based on the document entitled "The Mandate, Goals, Objectives and Strategies for the Ontario Ministry of Agriculture and Food: 1985 - 1995".

Two major programs have been developed to assist producers in adopting practices that conserve soil or protect water quality.

1) Soil and Water Environmental Enhancement Program

This program (SWEEP) represents a major federal-provincial commitment to address a particular runoff problem into Lake Erie. However, SWEEP will also act as an omnibus program to encompass a number of initiatives of the Ontario government relating to soil and water. Reduction of agricultural sediment is to be achieved by encouraging farmers to adopt better soil management and cropping practices.

OMAF's "Ontario Soil Conservation and Environmental Protection Assistance Program" (OSCEPAP II) has been incorporated into the SWEEP program. OSCEPAP is designed to help producers control soil erosion, maintain crop productivity and protect water resources. Grants are available to producers to assist with:

- projects installed for the primary purpose of correcting an existing soil erosion problem;
- manure storages that eliminate runoff from storage areas;
- systems designed to properly store, treat and dispose of milkhouse washwater;
- proper pesticide storage and handling facilities.

In the "Tillage 2000" aspect of SWEEP, OMAF's soil conservation advisors, in cooperation with farmers, establish on-farm trials to demonstrate the effects of crop rotation and conservation tillage methods on crop performance, soil conditions, and erosion.

2) Land Stewardship Program

The Land Stewardship Program provides grants to farmers for the adoption of conservation farming practices, where such practices have not been previously employed, that will enhance and sustain agricultural production and improve soil resources and water management by:

- reducing soil erosion and soil compaction
- restoring soil organic matter and structure
- minimizing potential for environmental contamination from agricultural land

Included in the Land Stewardship Program are:

1) Financial Assistance:

Grants will be provided to farmers to adopt conservation practices including:

- soil building and maintenance projects (e.g. crop rotation, cover crops, plow-down crops, windbreaks, improved crop residue management)

- retirement of fragile lands from agricultural production
- structures to reduce erosion
- acquisition of equipment for improved residue management
- technical training
- land stewardship leases

2) Increased Research on Topics Related to Land Stewardship

3) Increased Extension and Education Activities

6.5 Ministry of Natural Resources

The goal of the Ministry of Natural Resources is:

- To provide opportunities for outdoor recreation and resource development for the continuous social and economic benefit of the people of Ontario and to administer, protect and conserve public lands and waters.

The broad objectives of the Ministry are:

RESOURCE PRODUCTION

- To provide for an optimum continuous contribution to the economy of Ontario by stimulating and regulating the utilization of available supplies of fish, furbearers, minerals and trees by resource products industries.

OUTDOOR RECREATION

- To provide from public lands and waters and to encourage on other lands and waters:
  - a wide variety of outdoor recreational opportunities accessible to, and for the continuous benefit of, the people of Ontario;
  - the identification and conservation of unique or representative physical, biological, cultural and historical features of the province; and
  - a continuous contribution to the economy of Ontario from tourism and its related industries; and,

LAND AND WATER MANAGEMENT

- To facilitate the orderly development and conservation of Ontario's land and water resources for the continuous social and economic benefits for the people of Ontario; and
- to prevent loss of life, and to minimize social disruption, property damage and loss of natural resource values from forest fires, floods, erosion, earth slippage and abandoned mines.

The Ministry has programs to ensure the availability of both renewable and non-renewable resources. It regulates the use of these resources for the long-term benefit of the people of Ontario.

The Ministry has two responsibilities in land and water management: the first is custodial - to protect the capability and quality of public land and water; the second is to participate with other agencies in the planning and control of the total land area.

Specific objectives and targets for the Severn Sound area are being developed by the Ministry as part of the District Fisheries Plan. The regulatory tools available to the Ministry to accomplish specific objectives for an area include: setting of catch limits on number and/or size of fish taken; establishing sanctuaries for important fish habitat; and restricting the open season for the catching of fish species. The management tools available include stocking of fish to encourage existing or new populations and rehabilitating degraded habitat. The Ministry also reviews all construction projects in or near water to ensure the protection of fish habitat.

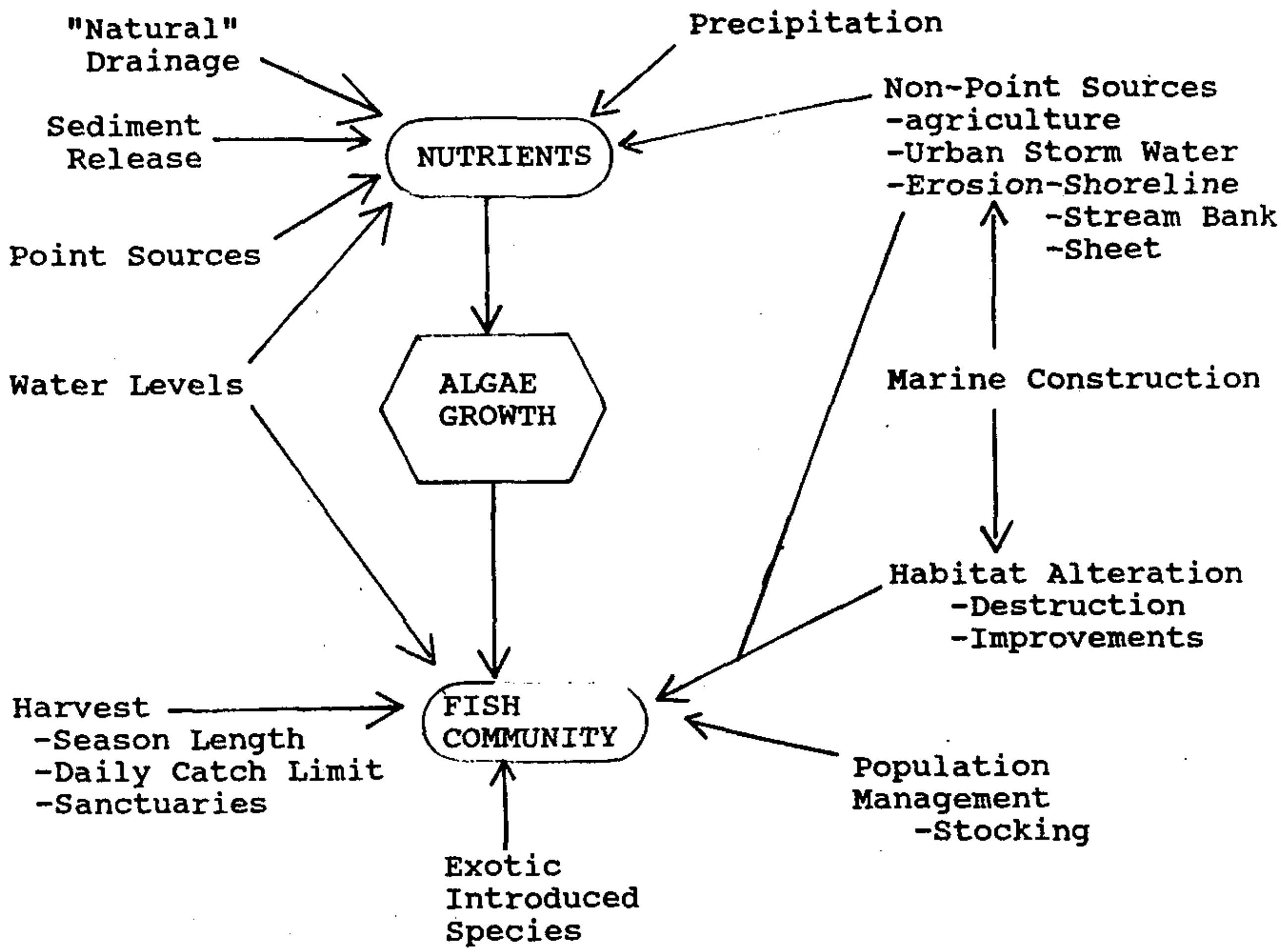
A stocking program for young walleye is operated by private interest groups in Severn Sound under the Community Fisheries Involvement Program of the Ministry (CPIP).

6.6 Towards a Plan for Severn Sound

The RAP Team considered the causes of nuisance algae growths in Severn Sound to stem from two main controlling factors: nutrients and fish community (Figure 28). Nutrients, especially phosphorus, generally limit the growth of algae in a water body. Some of the sources of nutrients are uncontrollable, such as the phosphorus in precipitation falling directly on the water surface, while other sources can be controlled to varying degrees, such as municipal point source discharges.

Algae growth is also affected by the fish community through the food chain. The fish community ultimately controls the cropping or grazing of algae by influencing the abundance of grazing organisms

Figure 28 Factors Influencing Algal Growth In Severn Sound



or zooplankton in the water body. The zooplankton, especially the large water fleas Daphnia, act to control the density of algae through grazing. Algae growth can also influence the fish community by affecting water quality in spawning or nursery habitat. Other factors unrelated to water quality could also influence the fish community such as fish harvest, the effect of exotic introduced species or fish stocking.

A Severn Sound Remedial Action Plan must consider the direct and indirect causal factors influencing algal growth when developing an effective set of goals and objectives that will control algal growth.

The Severn Sound RAP Work Team have considered causal factors of the nuisance algal growth in designing work planned for Severn Sound in 1988 (Table 15).

TABLE 15 SEVERN SOUND RAP FIELD WORK AND REPORTING SCHEDULE for 1988 & 89
For: - Environmental Database
- Pollution Sources/ Impact Studies

Task	Responsible Group/Person	Planned Completion Dates: Fieldwork	Results	Report Draft	Remarks
1. Nutrient Supply					
-update '84 work to '86	MOE-GLS/Sherman	Dec-86	Dec-87	May-88	-use of existing monitoring data in calculations
-algal bioassay	MOE-ABS/Nichols	Aug-87	Feb-88	Mar-88	-assesses nutrient availability for algal growth
-sediments as source	NWRI/Barica	Mar-89	Jun-89	Dec-89	-measured summer & under-ice nutrient release
-Penetang nutrient budget	MOE-GLS,ABS/Sherman,Overton		Nov-87	Jun-88	-use of existing monitoring data in calculations
-ag.as source-data summary	OMAF/Morris		Feb-88	May-88	-assessment of sources from soil erosion potential
-ag.as source-target sites	OMAF/Morris	Sep-88	Feb-89	Mar-89	-overlay mapping with field verification
-Sturgeon B.nutrient calc.	MOE-ABS/Overton		Mar-88	Apr-88	-desk assessment from existing data
2. Exchange/Waterbudget					
-for Sev.S. & Penetang	MOE-GLS/Kohli	Dec-85	Mar-87	Jul-88	-insufficient data collected 1985 for reliable exch. est
-for Severn Sound	MOE-GLS/Kohli	Oct-88	Apr-89	Aug-89	-enhanced grid of current meters to be deployed 1988
3. Environmental Conditions					
-open water monitoring	MOE-ABS/Nicholls,Gemza	Oct-88	Apr-89	Sep-89	-new stations to be added during 1988
-zooplankton analysis	MOE-ABS/Gemza	Oct-87	Aug-88	Oct-88	-I.D., enumeration and data analysis by consultant
-enhanced tribs monitoring	MOE-ABS,GLS/Overton,Sherman	Dec-88	Apr-89	Jun-89	-on Severn, Coldwater, Sturgeon, Hog, Wye & Copeland
-post construction surveys	MOE-CR,GLS/Shaw,Sherman	Oct-88	Apr-89	Sep-89	-consultant study of new Penetang and Victoria H. WPCPs
4. Biomonitoring					
-Juvenile fish collection	MOE-ABS/Suns (contract)	Sep-87	Mar-88	May-88	-reporting dependent on lab priority
-Sport fish collection	MNR,MOE-ABS/Craig, Johnson	Sep-87	Jun-88	Sep-88	-reporting dependent on lab priority
5. Fisheries studies					
-Walleye hatching success	MNR-Dist/Craig	Oct-87	Feb-88	Jul-88	-historical review of data to 1987
-Creel survey phase I	MNR-Dist/Craig	Sep-87	Feb-88	Mar-88	-prelim. assessment - last creel survey 1975
-Creel survey phase II	MNR-Dist/Craig	Sep-88	Feb-89	Mar-89	-to include RAP questions for anglers as part of PIP
-index trap netting	MNR-Dist/Craig	May-88	Feb-89	Mar-89	-historical review of data to 1988
-Sturgeon B.nursery study	MNR-Dist/Craig	Sep-88	Feb-89	Mar-89	-nearshore seining, repeat historical sites

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APPENDIX I - LAND USE SYSTEMS IN SEVERN SOUND AREA TOWNSHIPS

	Percentage of Total Land Devoted to Specific Uses					
Township	Orillia	Medonte	Flos	Tiny	Tay	Matchedash
Row Crop	3	7	11	3	1	<1
Vegetables	0	0	2	1	0	0
Grain System	1	3	9	1	0	0
Mixed System	4	6	11	12	7	1
Hay System	20	19	18	13	18	4
Pasture System	3	5	4	1	1	0
Total	31	40	55	31	27	5
Idle Agric.	7	12	8	6	4	1
Forest	42	42	32	52	47	67
Built-up	9	1	2	7	13	<1
Wetlands	8	<1	2	2	7	27
Other	3	5	1	2	2	0
Total	69	60	45	69	73	95
Total Acres	82935	72320	71492	35297	22721	50395

Source: Ontario Ministry of Agriculture and Food
Soil and Water Management Branch, 1983

APPENDIX II - STATUS OF WASTE DISPOSAL SITES WITHIN SEVERN SOUND DRAINAGE AREA: CERTIFIED SITES

CERT. NO	LOCATION		STATUS (1987)
A252303	Matchedash	Con. 5 Lot 14	Active
A252403	Medonte	Con. 13 Lot 19	Active
A510501	Baxter	Con. 6 Lot PT. 27	Active
A250701	Tiny	Con. 15 Lot 121	Closed 1973
A251401	Tay	Con. 5 Lot 14	Closed 1974
A252301	Matchedash	Con. 1 Lot 15	Closed 1984
A252402	Medonte	Con. 12 Lot 19	Closed 1976
A252901	Tay	Con. 4 Lot 16	Closed 1974
A252902	Tay	Con. 9 Lot 8	Closed 1974

APPENDIX II (cont'd) - STATUS OF WASTE DISPOSAL SITES WITHIN SEVERN SOUND DRAINAGE AREA: UNCERTIFIED SITES

X - No.	LOCATION		STATUS (1987)
4119	Penetanguishene		Closed 1966
4124	Tay	Con. 7	Closed 1972
4125	Tay	Con. 7	Closed 1955
4126	Matchedash	Con. 6 Lot 7	Closed
4127	Matchedash		Closed 1973
4133	Tiny	Con. 2 Lot 3	Closed 1972
4134	Tiny	Con. 4 Lot 2	Closed 1968
4138	Tiny	Con. 17 Lot 13	Closed 1971
4140	Tiny		Closed 1971
4142	Tiny	Con. 9 Lot 9	Closed 1960
4145	Tiny	Con. 16 Lot 2	Closed
4146	Tiny		Closed
4149	Midland		Closed 1965
4151	Tay	Con. 13 Lot 15	Closed
4152	Tay	Con. 4 Lot 16	Closed
4153	Tay	Con. 5 Lot 15	Closed
4154	Tay	Con. 5 Lot 14	Closed
4168	Tay	Con.10 Lot 18	Closed

*There are five unnumbered, uncertified waste disposal sites in Baxter ward. Date of closure is unknown.

APPENDIX III NITROGEN TO PHOSPHORUS RATIOS AT FIVE MAIN STATIONS IN SEVERN SOUND, 1969, 1973-1986

YEAR	P1	P4	M1	PM2	BS
1969	9.6	12.0	13.5	19.8	21.5
1973	11.1	16.4	12.9	15.0	19.8
1974	11.0	19.8	16.1	14.6	19.4
1975	14.8	22.8	18.1	20.7	21.8
1976	14.4	23.1	16.5	19.0	19.9
1977	12.0	27.3	18.9	20.4	24.6
1978	13.6	23.1	18.7	22.8	24.2
1979	16.7	25.6	20.8	19.5	22.6
1980	11.4	18.2	19.4	20.4	20.9
1981	17.6	24.0	14.3	18.1	13.3
1982	16.0	26.3	23.2	23.6	27.2
1983	12.3	26.6	20.1	17.3	20.0
1984	17.8	26.7	22.5	22.5	27.9
1985	13.3	36.3	29.0	20.7	28.6
1986	15.3	37.3	22.5	22.9	22.7

See Figure 12 for station locations.

APPENDIX IV

PHYTOPLANKTON COMPOSITION AT FIVE MAIN STATIONS IN SEVERN SOUND, 1969, 1973-1986

Summary of May-October average phytoplankton as a percentage of total biovolume (dominant algal classes) at Station P1 in Severn Sound, 1973-1985.

YEAR	PERCENTAGE OF TOTAL						TOTAL BIOVOLUME [$\mu^3 x 10^3$]
	Cyano-phyceae	Dino-phyceae	Crypto-phyceae	Chryso-phyceae	Chloro-phyceae	Bacillario-phyceae	
1973	3.4	46.2	11.9	2.0	1.1	28.5	7359
1974	2.7	9.0	37.2	4.9	5.1	41.1	5110
1975	6.1	17.9	13.8	1.8	7.8	52.6	5031
1976	3.6	7.5	17.9	3.3	6.2	61.4	3267
1977	2.1	54.7	10.0	2.6	2.6	27.8	5974
1978	1.7	18.9	11.4	1.3	2.4	58.6	9240
1979	0.8	34.1	18.7	4.6	3.1	38.6	6442
1980	5.4	2.0	35.7	1.8	3.2	52.0	6772
1981	1.1	7.7	27.7	3.8	2.3	57.3	4589
1982	2.4	0.2	33.6	10.1	2.4	50.6	4049
1983	2.0	8.9	31.1	5.3	10.7	42.0	4343
1984	8.8	11.2	34.0	5.1	4.9	36.0	5689
1985	0.8	8.2	24.1	5.0	4.9	57.0	4961

APPENDIX IV (cont'd)

Summary of May-October average phytoplankton as a percentage of total biovolume (dominant algal classes) at Station M1 in Severn Sound, 1973-1985.

YEAR	PERCENTAGE OF TOTAL						TOTAL BIOVOLUME [$\mu^3 x 10^3$]
	Cyano-phyceae	Dino-phyceae	Crypto-phyceae	Chryso-phyceae	Chloro-phyceae	Bacillario-phyceae	
1973	10.3	7.4	9.9	4.5	2.7	65.2	1596
1974	1.1	5.2	13.0	2.8	5.8	72.0	2238
1975	2.8	3.3	17.2	3.9	9.2	63.3	2840
1976	1.8	12.2	23.4	3.3	3.2	55.8	1766
1977	3.5	17.7	14.5	3.4	4.3	59.6	2156
1978	3.9	7.5	13.8	3.6	2.4	69.1	2400
1979	2.1	36.6	13.6	2.8	2.4	42.5	2660
1980	3.1	2.8	25.5	0.6	0.6	67.5	2543
1981	4.6	3.9	24.5	3.0	4.2	59.9	6417
1982	3.5	3.6	18.3	7.0	9.8	57.9	1963
1983	1.0	14.2	19.8	7.1	7.9	51.0	1459
1984	3.5	0.5	8.1	3.9	1.2	83.8	4919
1985	1.9	5.1	14.8	5.2	2.7	70.3	2017

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APPENDIX IV (cont'd)

Summary of May-October average phytoplankton as a percentage of total biovolume (dominant algal classes) at Station P4 in Severn Sound, 1973-1985.

YEAR	PERCENTAGE OF TOTAL						TOTAL BIOVOLUME [μ^3x10^3]
	Cyano-phyceae	Dino-phyceae	Crypto-phyceae	Chryso-phyceae	Chloro-phyceae	Bacillario-phyceae	
1973	2.5	11.8	4.7	3.4	3.6	74.0	2364
1974	1.9	8.9	7.8	2.9	4.3	74.2	2697
1975	2.1	6.4	12.5	3.7	8.5	66.8	2381
1976	3.1	0.5	20.4	4.5	12.1	59.3	1823
1977	6.1	9.9	10.9	3.0	6.4	63.6	2195
1978	6.1	4.8	11.3	6.9	3.3	67.4	1829
1979	9.5	14.9	12.3	8.6	3.8	50.8	1353
1980	2.7	1.6	10.9	1.0	1.3	82.5	4389
1981	0.9	3.6	23.4	4.2	4.0	63.9	1117
1982	1.3	0.3	11.5	5.5	3.8	77.7	1596
1983	2.0	3.9	15.1	5.0	5.0	69.0	1200
1984	7.7	5.3	13.0	6.1	3.0	64.9	2271
1985	1.8	3.3	12.7	5.3	8.2	68.8	2978

899A

APPENDIX IV (cont'd)

Summary of May-October average phytoplankton as a percentage of total biovolume (dominant algal classes) at Station BS in Severn Sound, 1973-1985.

YEAR	PERCENTAGE OF TOTAL						TOTAL BIOVOLUME [$\mu^3 x 10^3$]
	Cyano-phyceae	Dino-phyceae	Crypto-phyceae	Chryso-phyceae	Chloro-phyceae	Bacillario-phyceae	
1973	13.1	20.2	6.5	11.4	17.2	31.6	1835
1974	12.3	6.1	19.7	27.9	6.3	27.9	1472
1975	11.0	6.4	11.3	12.3	8.3	47.9	700
1976	1.8	2.4	22.3	17.8	9.9	45.2	883
1977	6.5	9.9	19.9	16.5	11.4	34.9	926
1978	9.6	12.8	21.3	18.2	8.6	29.6	865
1979	11.6	8.2	22.9	28.7	9.4	18.9	748
1980	19.9	12.4	20.0	24.9	4.1	18.0	1133
1981	5.1	8.5	31.1	29.1	10.3	16.0	731
1982	9.1	14.5	30.2	9.4	8.7	28.1	530
1983	47.0	3.1	13.9	14.3	11.7	8.0	2374
1984	2.1	17.0	27.3	24.7	3.0	25.9	954
1985	12.9	13.1	32.0	14.8	7.2	20.0	820

APPENDIX IV (cont'd)

Summary of May-October average phytoplankton as a percentage of total biovolume (dominant algal classes) at Station PM2 in Severn Sound, 1973-1985.

YEAR	PERCENTAGE OF TOTAL						TOTAL BIOVOLUME [$\mu^3 x 10^3$]
	Cyano-phyceae	Dino-phyceae	Crypto-phyceae	Chryso-phyceae	Chloro-phyceae	Bacillario-phyceae	
1973	21.0	3.8	21.0	7.6	4.9	41.4	1180
1974	1.2	7.4	11.6	6.3	2.3	71.2	2550
1975	2.9	1.3	11.4	5.1	12.7	66.6	2044
1976	3.9	4.7	16.4	6.9	4.0	63.9	1935
1977	11.4	6.8	7.8	4.2	2.3	67.4	1709
1978	11.9	9.7	14.4	15.0	4.6	44.3	1827
1979	3.1	26.8	14.3	6.5	2.5	46.3	1940
1980	12.9	4.9	14.1	2.7	2.1	63.3	3402
1981	0.0	9.6	31.8	4.1	4,3	50.1	899
1982	7.8	0.6	13.8	7.8	5.2	64.8	1474
1983	5.9	8.1	30.8	9.2	14.0	31.0	1657
1984	6.8	2.2	21.0	5.3	7.7	58.0	1378
1985	3.0	2.9	24.7	8.3	6.1	54.1	1985

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APPENDIX V - Plant tissue concentrations for selected sites in Severn Sound 1980, 1982

Elemental concentrations in fringing <u>Cladophora</u>

		ESSENTIAL NUTRIENTS (mg/g)		MAJOR ELEMENTS (mg/g)					TRACE ELEMENTS (μg/g)											LOI
SITE	DATE	P	N	Ca	Al	Fe	Mg	Mn	Zn	Pb	Cu	As	Cr	Ni	Cd	Co	Se	Sb	Hg	(%)
G1	AUGUST	1.2	24	16.1	1.18	2.70	3.45	1.03	160	12.0	7.5	5.9	9.8	6.3	L0.3	L3	0.4	0.2	L0.01	77
G2	AUGUST	3.1	61	-	-	-	-	-	200	24.0	11.8	4.6	13.5	17.0	L0.3	L3	0.6	0.3	L0.01	59
G3	AUGUST	1.2	24	11.5	0.48	0.89	2.06	0.35	160	8.3	5.2	4.0	6.8	7.0	0.4	L3	0.4	0.2	L0.01	77
G4	AUGUST	1.2	25	-	-	-	-	-	190	7.9	15.2	3.9	22.8	15.2	L0.3	L3	0.9	0.2	L0.01	54

G1 = Penetang Bay near Main St W.P.C.P.; G2 = Midland at foot of Victoria St.
G3 = Exposed Midland Bay near Midland W.P.C.P.; G4 = Sturgeon Bay at shoal

Sturgeon & Penetang Bay Macrophyte Survey 1982
Plant Tissue Analysis

Station	Sp	RST (%)	RSTA (%)	RSTLOI (%)	Fe (ug/g)	Mn (ug/g)	P (mg/g)	TKN (mg/g)	As (ug/g)	Cd (ug/g)	Cu (ug/g)	Hg (ug/g)	Ni (ug/g)	Pb (ug/g)	TOC (mg/g)	Zn (ug/g)
P12	Chara	14	72	28	2300	480	1.8	13.3	0.84	0.31	7.0	0.05	5.0	10.0	110	25
P11	C.dem.	38	41	59	2300	2100	4.5	30.5	0.92	0.46	5.0	0.06	18.0	16.0	250	64
P8	C.dem.	6	34	66	3500	3200	11.7	47.2	1.29	0.62	9.8	0.07	16.0	31.0	330	74
P11	E.can.	20	33	67	2500	640	3.4	24.2	0.85	0.36	7.4	0.06	8.3	11.0	240	32
P12	E.can.	30	68	32	4200	440	1.5	14.6	1.12	0.34	8.8	0.04	6.2	13.0	140	37
P7	E.can.	6	44	56	3300	850	4.6	31.3	0.83	9.80	7.2	0.06	8.7	16.0	320	34
P8	E.can.	20	19	81	5500	760	4.5	25.0	1.78	0.38	11.0	0.08	8.6	30.0	250	48
P1	H.dubia	22	14	86	16000	1200	8.5	29.8	2.92	0.40	14.0	0.10	7.0	73.0	280	87
P2	H.dubia	63	37	63	10000	960	5.6	21.3	1.76	0.49	16.0	0.17	24.0	43.0	210	78
P8	H.dubia	45	25	75	14000	880	5.9	25.2	2.37	0.36	13.0	0.12	9.4	28.0	290	64
P9	H.dubia	11	33	67	3800	1200	5.4	46.2	1.14	0.47	9.5	0.11	11.0	19.0	320	45
P10	H.dubia	8	21	79	960	970	1.8	23.9	0.51	0.48	5.9	0.05	12.0	15.0	330	55
P11	H.dubia	36	39	61	7500	1200	3.8	28.5	2.09	0.40	10.0	0.11	8.6	16.0	270	62
P7	M.ex.	13	34	66	1400	820	9.7	48.5	0.83	0.21	3.8	0.07	6.8	8.6	340	30
P9	M.ex.	72	28	72	1600	1000	3.7	27.9	0.52	0.30	6.1	0.06	6.0	8.5	360	23
P12	V.amer.	32	60	40	4300	430	1.5	14.2	0.96	0.25	7.5	0.04	7.1	19.0	60	50
P7	V.amer.	42	25	75	5900	870	4.1	28.2	0.92	0.34	9.8	0.09	10.0	21.0	300	61
SB31	M.spic.	33	39	61	3900	800	2.4	19.2	1.32	0.36	6.5	0.07	3.8	11.0	270	19
SB32	M.spic.	85	41	59	4900	740	1.8	17.1	1.35	0.28	4.9	0.07	4.5	7.6	260	26
SB33	M.spic.	71	35	65	3700	610	3.0	18.8	1.21	0.48	5.4	0.04	4.2	8.3	270	21

APPENDIX VI

Contaminant concentration in midge larvae and mayflies (Hexagenia) tissues from Midland Bay, Penetang Bay and a control area off Beausoleil Island, 1985 (all results in ug/g wet wt.)

	Penetang Harbour Stn 530 chir.	Midland Bay Stn 515 chir.	Midland Bay Stn 519 chir.	Midland Bay Stn 521 chir.	Beausoleil Island Control mayfly	Detection Limit
Aluminum					357	
Arsenic	0.04	0.03	0.05	0.08	0.41	
Cadmium	0.08	0.06	0.05	0.05	0.06	
Chromium	1.70	1.20	1.60	1.40	1.30	
Copper	2.54	2.65	1.74	2.48	2.50	
Iron	620	520	420	600	1834	
Lead	0.25	1.30	1.40	0.25	1.20	
Manganese	30.0	16.0	20.0	16.0	24.7	
Mercury	0.02	0.02	0.01	0.02	0.05	
Nickel					1.4	
Zinc	15	13	11	16	31	
% lipid		0.38				
% ash		1.81				
Aldrin		ND			ND	0.001
A-BHC		ND			ND	0.001
B-BHC		ND			ND	0.001
G_BHC		ND			ND	0.001
A-chlordane		ND			ND	0.002
G-chlordane		ND			ND	0.002
Dieldrin		ND			ND	0.002
Methoxychlor		ND			ND	0.005
Endosulfan I		ND			ND	0.001
Endosulfan II		ND			ND	0.002
Endrin		ND			ND	0.005
Endosulfan-sulphate		ND			ND	0.004
Heptachlor-epoxide		ND			ND	0.002
Heptachlor		0.001			ND	0.001
Mirex		ND			ND	0.001
Oxychlordane		ND			ND	0.002
op-DDT		ND			ND	0.005
total PCB		0.060			ND	0.020
pp-DDD		0.002			ND	0.002
pp-DDE		0.008			ND	0.002
pp-DDT		ND			ND	0.005
Hexachlorobenzene		0.001			ND	0.001

ND = not detectable

APPENDIX VII **ORGANOCHLORINE AND MERCURY RESIDUES IN YOUNG-OF-THE-YEAR SPOTTAIL SHINERS FROM THE SEVERN SOUND - 1987**

Site No.		N	Fish Size (mm)	% Lipid	PCB	DDE	HCB	Mercury	
1	Beausoleil Island	7	58±4	4.2±.4	ND	7±2	ND	29±7	
2	Penetang Bay - Michaud Pt.	7	54±3	4.2±.3	ND	6±3	ND	11±4	
3	Penetang Bay - Asylium Pt.	7	58±4	4.3±.4	ND	11±8	2±1	23±5	
4	Penetang Bay - Tannery Pt.	7	63±4	5.9±.8	27±13	6±2	ND	20±8	
5	Penetanguishene WPCP	7	52±4	3.7±.4	ND	5±3	ND	16±8	
6	Not Available								
7	Midland - Downtown	7	59±4	4.8±1.1	164±42	9±1	ND	13±3	
8	Midland - WPCP	4	66±7	6.6±.8	55±25	19±19	ND	13±3	
9	Wye River	7	62±5	6.1±.8	ND	9±1	ND	14±3	
10	Grandview Beach	7	63±5	6.6±.6	24±18	13±5	1±1		
11	Port McNicoll	6	55±2	3.8±.7	ND	7±2	1±1	22±8	
12	Hog Bay - West Shore	7	52±3	3.8±.6	59±30	4±2	ND	26±14	
13	Methodist Island	7	52±3	3.1±.4	ND	4±2	3±2	11±4	
14	Victoria Harbour	4	50±3	4.0±1.2	ND	5±0	TR	17±10	
15	Sturgeon River	7	72±3	2.7±.2	ND	6±2	ND	37±15	YEARLING FISH(1+)
16	Sturgeon Bay	7	71±7	5.7±.8	ND	12±4	TR	27±10	YEARLING FISH(1+)
17	Waubaushene	7	65±6	6.6±.3	ND	10±3	1±1	11±4	
18	Port Severn	7	67±3	2.6±.1	ND	5±1	1±1	40±0	

APPENDIX VIII - CONTAMINANT SAMPLING PLAN FOR SEVERN SOUND

1988

Carp
Northern Pike

1989

Walleye
Black Crappie

1990

Smallmouth Bass

1991

Northern Pike
Pink Salmon

1992

Yellow Perch

Consumption Guidelines for Sport Fish in Severn Sound

Waterbody / Cours d'eau	Fish Species / Espèces de poisson	Fish size in centimetres (inches) / Longueur du poisson en centimètres (pouces)									
		< 15 (< 6)	15-20 (6-8)	20-25 (8-10)	25-30 (10-12)	30-35 (12-14)	35-45 (14-18)	45-55 (18-22)	55-65 (22-26)	65-75 (26-30)	> 75 (> 30)
Georgian Bay GB #4 / Baie Georgian GB #4 Penetang Harbour/Havre Penetang 4447/7956 Tiny Twp./Canton de Tiny Simcoe Co./Cté de Simcoe	Black Crappie[2] / Marigane noire[2]										
Georgian Bay GB #4 / Baie Georgian GB #4 Penetang, Midland 4450/7954 Simcoe Co./Cté de Simcoe	Yellow Perch[4] / Perchaude[4]										
	Walleye[4] / Doré[4]										
	Rainbow Trout[4] / Truite arc-en-ciel[4]										
	Rock Bass[4] / Crapet de roche[4]										
	White Sucker[4] / Meunier noir[4]										
Georgian Bay GB #4 / Baie Georgian GB #4 Sturgeon Bay/Baie Sturgeon 4444/7944 Tay Twp./Canton de Tay Simcoe Co./Cté de Simcoe	Black Crappie[2] / Marigane noire[2]										
	Smallmouth Bass[2] / Achigan à petite bouche[2]										
Georgian Bay GB #4 / Baie Georgian GB #4 Port Severn 4448/7943 Tay Twp./Canton de Tay Simcoe County/Cté de Simcoe	Walleye[1] / Doré[1]										
Georgian Bay GB #4 / Baie Georgian GB #4 Matchedash Bay/Baie Matchedash 4444/7940 Simcoe Co./Cté de Simcoe	Carp[2] / Carpe[2]										

Consumption Guidelines

One week	No restrictions	10 meals per wk. 2.3 kg./wk. (5.1 lb./wk.)	7 meals per wk. 1.54 kg./wk. (3.4 lb./wk.)	1 or 2 meals/wk. 0.45 kg./wk. (1 lb./wk.)	None
Two weeks	No restrictions	5 meals per wk. 1.3 kg./wk. (2.8 lb./wk.)	4 meals per wk. 0.86 kg./wk. (1.9 lb./wk.)	1 or 2 meals/wk. 0.45 kg./wk. (1 lb./wk.)	None
Three weeks	No restrictions	4 meals per wk. 0.95 kg./wk. (2.1 lb./wk.)	3 meals per wk. 0.63 kg./wk. (1.4 lb./wk.)	1 or 2 meals/wk. 0.45 kg./wk. (1 lb./wk.)	None
Long-term consumption	No restrictions	0.226 kg./wk. (0.5 lb./wk.)	0.136 kg./wk. (0.3 lb./wk.)	1 or 2 meals per month 0.45 kg./mo. (1 lb./mo.)	None

Guide de consommation

Une semaine	Pas de restrictions	10 repas par sem. 2,3 kg/sem. (5,1 lb./sem.)	7 repas par sem. 1,54 kg/sem. (3,4 lb/sem.)	1 ou 2 repas par sem. 0,45 kg/sem. (1 lb/sem.)	Aucun
Deux semaines	Pas de restrictions	5 repas par sem. 1,3 kg/sem. (2,8 lb/sem.)	4 repas par sem. 0,86 kg/sem. (1,9 lb/sem.)	1 ou 2 repas par sem. 0,45 kg/sem (1 lb/sem.)	Aucun
Trois semaines	Pas de restrictions	4 repas par sem. 0,95 kg/sem. (2,1 lb/sem.)	3 repas par sem. 0,63 kg/sem. (1,4 lb/sem.)	1 ou 2 repas par sem 0,45 kg/sem. (1 lb/sem.)	Aucun
Consommation à long terme	Pas de restrictions	0,226 kg/sem. (0,5 lb/sem.)	0,136 kg/sem. (0,3 lb/sem.)	1 ou 2 repas par mois 0,45 kg/mois (1 lb/mois)	Aucun

Contaminant identification / Identification des polluants

	Contaminant identification	Identification des polluants
1	Mercury	Mercure
2	Mercury, PCB, mirex and pesticides.	Mercure, BPC, mirex et pesticides
3	PCB, mirex and pesticides	BPC, mirex et pesticides
4	Mercury, PCB and mirex.	Mercure, BPC et mirex
5	Mercury, other metals, PCB, mirex and pesticides.	Mercure, autres métaux, BPC, mirex et pesticides
6	Mercury, other metals.	Mercure et autres métaux
7	2,3,7,8-TCDD (Dioxin)	2,3,7,8-TCDD (dioxine)
8	Toxaphene	Toxaphène

Children under 15 and women of child-bearing age should eat only .

Les enfants de moins de 15 ans et les femmes en âge de procréer ne devraient manger que des poissons représentés par .

APPENDIX IX
SEVERN SOUND PHOSPHORUS SUPPLY ASSUMPTIONS

Severn River

1. Flow data for the Severn River was taken at Swift Rapids. The remaining drainage area was considered to be less than 5% of the overall flow and therefore within the error estimate at this station.

2. Any missing nutrient data was obtained by interpolation.

Sewage Plants

1. Any missing flow data was obtained by interpolation.

2. All flow devices at the WPCP's have been recently calibrated.

3. Load for a day was calculated by multiplying daily flow times average monthly concentration for each plant.

4. Penetanguishene Mental Health STP did not take daily flow data during the weekend days, therefore daily load could not be calculated.

Tributaries

1. Flow data was available at two points: (1) Coldwater River at Coldwater; (2) Wye River at Wyebridge from Water Survey of Canada.

2. Unit area runoff from Coldwater and Wye River stations were used to prorate streams without flow data.

Organochlorine

An organic compound which includes chemically bound chlorine. Many organochlorines are formed in industrial processes whenever chlorine or chlorine based compounds are used. Thousands of chlorinated organic compounds exist, but only a small proportion of those in industrial processes have been identified.

Phosphorus

Phosphorus occurs naturally in igneous and other types of rocks and may enter the aquatic environment through weathering of rock or precipitation. Some uses for phosphorus include soaps and detergents, fertilizer production, pesticides and insecticides. Domestic and livestock wastes, industrial effluents and agricultural drainage from fertilized land contribute phosphorus to waters.

Phosphorus (total and soluble reactive) is an important nutrient utilized by plants and algae. Phosphorus is usually found in low concentrations in surface water because it is actively taken up by plants. High concentrations of phosphorus can promote nuisance levels of algal and plant growth.

Phytoplankton

Algae or microscopic plants that live suspended in the water column of a lake. They form the base of the natural food chain.

PCBs

PCBs are a group of chlorinated organic compounds first commercially developed in the late 1920's. They are not of natural origin or formed in the natural environment so their presence can always be attributed to man's activities. PCBs are stable and relatively inert compounds: they break down very slowly in the environment and are destroyed by burning only at very high temperatures. These properties led to widespread use of PCBs as electrical transformer insulating fluids, extreme pressure oils and greases, hydraulic fluids, and as fire retardants and plasticizers in products such as paints, inks, caulking compounds and sealants.

Trace Contaminants

Toxic and other deleterious substances found in trace concentrations in the environment.

Zooplankton

The animal portion of the community that live suspended in the water column of a lake.