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Inland Waters Directorate

Ontario Region

WINTER NAVIGATION SEASON EXTENSION ON THE GREAT LAKES - ST. LAWRENCE SEAWAY

-BACKGROUND CONSIDERATIONS AND ENVIRONMENTAL ISSUES RELATIVE TO CANADIAN CONCERNS

Direction générale des eaux intérieures

Region de l'Ontario

Canada

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Prepared by:

Water Planning and Management Branch
Inland Waters Directorate, Ontario Region

on behalf of the

Ontario Regional Screening and Coordinating Committee

November, 1984

PREFACE

The intention of this report is to present an informative and updated review of the U.S. - initiated proposal for winter navigation season extension on the Great Lakes - St. Lawrence Seaway (GL-SLS) and to discuss the potential effects/impacts on environmental resources which may result along Canadian portions of the GL-SLS. In the latter discussion an attempt will be made to focus on and highlight the relative sensitivities of certain reaches of the Seaway to impacts from winter navigation activities.

It is hoped that the material consolidated within this report, together with overview considerations of past Canadian involvements, implications for the federal Department of Environment (DOE) services, and baseline study requirements, will assist DOE Ontario Region in developing both its own position with respect to winter navigation and strategies for the federal government to effectively deal with concerns associated with the proposal. In the sense that this is an informational background document, no formal recommendations are contained in the report.

EXECUTIVE SUMMARY

Recent events in the U.S. have once again brought to the fore winter navigation season extension on the Great Lakes - St. Lawrence Seaway System (GL-SLS). With the possibility of U.S. Congress authorization for the U.S. Army Corps of Engineers (USACE) to proceed with the implementation of their 1979 plan, there is mounting pressure on Canada to clearly define its position on winter navigation and its concerns relative to potential environmental effects and impacts.

This report endeavours to provide some perspective on environmental issues relative to Canadian concerns associated with winter navigation season extension. In doing so, it has briefly traced the background of the USACE proposal, subsequent reviews, its current status, and past Canadian involvement in season extension-related activities.

In addition to a review of the generic environmental effects which would result from implementation of winter navigation on the Great Lakes, a closer examination of the relative environmental sensitivities of portions of the GL-SLS was undertaken. The three components considered, i.e. Upper Lakes Section (Lakes Superior, Huron, Michigan, St. Marys River), Interconnecting Channels (Middle) Section (St. Clair/Detroit Rivers, Lakes St. Clair, Erie), and Lower Section (Welland Canal, Lake Ontario, St. Lawrence River), reflected both the likely phasing of winter navigation implementation and an increasing sensitivity to project impacts, progressing downstream. Many of the identified impacts are considered to be potentially significant, however, the lack of baseline data precludes substantive analyses of impacts and degradation/damage to the Great Lakes ecosystem, other water users, and shore properties. Given the larger proportion of sensitive shore and littoral environments in Canada along the GL-SLS, the potential effects in Canada would be proportionally greater than in the U.S., as would be the costs of providing needed data on the winter environment for a thorough environmental assessment.

The question of differences between year-round navigation and 10 3/4 - month navigation does not preclude that major modifications to the system will be required in either case. Most environmental concerns expressed in the report would therefore continue to be valid, although uncertain as to severity or final significance. The 10 3/4 month option does, nevertheless, provide some opportunity for stable ice formation and winter recovery of biological communities; however, even this may be optimistic since the remaining 1 1/4 months may not result in a "normal" winter (i.e., more than 1 1/4 months may be needed to recover to near normal conditions).

Since the USACE already believes it has adequate mandate and authority to proceed with certain implementation works, unilateral U.S. action on winter navigation may test the question of liability for possible damages or effects on the Canadian side. The determination of any effects would be virtually impossible without Canadian effort on baseline data collection, monitoring, etc.

A partial review of Department of Environment services indicated that many areas of DOE mandates and responsibilities could be affected by winter navigation activities. These ranged from wildlife/migratory birds and habitat management, wetlands ownership, National Parks and Historic site management, shoreline recreation, canal operations to ice reconnaissance support, lake level regulation support and hazardous spill contingency planning. In addition to the costs of acquiring baseline data, the impacts of winter navigation on the conduct of DOE activities and programs (sometimes at conflict, for example, flood damage reduction, shoreland management, Great Lakes Water Quality) must be considered in the overall cost/benefit of navigation season extension.

It is recognized that the USACE economic evaluation of cost/benefit of season extension has ignored environmental costs and damages, and the large cost to Canada to undertake what would be its share of season extension required improvements. The additional costs of baseline studies and increased support services also need to be included in a more acceptable evaluation of costs and benefits. The inclusion of these latter categories of additional costs to the public and the environment may significantly lessen any perceived benefits of winter navigation season extension notwithstanding prevailing economic conditions.

Finally, given the scope of the winter navigation issue and the many interests involved, it is considered that an International Joint Commission Reference Study would be an appropriate vehicle for addressing the myriad of concerns, coordinating baseline data collection activities, and generally providing a high profile for the conduct of a system-wide environmental assessment. It is recognized, however, that such studies could be undertaken by appropriate federal, provincial/state agencies through their respective programs or through some other bilateral mechanisms.

TABLE 2. SUMMARY OF ENVIRONMENTAL ISSUES/EFFECTS

(Each cell: short term (temporary) symbol / long term symbol; – = none)

WINTER NAVIGATION ACTIVITIES / SECTION / GREAT LAKES ENVIRONMENTAL COMPONENTS	SYSTEM MODIFICATION									ICE CONTROL MEASURES									VESSEL OPERATIONS/ ICE BREAKING			ACCIDENTAL SPILLS		
	CONSTRUCT. (LOCKS, OTHER FAC.)			DREDGING			COMPENSAT. WORKS			ICE BOOM OPERATIONS			AIR BUBBLERS			ARTIFICIAL ISLANDS								
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
WILDLIFE	✸ / ▽		● / ▽	✸ / –	● / ▽	● / ▽							● / ▽					▽ / ▽	● / ▽	● / ▽	● / ●	● / ●	● / ●	● / ●
FISHERIES	● / ●		● / ▽	● / ▽	● / ▽	● / ▽		● / ●					● / ▽					● / ▽	● / ●	● / ●	● / ●	● / ●	● / ●	● / ●
BENTHOS	● / ▽		● / ▽	● / ▽	● / ▽	● / ▽							▽ / ▽					● / ▽	● / ▽	● / ▽	● / ●	▽ / –	▽ / –	▽ / –
VEGETATION & SHORE ENVIRONS			● / ▽	▽ / ▽	▽ / ▽	● / ▽		▽ / ▽		● / –		▽ / –		▽ / –				▽ / ▽	● / ▽	● / ▽	● / ●	● / ●	● / ●	● / ●
WATER QUALITY	● / ▽		● / ▽	● / ▽	● / ●	● / ▽							▽ / –					▽ / ▽	● / ▽	● / ▽	● / ●	● / ▽	● / ▽	● / ▽
WATER QUANTITY /HYDRAULICS	● / ▽		● / ●	▽ / ▽	● / ▽	● / ●		● / ▽		● / ●		● / ●		▽ / ▽				● / ●	● / ▽	● / ●	● / ●			
AIR QUALITY/NOISE	✸ / ▽		✸ / –	✸ / –	✸ / –	✸ / ▽													✸ / –	✸ / –	✸ / ▽			
SOCIAL/WATER USERS			● / ▽	✸ / –	✸ / –	● / ●		▽ / ▽		● / –		● / ●						▽ / ▽	● / ▽	● / ●	● / ●	● / ▽	● / ▽	● / ▽
WATER MANAGEMENT -LAKE LEVELREGULATION GLWQ AGREEMENT	● / ▽		● / ▽	▽ / ▽	● / ▽	● / ●		● / ▽		● / ●		● / ●		▽ / ▽				▽ / ▽	● / ▽	● / ●	● / ●	● / ▽	● / ▽	● / ▽

✪ UPPER LAKES SECTION ☆ INTERCONNECTING CHANNELS (MIDDLE) SECTION ★ LOWER SECTION

SEVERITY OF ADVERSE EFFECTS

	EFFECTS: SHORT TERM (TEMPORARY)	LONG TERM
POTENTIALLY SIGNIFICANT	●	● (large)
UNKNOWN EFFECTS OR SIGNIFICANCE	▽	▽ (large)
MINOR EFFECT	✸	✸ (large)

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K. Ogilvie	(RSCC Chairman, RDG's Office)
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G. McKee	(Parks/OR)
L. Kamp	(IWD/OR)
T. Allsop	(AES/OR)
J. Smith	(EPS/OR)
A. Ellis	(IWD/HQ)
J. Moening	(IWD/HQ)
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1. INTRODUCTION

The Great Lakes - St. Lawrence Seaway, a 3770 km navigable waterway extending from the western shores of Lake Superior to Anticosti Island in the Gulf of St. Lawrence, provides a major transportation route linking mid-North America with the Atlantic Seaboard and many trans-oceanic ports (Figure 1).

1.1 Elements in the Waterway System

The GL-SLS section between Anticosti Island and Montreal is open for year round navigation and has the capability of allowing the transit of vessels with a draft of 10.7m (35 ft.). Between Montreal and Lake Ontario, there are 7 locks which lift vessels approximately 67m (220 ft.); five are owned and operated by the Canadian St. Lawrence Seaway Authority (SLSA), two by the U.S. St. Lawrence Seaway Development Corporation (SLSDC). Vessels traversing this section are limited to a length of 222.5m (730 ft.), width of 23m (76 ft.), and a draft of 7.9m (26 ft.). A major hydro-electric development of Quebec Hydro exists near the Beauharnois Lock while Ontario Hydro and the New York Power Authority have major facilities near Cornwall, Ontario.

The Welland Canal section of the seaway allows vessel movement over the 43 km (27 mi.) between Lake Ontario and Lake Erie. Along the Canal which is owned and operated by the SLSA, there are 8 locks (3 of which are twinned) that lift vessels approximately 99m (325 ft.) into Lake Erie. The locks at the Welland Canal measure 244m (800 ft.) long and 24m (80 ft.) wide, with depth at sill being 9m (30 ft.).

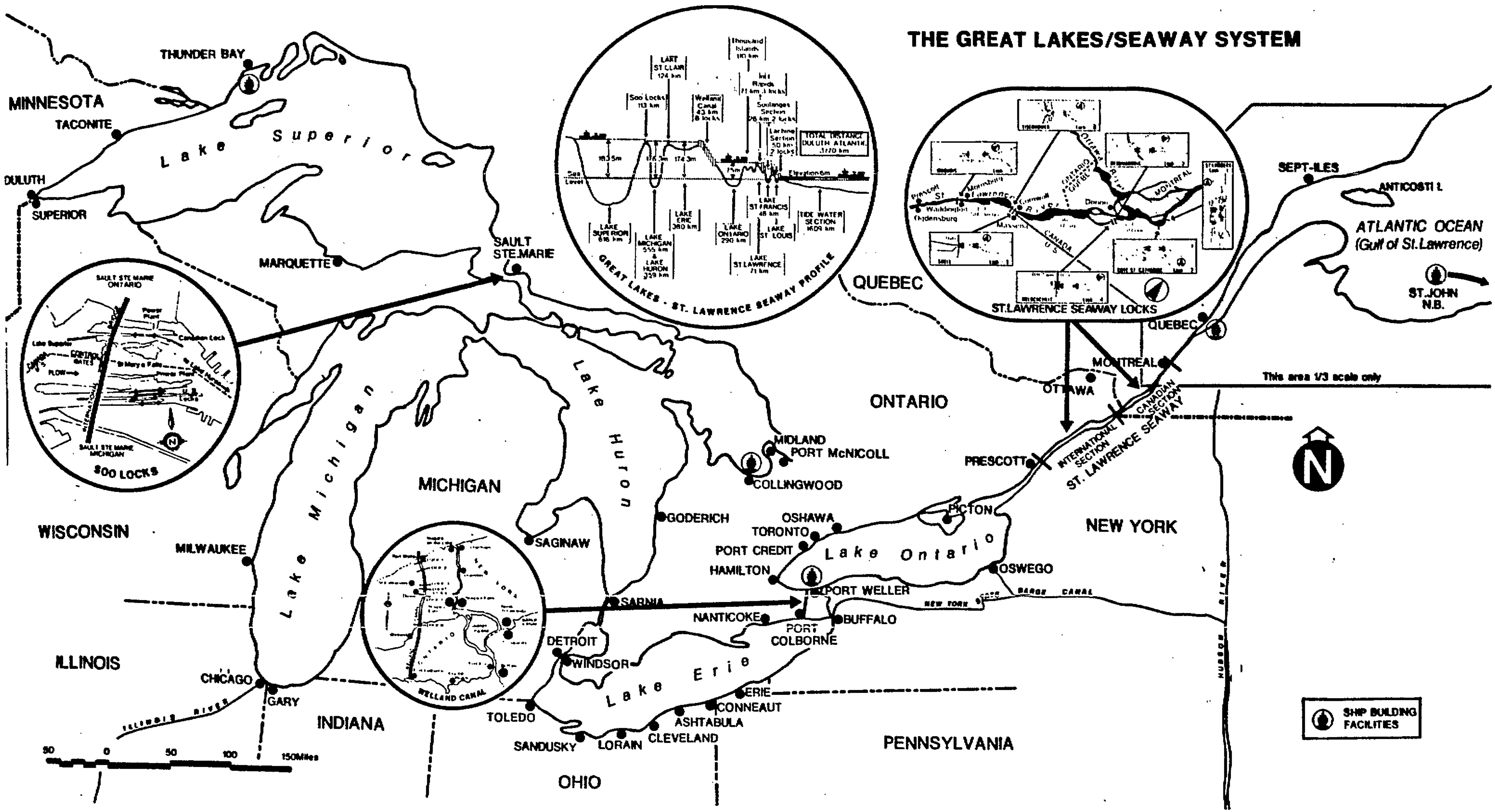

FIGURE 1. Location Map

Channels (Detroit River, Lake St. Clair, St. Clair River) between Lakes Erie, Huron, and Michigan contain no locks and allow access for vessels with a 7.9m (26 ft.) draft. Access into Lake Superior is through the St. Marys River and via 4 U.S. locks and one Canadian lock at Sault Ste. Marie. The Canadian lock, operated by Parks Canada, is limited to shallow draft and narrow vessels. Two of the U.S. locks allow less than 7.9m (26 ft.) draft. The newer U.S. Poe Lock can accommodate vessels of 305m (1,000 ft.) length and 32m (105 ft.) width. The U.S. locks are operated by the U.S. Army Corps of Engineers (USACE).

1.2 Navigation Season Extension Background

The duration of the navigation season on the Great Lakes - St. Lawrence Seaway above Montreal is limited each year by the development of winter ice (Figure 2) and harsh weather conditions. Historically, the navigation season in Lake Ontario - St. Lawrence River spans an 8 1/2 month period from April 1 to December 15, varying somewhat as ice and weather conditions permit. Elsewhere on the navigation system, it is possible to continue vessel movements through December 31 (Soo Locks now operate to January 8 ± a week). With the exception of intra-lake shipping only, all vessel traffic traditionally ceases after this date, because ice conditions in the connecting channels and canals of the Seaway preclude further system-wide navigation. Until recently, petroleum products were shipped by tanker during winter months from Sarnia to various ports on Lake Huron and Georgian Bay. The amount of this shipping is decreasing, however, due to economic conditions (EPS, 1984: correspondence).

Soon after the opening of the GL-SLS in 1959 and the addition of larger ocean-going vessels to regular lake traffic, the capacity of the waterway to accommodate increased commercial shipping activities came under questioning by port, shipping, and industry interests. A further development - that of the taconite pellet, which enabled the steel industry to utilize vast quantities of low grade ore and which could be

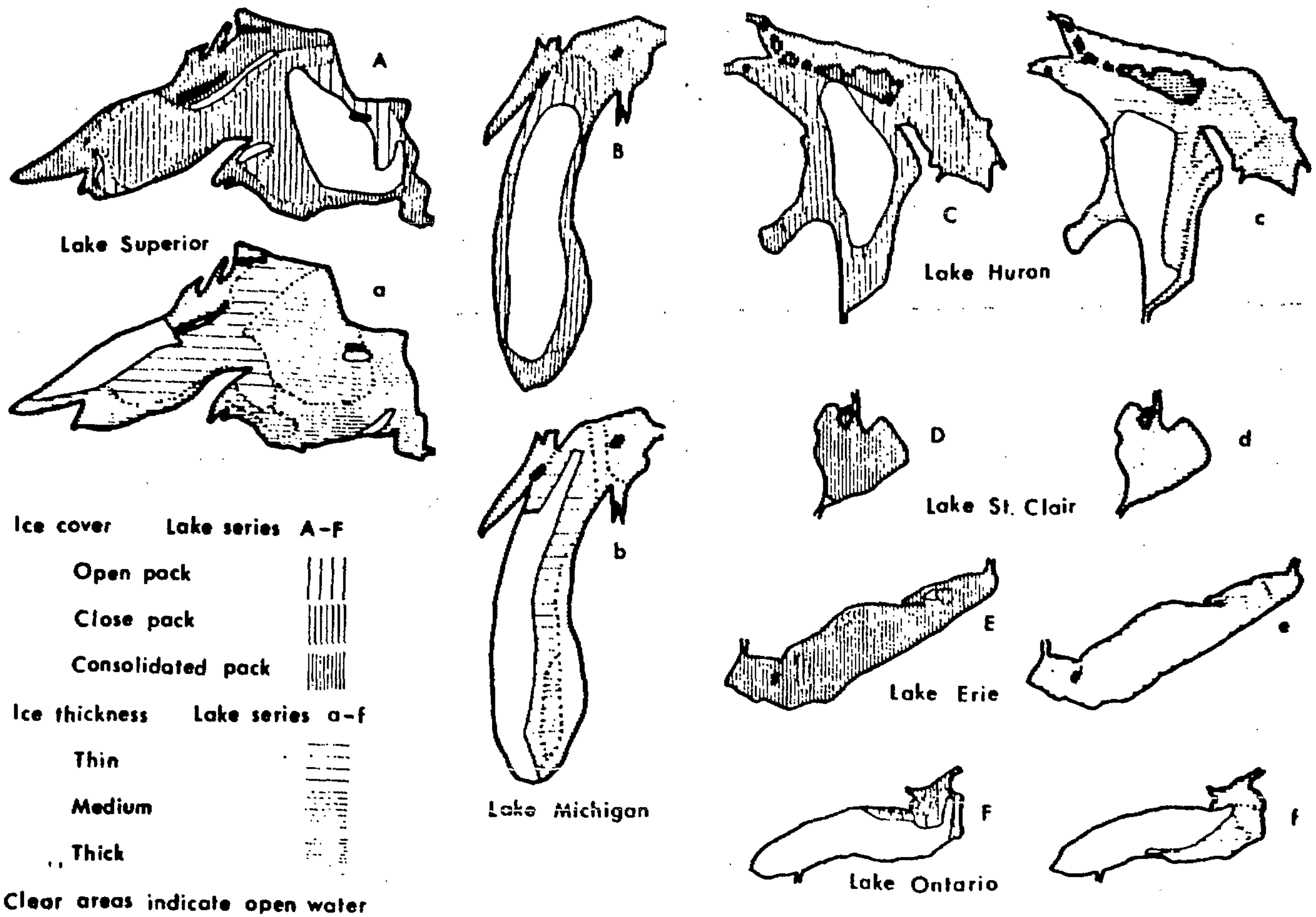

FIGURE 2. Ice conditions on the Great Lakes. Figures A - F indicate maximum cover during a "normal" winter while a- f, ice thickness on Feb. 13, 1977. (Source: Niimi, 1982, after Quinn et al., 1978)

handled in winter without freezing, prompted the steel industry also to vigorously support an expansion of shipping capacity. Since the annual termination of commercial navigation on the GL-SLS was seen to be a constraint on capacity expansion, its extension was considered an obvious means of achieving increased traffic capacity without incurring the tremendous capital costs associated with lock and channel enlargement.

In 1965, the United States Congress authorized the U.S. Army Corps of Engineers (USACE) to undertake an investigation of the technical and economic feasibility of season extension. The first Survey Report on Great Lakes and St. Lawrence Seaway Navigation Season Extension, released late 1969, identified some of the problems and benefits to be derived from winter navigation. The report generated considerable interest among local port authorities, certain shipping interests and government. This favourable response prompted the USACE to recommend that a full survey study on navigation season extension be undertaken.

In 1970, the U.S. Congress approved Public Law 91-611 under the Rivers and Harbours Act which authorized the USACE to conduct a further 3-year study on the feasibility and effects of winter navigation. The study was extended in 1974 and 1976 under the Water Resources Development Act. A major undertaking of the study was the demonstration program wherein actual field trials of winter navigation were carried out.

A Winter Navigation Board was created in 1971, from representatives of federal, state, public, and private interests, to provide advice and guidance to the USACE. Part of the Board consisted of work groups responsible for coordinating activities dealing with engineering, economic and environmental aspects of the project. Canada was represented as an observer on the Board by the St. Lawrence Seaway Authority, the Canadian Coast Guard and the International Joint Commission (IJC).

Numerous interim reports were released by the USACE and the Winter Navigation Board throughout the eight-year Demonstration Program. After the conclusion of the program in 1979, the USACE assimilated the data and information gathered during the study into a six volume report entitled, Final Survey Study for Great Lakes and St. Lawrence Seaway Navigation Season Extension. The report recommended that it was engineeringly and economically feasible to extend navigation on a year-round basis on Lakes Superior, Michigan, and Huron, up to year round on Lake Erie, and up to 10 months on Lake Ontario and the St.Lawrence River for the U.S. portion of the system. Measures used to achieve these objectives would include fairly extensive use of air bubblers and ice booms to control the formation and movement of ice, lock modifications, ice breaking activities, channel dredging, and improved winter navigation aids and traffic control. The report also proposed that winter navigation season extension be phased in over geographic area and time, according to future increases in capacity demand. TABLE 1 indicates the implementation phases for season extension on the GL-SLS, while APPENDIX 1 provides a more complete listing of required implementation activities.

According to the USACE Study, phasing would take place in conjunction with an "adaptive" approach to environmental assessment. After project authorization, environmental studies would be conducted as necessary before particular project phases were initiated. The objective of this approach was to identify environmental impacts and gather environmental baseline data, while allowing project planning and construction activities to continue (USACE, 1979). A program of environmental studies, integrated with an engineering schedule, was outlined in the Environmental Plan of Action (EPOA) prepared by the U.S. Fish and Wildlife Service (USACE, 1979). Should adverse environmental impacts be identified, mitigative procedures would be applied or the particular activity causing the impact would be halted. The integrity of this approach became a highly contentious issue with environmentalists, who feared that the project would not be halted once authorization was granted.

The USACE report recognized that a formal agreement with the Government of Canada would be required for any extension of the project on the GL-SLS beyond U.S. territorial waters of the upper three Great Lakes. It was also noted that critical sections of the system such as the Welland Canal and a major portion of the St. Lawrence River are entirely within Canada. Although Canada was never formally approached with the navigation season extension proposal, the USACE implied eventual Canadian participation in its derivation of project costs. It was assumed that the U.S. would pay 100% of all improvements solely within U.S. territorial boundaries, and 50% of the total costs for improvements bridging the international boundary. Similarly, it was assumed that Canada would pay all costs for improvements within its territorial boundaries, and 50% of the costs of improvements bridging the international boundary. Canadian investigations regarding winter navigation are further discussed under section 2.2.

TABLE 1. GREAT LAKES WINTER NAVIGATION SEASON EXTENSION - EXTENSION PHASES

	UPPER LAKES (SUPERIOR) HURON, MICHIGAN) & ST. MARYS RIVER	ST. CLAIR RIVER, LAKE ST. CLAIR, DETROIT RIVER, LAKE ERIE	WELLAND CANAL LAKE ONTARIO & ST.LAWRENCE RIVER
NAVIGATION SEASON STUDY BASE CONDITION:	1 Apr.-31 Jan.(±2 wks)	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-15 Dec. 1 Apr.-31 Dec. (Welland)
Existing Condition:	1 Apr. - 8 Jan. (± 1 wk)	1 Apr. - 31 Dec.	(Same as above)
Proposed Implementation Phases:			
- Phase I	Year Round	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-15 Dec.
- Phase II	Year Round	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-31 Dec.
- Phase III	Year Round	Year Round	1 Apr.-31 Dec.
- Phase IV	Year Round	Year Round	20 Mar.-31 Dec.
- Phase V	Year Round	Year Round	7 Mar.-7 Jan.
- Phase VI	Year Round	Year Round	7 Feb.-7 Jan.

2. STATUS OF WINTER NAVIGATION PROPOSAL

Following completion of the USACE (Detroit District) Final Survey Report on Navigation Season, this report and other related background information and data were reviewed by the Board of Engineers for Rivers and Harbours, U.S. Department of the Army (prior to transmittal to Congress). In March 1981, the Review Board released its findings, among which were:

1. that season extension in the U.S. was primarily an operational matter for which responsible agencies already have adequate authority (although specific measures may require additional authority and resources);

2. that the USACE continue further environmental and other analyses of the 1 April to 31 January ± 2 weeks season on the upper four Great Lakes under present operational programs;

3. that navigation season extension of up to 10 months on the GL-SLS (7 March to 7 January) and extending to about 10 3/4 months (7 March to 31 January ± 2 weeks) on the upper four Great Lakes was economically justified, contingent upon appropriate Canadian cooperation and support (which should be actively pursued by the U.S.);

4. that an additional extension to year-round navigation on the upper Great Lakes appeared marginally economically feasible on the face of existing information (i.e. economic analysis was not sufficient to determine merit of additional extension); and

5. that the "Adaptive Assessment Technique" and "Environmental Plan of Action" proposed were not acceptable for the project and that a conventional predictive-type environmental impact statement to assess environmental problems and solutions should be prepared prior to plan implementation.

The Board of Engineers for Rivers and Harbours also concluded that the Detroit District USACE's report contained insufficient information to establish whether or not a 1 or 1 1/2 month extension of the navigation season, under average winter conditions, posed an unacceptable environmental risk. The Board, therefore, recommended additional study to provide a proper assessment of environmental concerns, particularly for the St. Lawrence River.

In March of 1982, the Chief of Engineers, U.S. Department of the Army, transmitted the USACE and Review Board reports to the Secretary of the Army. The Chief of Engineers essentially reiterated the findings and recommendations of the Board of Engineers for Rivers and Harbours, noting in particular, that the implementation may be accomplished incrementally, both with respect to the length of season and geographical scope of season extension. However, contrary to the Board's recommendation against adaptive environmental assessment, the Chief indicated his support for it and the concept of environmental reports being prepared on an incremental basis (Bratton, 1982: letter of transmittal).

2.1 Current U.S. Debate

With the closing of the Soo Locks on December 31, 1981, and the failure of the U.S. Congress to authorize further funds for extended season winter navigation, the project came to a standstill. This standstill was temporary, however, from the perspective of any visible action taking place on winter navigation. In early August 1983, the U.S. House Committee on Public Works and Transportation unanimously voted for winter navigation in Bill HR-3678, "The Water Resources, Conservation, Development, and Infrastructure Improvement and Rehabilitation Act of 1983". Section 1123 of the $12 billion water projects bill, written by Minnesota Congressman Arlan Stangeland, called for the extension of winter navigation on the GL-SLS substantially in accordance with recommendations made in the 1979 report of the USACE.

Many Great Lakes congressmen who opposed winter navigation were not aware that the House Committee had taken up the project until after the fact. This sparked some members of the U.S. House of Representatives to organize public meetings in an attempt to rally opposition among local politicians, public and business interests on both sides of the U.S.-Canada border. By the end of 1983, Congress had adjourned without acting on the measure but in late June 1984, Congress deleted the winter navigation season extension amendment from its 1983 Omnibus Water Resources Bill.

2.2 Canadian Action on the Winter Navigation Issue

Since the inception of the U.S. initiative on winter navigation, Canada has never been formally approached either for support, cooperation, or indication of concerns. Numerous interested federal and provincial agencies have, nonetheless, followed closely developments on the U.S. side and have frequently been involved as observers or participants in related committees (eg. Ontario Ministry of Natural Resources - U.S. Fish and Wildlife Service meetings to develop Environmental Plan of Action; St. Lawrence Seaway Authority and Canadian Coast Guard - U.S. Winter Navigation Board).

While not cast as a formal position, Canada has generally maintained the view that winter navigation season extension, given existing economic conditions, was not justifiable from the perspective of Canada; environmental considerations, aside. The traditional navigation season with flexibility in opening and closing dates dependent on winter condition severity was seen to be sufficient to meet Canada's needs. In the spring of 1978, the Canadian SLSA commissioned a feasibility study of winter navigation in the Lake Ontario - St. Lawrence River section. The consultant's report (LBA Consulting Partners, 1978) concluded that firming up an 8 1/2 month season could be easily achieved, but that a 9 1/2 - 11 month season was not economically advantageous to Canada.

Confronted with the prospect of passage of the 1983 Omnibus Water Resources Bill calling for phased implementation of navigation season extension, Canada indicated its formal position on the project. Environment Canada's presentation before the Canada/U.S. Legislative Panel on GL-SLS Capacity on September 16, 1983 laid the basis for the formulation and transmittal of a diplomatic note from the Canadian Embassy in Washington to the U.S. State Department. The note cited Canada's position that:

1. a number of questions must be addressed prior to any decision on implementation of navigation season extension including the recognition by the 1979 report that a formal agreement with Canada was required for any extension beyond the upper three Great Lakes;

2. the possibility of significant adverse transboundary effects must be addressed through a thorough and system-wide environmental impact assessment prior to implementation of any proposal (including demonstration projects);

3. season extension was only one of several options to deal with capacity problems;

4. there were no parallel plans on Canada's part to extend the navigation season due to indications of poor economic justification, very limited expression of Canadian industry interest and support, and current under-utilization of seaway capacity; and

5. Canada was focusing its efforts on improving the utilization of the existing season through such means as infrastructure modification on the Welland Canal and improved traffic control systems.

The Canadian Embassy requested the U.S. State Department to relay these views for consideration by Congress in its deliberations on the proposed navigation season extension.

2.3 Other Canadian Involvements

As early as February of 1976 a proposal was put forward to the Canadian Marine Transportation Administration by the St. Lawrence Seaway Authority. This proposal called for a gradual extending of the season by a 3-phase program over approximately 10 years:

1) firming up the present season (April 1 to December 15);

2) extending season to December 31; and

3) opening season earlier, on March 15.

At that time estimated costs for the program which consisted of structures, modifications, improvements, and ice breaking operations were $19.3 million capital and $1.6 million O & M. The SLSA budgetted for the availability of these funds, in the event of approval of a Canadian program, and held discussions with its U.S. counterpart, the SLSDC to develop coordinated action particularly for phases 2 and 3 where international cooperation and cost-sharing was required.

Formal approval of the Canadian program is not evident through the documentation available. However, the SLSA released a position paper on navigation season extension in August, 1983 at about the time the 1983 Omnibus Water Resources Bill passed the U.S. House Committee on Public Works and Transportation. This statement indicated that a $7.4 million dollar program of studies and improvements carried out by the SLSA (since 1965) had resulted in a reliable operation during the April 1 to December 15 season (8 1/2 months). An ice boom at the Lake St. Francis entrance to the Beauharnois Canal and man-made ice retention islands in Lake St.

Louis were completed in 1982, contributing significantly to improved lake/canal conditions during opening and closing periods of the 8 1/2 month season. The statement also indicated that work was continuing on the development of an acceptable electronic navigation system necessary to achieve full utilization of the present season (SLSA, 1983).

While no direct reference is made to the 1976 proposed program in the SLSA position paper, it quite clearly echoes the completion of implementation of measures identified with phase 1 of the program. The SLSA position paper further concludes that an extension of several weeks to about 9 1/2 months could be achieved relatively modestly at a cost of $42.5 million, but that detailed studies, cost-sharing agreements, and a lead time of some five years would be required.

2.4 International Joint Commission Involvement

The International Joint Commission (IJC), established by the Canada/U.S. Boundary Waters Treaty of 1909, is one of the mechanisms utilized by the two countries to provide advice and assist in the resolution of transboundary issues which stem from their actions or those of their citizens. There were clear indications that transboundary water level and flow and environmental impacts would result from the U.S. winter navigation proposal. The IJC was not asked by either government to review related concerns.

In 1979, during Public Hearings on the Pollution from Land Use Activities Reference Report, the IJC noted expression of public concern about the environmental effects of navigation season extension on the GL-SLS, particularly the effects of changes that may occur in the levels and flows of the connecting channels and water quality. Both governments were notified the review of such impacts fall within IJC responsibilities in terms of water level regulation and the Can./U.S. Great Lakes Water Quality Agreement. The IJC requested a preliminary investigation of water quality impacts from the Great Lakes Water Quality Board and intended to consult with the Great Lakes Science Advisory Board.

However, there was insufficient information in the USACE reports even for a preliminary review of water quality effects. In late 1979, the USACE Navigation board mandate ended and the study was put in abeyance. Since nothing further was to be done that might affect the IJC's jurisdiction over lake regulation or water quality, there was, in fact, no reason the the Commission to study problems that would not likely occur.

3. ENVIRONMENTAL CONCERNS AND ISSUES

Studies conducted during the USACE Demonstration Program identified a multitude of potential and observed environmental impacts or concerns, which were derived from winter navigation and support activities (see Winter Navigation Environmental Effects Matrix, Appendix 2). These activities would be widely dispersed throughout the lakes, connecting channels, harbours, canals and locks of the entire navigation system. Although specific environmental impacts of the various activities have been identified, they are only part of a much broader environmental issue - the lack of baseline data with which to compare environmental quality after the project is initiated. This information gap has been and continues to be a serious deficiency in the results of the Demonstration Program. The credibility of the USACE conclusion that season extension can be achieved in an environmentally acceptable manner, is undermined by this weakness (USACE 1979). The problem is made more acute by the fact that the USACE has proposed to gather the required data by conducting environmental studies as the project is phased into operation (U.S. Fish and Wildlife Service, 1979 Crossland, 1981). Significant environmental damage could occur before being recognized. Even the IJC has expressed concern that major programs such as this, once underway, are extremely difficult to stop if adverse environmental impacts are later discovered (IJC Correspondence; July, 1979).

The lack of baseline data is a critical deficiency which has been identified repeatedly by reviewers of the navigation season extension proposal, citing numerous state, federal, and international agency statements. The U.S. Fish and Wildlife Service, for example, recommended a three-year moratorium on extending the season so that environmental baseline studies could proceed without interference. The Michigan United Conservation Club (MUCC) 1983, "Great Lakes Crisis: Winter Navigation Information Kit", cites further opposition and concern over lack of data and the inability to make an informal judgement on environmental impacts until comprehensive baseline data had been gathered and evaluated.

Very little is currently known about the natural environment of the GL-SLS during winter months. Given current information deficiencies it is questionable whether true impacts can be predicted. Furthermore, present means of mitigating the impacts which may be predictable are inadequately developed. Undertaking navigation extension without prior knowledge and adequate mitigative measures could cause irreversible environmental damage. The absence of baseline data will make it extremely difficult in the future to specifically demonstrate that damage or widespread, long-term impacts (for example, progressive degradation of submergent vegetation in shoreline marshes) has resulted from winter navigation practices (CWS correspondence; 1983).

In making the decision to increase the carrying capacity of the GL-SLS, there are likely three options that could be considered. The first option, extension of the navigation season beyond the mid-December closing date would be the most immediate measure to partially achieve this objective. A second option would be to conduct improvements on the GL-SLS to accommodate larger vessels and yet maintain the existing navigation season. The third option would combine both season extension and system improvements (Niimi, 1982). It can be argued to some extent that action on both of the first two options has been progressing over the years in the U.S. and in Canada, notwithstanding any formal or visible commitment to a given option. Thus, <u>de facto</u>, the third option appears to really be the one elected and more evident in the piecemeal implementation measures undertaken to date.

Given the geographic scope of the GL-SLS and the planned "phased-in" approach to navigation season extension, a closer examination of specific concerns and issues which follows can be addressed by considering 3 components of the GL-SLS system:

(i) upper lakes (Superior, Michigan, Huron) and the St. Marys River (Upper Lakes section);

(ii) interconnecting channels (St. Clair River, Detroit River) and Lakes St. Clair and Erie (Middle Interconnecting Channel section); and

(iii) Welland Canal, Lake Ontario, St. Lawrence River (Lower section).

For the most part, it is expected that areas most sensitive to winter navigation effects would be the interconnecting channels (St. Marys River, St. Clair River, Detroit River) and the St. Lawrence River by virtue of the confined and constricted nature of these channel-ways and close proximity to vessel traffic.

Although the ensuing discussion will center on the 3 above defined sections, it should be clear that generally most potential environmental effects of winter navigation could occur virtually along any route in the GL-SLS. Thus, in some cases the discussion of expected effects, such as on water quality, can equally relate to other sections of the GL-SLS. The difference in possible magnitude and severity would be dictated by local environmental conditions and sensitivity. By the same token, the duration of winter navigation operations and required system improvements could bear significantly on the frequency and severity of impacts. For example, the difference in potential effects resulting from year-round navigation compared to 10 3/4 months could depend mainly on differences in the number or amount of vessel transits. A 10 3/4 month season would allow ice formation and winter recovery for biological resources. This would not be likely under a 12 month season. However, to achieve either extension, the same system modifications and associated measures (such as dredging, ice boom operations, etc.) may have had to take place with their attendant effects.

3.1 Winter Navigation Activities and Environmental Effects

As prelude to discussions of the sensitivities of the three GL-SLS segments to winter navigation activities, it is helpful to consider the environmental effects associated with winter navigation in general. The following information provided is generic in nature and would apply to vessel transit routes and other activity locations as identified in Appendix 1.

3.1.1 System Modification Effects

Dredging of channels and harbours will be necessary to ensure that maximum Seaway draft is maintained throughout the winter and to reduce water velocity as an ice control method. Dredging may cause significant but temporary nutrient loading of the immediate activity area. If the disturbed sediments are highly organic, there will be a decrease in the dissolved oxygen content of the surrounding waters. Increased nutrient loading and lower dissolved oxygen levels could also be expected at open water dredge spoil dump sites. Such dumping may, however, create favourable biomass production and soft bottom habitats in oligotrophic water bodies.

In addition to the potential resuspension and redistribution of toxic contaminants and nutrients which can ultimately affect the abundance and edibility of certain fish species, dredging poses a serious threat to aquatic vegetation through the direct removal of the plants and siltation of leaf surfaces. Secondary impacts of removal include destruction of the aquatic habitat and disruption of the food chain. The settling of resuspended sediments on leaf surfaces could decrease productivity by interfering with photosynthesis and nutrient absorption.

In terms of benthic organisms, dredging can either result in the immediate death of the organism or its displacement. Dredging causes a rapid and drastic alteration of the water-sediment interface. If benthos survive the initial dredging, they may be unable to adjust to the radically altered environment, resulting in death. Open water disposal of dredge spoil can kill or disturb benthos by burial. Benthos are a major food source for many fish and wildlife species and are key elements in many food chains. If the impacts of winter navigation on benthos results in substantial population reductions, then the secondary impacts on terrestrial carnivores, fish and birds such as gulls, herons, ravens, grebes, crows and cormorants could be disasterous.

It has been suggested that dredged navigation channels may serve as migration routes or places of refuge for benthic organisms during periods of prolonged, extreme cold (USACE, 1979). The activities of an extended season would disturb this environment, which normally would remain stable during the winter. High mortality would be likely to result from habitat disturbance at this time of year.

Long-term impacts related to modification of bottom geometry in areas of dredging may result in pools of stagnant water or in increased flushing time for polluted waters. Noise, physical presence of equipment, changes in water quality may disrupt fish migration patterns, interfere with spawning and result in the smothering of eggs and burial of spawning grounds. The removal of natural shelters including macrophyte beds and reefs by new dredging activities would act to reduce the availability of spawning, feeding and nursery areas. Such changes occurring at lower trophic levels will have adverse impacts on fish and may ultimately decimate a fishery.

Construction of structures such as locks, compensating works and breakwaters have their attendant environmental effects. The operations of heavy equipment and creation of dust may pose temporary deterioration of air quality. Short-term impacts on local water quality conditions would be similar to those associated with dredging (perhaps less severe but of longer duration). Changes in water flow patterns, however, could drastically affect the local aquatic environment. Fixed compensating works, for example, could result in areas of dead water immediately downstream of the structures. New circulation patterns may cause erosion or deposition of sediments, altering the suitability of some areas for certain species and resulting in changes in species composition.

Compensating works and shore protection limit the range of water level fluctuations which are vital to the maintenance of wetlands. A reduction in the area of inundation will cause loss of spawning, nursery and feeding habitat. Regulation of water levels may not permit deeper water wetlands to dry out, reducing forage production which would be utilized by fish fry during high water levels. If compensating works do not permit inundation of wetlands during fall, then the fish feeding area is significantly reduced, and fish may enter the winter season in poor physical condition.

Changing current patterns induced by dredging or compensating works could reduce aeration to fish eggs or create currents too swift for egg stabilization. Rip-rapping and other shore protection measures will reduce the water flow into wetlands, reducing aeration and cleansing ofthe wetland environment. This would make the wetland habitat unsuitable for spawning and rearing activities. Low downstream water levels, caused by vessel induced ice jamming, may reduce the spawning habitat of northern pike and other spring spawners.

The impact of noise generated by dredging, construction, icebreaking and vessel activity is a function of the activity locations and time of occurrence. The tolerance or acceptability of the noise depends on its decible level and duration. The impacts of excessive and prolonged noise can be reflected in the physical and mental health of an individual, and the aesthetic appreciation of an area.

The noise from dredging and construction would be a temporary annoyance to residents adjacent to lake, harbour or channel shorelines. The proper timing of the activity would reduce or eliminate the impact. The least number of residents would be exposed to noise if construction and dredging were conducted during the fall, winter or spring, when most people have closed their cottages for the season. This mitigative procedure does not provide a reprieve for permanent shoreline or island residents.

3.1.2 Effects of Vessel Operations

Explosive liquefaction is a phenomenon resulting in the resuspension of bottom sediments by a sudden pressure release on the channel bottom. This sudden pressure release is caused by a moving trough of water, which is produced by the passage of large, heavily loaded vessels. Although this is not strictly a winter navigation phenomena, the frequency and magnitude of the occurrence is greater in winter because of the need to overcome ice fields. The process results in increased turbidity near the lake or channel bed. An increase in the degree and duration of turbid conditions is also caused by high engine thrust propellor wash, from vessels and ice breakers operating in thick or dense ice. The turbulence created by this thrust resuspends sediments that would otherwise remain undisturbed.

Sinkage is another phenomenon that may contribute significantly to increased turbidity resulting from propellor wash. The occurrence of sinkage is aggrevated when a vessel uses high engine thrust to overcome an ice field. As the thrust increases, so must the volume of water that passes between the ship's hull and the channel's bed. This results in a pressure drop in the water beneath the vessel, causing it to drop down or "sink" closer to the bottom. The propellor is brought into closer contact with the bottom, causing a high degree of sediment resuspension.

In constricted waterways rapid fluctuations in water levels can be expected during passage of a vessel. With the water level drop associated with sinkage, a trough effect is created which extends across the channel and moves at the speed of the vessel. The water level surges beyond the normal water line and then returns to its previous level following vessel passage. In open water, the moving trough creates a pressure wave which resuspends and redistributes bottom sediment and exacerbates shoreline erosion. Under ice cover its effects are significantly increased because of resistance and the dissipation of force when waves intersect the shoreline.

A primary concern of winter navigation is the superimposition of water level surges on the fluctuation in lake water levels due to natural processes wherein levels gradually increase over the winter and peak during spring. Sudden changes in water levels due to vessel passage could be more damaging if phased with water level amplitudes occurring at the time (i.e. high water levels become higher, etc.).

Ice breaking and vessel passage cause a large number of ice pieces to break away from the sides of the vessel track. These pieces can be washed under the ice cover and carried away by the current, until they lodge and accumulate beneath the surface. The resulting ice dams have been observed to extend 30 feet or more below the surface. This hanging ice creates a major obstruction to channel flow and may cause upstream flooding, water level drop downstream, alteration of water current velocities and direction of flow. Breaching of a hanging ice dam can result in extensive flooding of the ice surface and adjacent shore zones. Shoreline areas already prone to erosion processes and also flooding are illustrated in Appendix 3.

Survey studies of river shorelines during the Demonstration Program, led the USACE to conclude that although ship passage had a significant impact on nearshore hydraulics, there was no relationship between winter navigation and shoreline erosion (USACE, 1981). The validity of this conclusion is questionable since the surveys were conducted only twice throughout a three year period. In the Final Survey Report the USACE states that disruption of the ice cover could amplify the natural impacts of the ice (USACE, 1979).

Damage to the shoreline by lattera1 ice movement, induced by vessel passage, has been difficult to assess. When vessels transit a turn in an ice-choked channel, a compressive force is exerted on the convex side of the turn, and a tension force is exerted on the concave side. The tension force creates a vacuum on the concave side, which is strong enough to pull ice away from the shoreline (USACE, 1973). If the ice is grounded, gouging and scouring of the shoreline will occur as the ice is pulled away. Any sediment at the ice-soil interface that was entrained within the ice mass during freeze-up, can be transported considerable distances in ice that has been broken away from the shoreline. Although the volume of sediment removed may be small, the process derives its significance from the slow rate at which these sediments are replaced by natural processes. The compressive force also causes the ice to fracture and pile up on the shore. If a beach or bank profile is steep severe erosion can occur as a result of gouging. Ice pile up on the shore may also result when a vessel or ice breaker pushes an ice field.

The accumulation of ice, fragmented by vessel or ice breaker transit, beneath the ice surface, may be sufficient to deflect the water flow onto a highly erodable channel bed or bank. However, the extent to which this occurs is not known and would be difficult to assess.

Ice breaking and vessel operations may result in structural damage to privately-, commercially-, and publically-, owned docks and recreational facilities. The amount of damage to occur in any given area is a function of the severity of weather and ice conditions, proximity of the shipping track to the shoreline and the frequency of ice breaker and vessel passage.

The behaviour of ice under the influence of drawdown and surge is responsible for most shore structure damage. Ice becomes attached to shoreline structures by freezing around pilings or floats. The pull of the ice away from the shoreline by the draw of a passing vessel can snap pilings, crush floats and pull the structure away from the shoreline.

Structures located on the convex side of a turn in a constricted channel can be dislodged and crushed by the push of ice onto the shoreline. Boat houses and docks are particularly susceptable to this type of damage, which is indirectly caused by the tension and compression forces created by vessel transit. Ice movement after vessel passage - that is, wind -driven ice push, may be more significant than movement induced by vessel passage itself.

The noise generated by icebreaking and vessel activity could have a significant impact on permanent shoreline residents, since the noise would be occurring in addition to that which is heard during the regular season. Traditionally, the winter would be a noise-free period for these residents. Additionally, vibrations originating from vessel or icebreaker operations, can be transmitted and felt on shore. The method of transmission is unknown, but it is partially a function of the characteristics of the ice cover. The vibrations can vary from a minor annoyance to severe shaking, strong enough to crack walls in shoreline residences.

The land and water habitats are utilized by a wide variety of wildlife forms for feeding, breeding, migration and shelter. Restrictions on the amount of available food, high metabolic energy consumption and harsh weather conditions make winter a stressful season for most wildlife forms. Another stress on waterfowl and shorebirds will be the energy expended while fleeing from the disturbance of passing vessels. Most of a bird's energy is utilized during the search for food at this time of the year. The physical stress of fleeing will consume energy that would otherwise be used for feeding activities.

Concern has been expressed about the impact of icebreaking and vessel transit on the activities and movements of terrestrial mammals (Crossland, 1981 and USACE, 1981). The impacts of the inability of wildlife to freely cross the river channels of the navigation system have not been thoroughly studied. The ability to cross frozen water surfaces may be an important factor influencing the distribution of some species.

It may also be the limiting factor on range expansion to compensate for seasonally low supply of food and shelter resources. The red fox and the coyote cross ice covered channels by mid-winter to search for food resources. Disruption of the ice cover may cause a decline of species density on off-shore islands and may alter the migration and feeding behaviour of mammals that remain active throughout the winter (USACE, 1979). Drownings of larger mammals (deer, moose) are likely to occur if they attempt to cross freshly broken ice. Note that animal crossing studies have been limited to eastern Lake Superior, the St. Marys River and some sections of the St. Lawrence River. This represents only a small sampling of potential crossing sites.

Although navigation has an impact on benthos during the normal season, this impact is aggrevated and prolonged by winter navigation activities. Navigation influences benthic organisms by creating an unstable habitat. Habitat stability returns with the termination of the shipping season each December. If winter navigation is implemented, the temporary reprieve from habitat disruption is eliminated, creating an unstable benthic habitat almost year-round.

Explosive liquefaction, vessel squat and pressure surges are the most serious threats to benthic habitat stability. The sudden pressure release associated with explosive liquefaction on the channel bottom, causes the bed to quake and suspend bottom materials, including benthic organisms. If off-shore currents displace the suspended mass to waters with a significant temperature change, the thermal shock may be sufficient to kill the benthos. Pressure surges under the ice cover have been observed to expel benthic organisms as well as sediment, aquatic vegetation and small fish, onto the ice surface through pressure cracks (USACE, 1979). Studies on this impact have been limited to the St. Marys River. Vessel squat disrupts the benthic habitat through resuspension of sediments and direct displacement of actual organisms. The settling of suspended sediments can bury benthos and alter the morphology of the bottom habitat.

The benthic habitat is also subject to disruption by the action of ice on channel beds. The drawdown effect of a passing vessel brings ice into direct contact with the bottom. The scouring action of the ice can crush or displace benthos and destroy their habitat. The disruption of the ice cover on upstream lakes may contribute to ice scouring on constricted channels downstream, posing a threat to benthic communities.

Extended season navigation would result in interference by ice and vessels with traditional cross-channel modes of transportation - ferry service, walking and snowmobile. The reliability of ferry service and the ease with which crossings can be made by any mode, would be reduced because of variable ice conditions and the greater potential for equipment damage to occur.

Traditional recreational use patterns could be disturbed by the increased hazard of unstable, cracked or thin ice adjacent to navigation channels. Recreational activities which are likely to be influenced by ice conditions include: hockey, skating, walking, skiing, snowmobiling and ice fishing. Damage to or loss of shoreline recreational facilities can likely result from ice action, ice jam flooding and aggrevated shoreline erosion. The liability for such damages has been a major public issue, arising from damages caused by Demonstration Program activities. Mitigation procedures to reduce shoreline erosion and shore structure damage may decrease the aesthetic value of shoreline areas.

3.1.3 Ice Control Measures

The use of an air bubbler system to control ice has been proposed for Whitefish Bay, Birch Point, Middle Neebish Channel, and Lime Island (USACE, 1979). The system has been described as an underwater pipe through which compressed air would be pumped to create a 12 inch "mound" or standing wave on the surface that would control ice movement (Timbrell, 1981). Its impact could be significant in terms of the alteration of water temperature profiles and possible disruption of fish movements. The installation of bubbler piping would likely destroy benthos and their habitat in the immediate area, although recolonization may occur if the disturbance is not continuous as would not be the case in or adjacent to navigation channels. A study on the environmental impacts of bubbler operation concluded that the population of benthic organisms increased at the bubbler sites (Environmental Evaluation Work Group, 1973). Although the exact cause of this increase was not discovered, it was proposed that higher oxygen levels at the lower depths was responsible.

Bubblers, combined with turbulence created by vessel passage could increase the duration and distribution of suspended sediments. Although more investigation is required, the disturbance of the water's thermal balance by bubblers is expected to be minimal. If thermal ice suppression does not cause the water temperature to rise more than 4°F, then there will be little effect on the water's ability to dissolve and hold oxygen. Oxygen levels may actually increase because of the absence of ice cover.

The proposed use of thermal effluent to reduce the thickness or prevent the development of an ice cover at strategic locations, could have an impact on fisheries. Fish will congregate at release sites where the temperature is best suited to their particular species. It is not known whether this is harmful or beneficial to fish populations. As a regular maintenance procedure, chemicals are used within cooling systems to prevent the growth of algae. This shock defouling necessitates the release of chemicals which may be toxic to some fish. Fish sensitive to these chemicals may be forced to flee the area and may suffer from thermal shock as they enter cooler waters. This could result in large fish kills during the winter.

The open water created by thermal ice suppression and bubblers may attract waterfowl to unproductive areas of water bodies. The higher demand on limited food resources may cause birds to seek out these open areas, only to suffer from more acute malnutrition. Propellor wash and pressure surges can reduce the amount of food available to waterfowl through the disturbance or removal of benthos and submerged vegetation.

3.1.4 Spills of Oil and Hazardous Materials

An important concern of winter navigation touches the greater risk of oil spills and hazardous chemical spills during increased shipping traffic under hazardous conditions. In the event of a spill the potential for containment or for clean-up is greatly reduced by the presence of ice and winter surface weather. There exists a joint Canada/U.S. Marine Pollution Contingency Plan which places the responsibility on the Coast Guards and ensures a coordinated response by both countries on spills in the GL-SLC. Canada is one of the leading countries in the field of oil/toxic material spill clean-up and containment, however, the technology to deal with spills under winter conditions, particularly under ice, is poor at best. The impact of a spill may be catastrophic because the material would not be readily recoverable and would spread downstream under ice along the shoreline. During early spring, inshore areas and flooded wetlands are utilized by fish, waterfowl, and some furbearers. Impact would likely be maximal because of large congregations at this time for spawning and mating (Niimi, 1982).

Direct mortality risks of waterfowl will be greater in winter where overwintering waterfowl are concentrated in open water areas. Even if the oil or toxic chemical spill does not occur in the open water area, materials may be transported under ice to such areas. Other effects of winter navigation (loose ice closing some open waters and concentrating birds elsewhere) and development (thermal discharges increasing local concentrations of overwintering waterfowl) may interact and greatly increase potential mortality rates.

Other wildlife species that overwinter in Canadian waters may be killed by spills. Also, the residual oils or other toxic materials remaining in wetlands after a winter spill may be "time bombs ticking away" until spring. Migrating birds that utilize aquatic or marsh habitats in spring may be affected. Mammals, reptiles, amphibians and fish that emerge from hibernation in these habitats or that congregate in them to breed could be killed. Reproduction may fail, especially for species with aquatic eggs and larvae.

An extended season will result in more oily vessel waste from normal ship operations being passed overboard. The amount of oil entering the system can be expected to increase in direct proportion to traffic growth (LBA Consulting Partners, 1978). This may result in decreased cleansing time and ecosystem stress during the spring, when wastes, accumulated over the winter, begin to degrade. Winter conditions would contribute to the difficulty of monitoring ship discharges, as required under terms of the Canada/U.S. Great Lakes Water Quality Agreement.

3.2 Upper Lakes Section

In this section of the GL-SLS, Canadian concerns with regard to winter navigation would primarily focus on the St. Marys River. Portions of the river have already undergone extensive alterations due to previous dredging for purposes of navigation, and water pollution problems persist in the upper reaches around Sault Ste. Marie, Ontario (source of industrial/municipal water pollutants).

According to USACE projections, development of the St. Marys River section would be the least costly since it contains only one series of locks and dredging cost is the lowest relative to other sections. This section has been open to extended winter navigation intermittently over the past few years and further development would be more beneficial to the U.S. rather than Canada due to access to Lake Michigan. However, heavy ice cover at the confluences of Lakes Superior, Huron, and Michigan would be important considerations on determining what measures are used (Niimi, 1982).

It is estimated that up to 3 million cubic yards of material in the St. Marys River would have to be dredged (USACE 1979). Past operations to deepen navigation channels in the St. Marys River have created artificially steep banks in many reaches of the river (USACE, 1975) and have thus, contributed to accelerating scour and shore erosion processes. In some cases, the disposal of dredged materials has involved the creation of barrier reefs or islands to protect neighbouring mainland shores from the wave wash of passing vessels. However, because these have not usually been adequately protected themselves, many have been severely eroded and contribute to the river sediment load. Concerns have also been expressed that dredging activities have affected the distribution of river flows around Sugar Island, a factor in continuing water quality degradation of the Lake George Channel (Bien et al., 1982).

Dredging in the St. Marys River may result in the exposure of bottom gravel areas which provide a favourable spawning habitat for sea lamprey. An increase in the population of this parasite could severely reduce lake whitefish and trout populations. Scientists engaged in long-term studies of the St. Marys River have found that previous dredging (1959) reduced the mayfly population. The insect was a major food source for many fish species and its reduction has already had a long-term impact on species density in the river (Crossland, 1981). There is also belief that, due to previous USACE projects over the last 80 years, the St. Marys ecosystem has been altered to the point that certain fish species no longer exist in the system and those that do are being stressed to the point of elimination (Gleason, 1983: pers. communication).

In July 1982, the USACE (Detroit District) released a preliminary feasibility study for connecting channels and harbours in the GL-SLS system. This report concluded that a second Poe-size lock on the St. Marys River was beneficial to effect improvements for commercial navigation. Although not allegedly connected with winter navigation, the proposal is difficult to keep separate as not facilitating the introduction of winter navigation. In addition to the lock construction, deepening the St. Marys River from the Vidal Shoals Channel (just upstream of the compensating works) to the Brush Point Course in Lake Superior is proposed (USACE, 1982). Deepening this section could result in a slightly higher head for downstream power plants on the St. Marys River. A larger, new lock at Sault Ste. Marie can be expected to facilitate the migration of sea lamprey which attaches itself to transient vessels (McCombie, 1968).

Studies conducted on the St. Marys River revealed that the drawdown of water from under the ice caused it to crack into large pieces and rest on the bottom. The surge that followed was observed to be one foot higher than the normal water level, and caused the ice pieces to shift violently upward and toward shore, gouging sediments in the process. As the surge rushed towards shore, the pressure it created was sufficient to widen the cracks which had developed during drawdown. The expulsion of bottom sediments and water through these cracks onto the ice surface or adjacent shoreline areas was observed to occur. During the study, the slope of the river bank remained stable, but the horizontal displacement caused by erosion was measurable (Environmental Evaluation Work Group, 1973).

St. Marys Falls, the Canadian shore at Sault Ste. Marie and along the North Channel have been identified as critical areas for wintering waterfowl. Sugar Island and the North Channel are critical areas for bald eagles, an endangered species in Ontario and in some States. Disturbance by ships could easily change this distribution and local feeding patterns. A positive factor may be the attraction of eagles to open water areas to prey on vulnerable waterfowl, despite their normal preference for a fish diet (Moenig, 1983: correspondence). Observations made during an extended season revealed that waterfowl and bald eagles, which traditionally frequented the navigation channel during the winter, fled at the site of on-coming vessels or avoided the channel at all times. A permanent extended season may result in long-term alteration of bird behaviour. Maintenance dredging, shoreline changes and changed flow distribution, through possible effects on water quality, may also affect prey species for migrating birds (CWS, 1983: correspondence).

Fishermen on the St. Marys River have reported a change in the species composition of their catches since the Demonstration Program was conducted. The catch of bass has declined, bullhead have disappeared from a three mile stretch adjacent to the navigation channel, no herring have been caught and perch has disappeared from the waters around Drummond Island. Fishermen have also observed sediments, resuspended by vessel passage, turn the water muddy for at least eight hours, miles from the navigation channel (Crossland, 1981). The impact of sedimentation may be more widely distributed than was first anticipated.

It is thought, from the analysis of limited data, that there is a significant increase in the quantity of macro-invertebrate drift under the ice cover, during vessel passage. However, a study on macro-invertebrate drift in the St. Marys River failed to identify what effect this drift would have on the food chain in the St. Marys River.

The St. Marys River - Little Rapids Cut ice boom has been in operation annually since 1976. Its installation was originally accomplished under the Navigation Season Extension Demonstration Program to prevent the massive ice run into the Little Rapids Cut from Soo Harbour and, at the same time, permit vessel passage. However, since then the USACE has argued its independent utility in reducing the possibility of ice jams, flooding, and power loss for hydropower plants, and the adverse effects of natural ice conditions on the Sugar Island Ferry. The USACE has maintained that the presence of the ice boom has not adversely altered the normal retardation of flow caused naturally by ice in the Soo Harbour and in and below Little Rapids Cut. The position of Canadian officials, nevertheless, has continued to be that the effects of the boom on levels and flow are still unknown and can only be determined after many years of observations. There have been additional concerns expressed about ice boom, navigation, and dredging effects on the distribution of flows around Sugar Island.

One of the principal concerns for Canada with respect to the installation of this ice boom is the possibility of an ice jam caused as a result of continuing extension of the navigation season and ice boom failure in the lower St. Marys River. Such ice jamming could result in flooding in Sault Ste. Marie, Ontario and necessitate reductions in outflow from Lake Superior to alleviate these conditions to the effect that high water levels would occur on Lake Superior. During several of the early years of operation, the ice boom failed indicating insufficient strength to withstand the stresses imposed on it, particularly when Lake Superior outflows are at their winter maximum (about 85,000 cfs). No adverse effects on flows and levels were noted as a result of the failures; however, if the January 1978 case can be used as any indication, it was only fortuitous circumstances that powerhouse flows were reduced (due to ice problems) at a time when ice jamming occurred downstream (Foulds, 1978: correspondence).

3.3 Interconnecting Channels (Middle) Section

This section of the GL-SLS, as defined for purposes of this report, consists of the St. Clair and Detroit Rivers, Lake St. Clair and Lake Erie. The two rivers have an extensive history of pollution problems stemming from adjacent chemical industries; Lake Erie is equally infamous for its problems with accelerated eutrophication. Yet within this portion of the GL-SLS are also found numerous environmentally sensitive areas such as the wetlands of Lake St. Clair and along the Canadian shores of Lake Erie (Appendix 4). On the Canadian side there are a total of 62,900 acres of various wetland types adjacent to the waterways compared to 34,700 acres on the U.S. side (IJC, 1981).

The St. Clair River-Lake St. Clair-Detroit River make up the St. Clair complex. This complex is an important fish habitat and an important nursery area for fish moving to Lakes Huron and Erie. A highly diverse assemblage of benthic macro invertebrates such as mayflies, caddisflies, oligochaetes, chironomids, snails, and clams can be found throughout the river, except in the dredged shipping channel. Many of the fish species that can be found in this river move to or from Lakes Huron, St. Clair and Erie for spawning. These species include walleye, muskellunge, rainbow trout, lake sturgeon, smelt, coho and chinook salmon, smallmouth bass, yellow perch, freshwater drum, and channel catfish.

The lower end of the St. Clair River forms the St. Clair River Delta which extends into Lake St. Clair and contains approximately 22,700 acres of wetlands important to many species, including northern pike, smallmouth bass, yellow perch, bluegill, and walleye.

Lake St. Clair is a large, round, shallow basin with a gently sloping bottom and a maximum depth of about 21 feet. The nearshore zones, especially on the northern and eastern sections of the lake have large areas of wetland habitats. Because of its shallowness, submergent aquatic vegetation is common throughout the lake; it provides food cover and spawning areas for many fish species. Lake St. Clair is noted for the muskellunge, but also noteworthy is the relatively uncommon lake sturgeon which spawns in the North Channel of the delta area.

The Detroit River is a very heavily developed 31-mile long river. Water quality is gradually improving and sport fishing for freshwater drum, channel catfish, yellow perch, walleye, rock bass and smallmouth bass takes place. The Michigan Department of Natural Resources has been conducting a stocking program (coho and chinook salmon and rainbow trout) to provide more recreational fishing opportunities.

The Canadian waters of the central basin of Lake Erie contains two of Ontario's five Lake Erie commercial fish statistical districts (No. OE-2 and OE-3). These two districts produced approximately 53 percent of the total Lake Erie commercial fish catch for Ontario in 1977 with a dockside value of over 4 million dollars. The mainstays of this harvest in order of importance were: smelt, yellow perch, white bass, northern pike and freshwater drum. Although the central basin supplies a major portion of Lake Erie's commercial fish catch, and has areas of concentrated recreational fishing, very little quantified or even qualified information exists concerning spawning and/or nursery areas within the basin. Rondeau Bay is probably the most important warmwater spawning and nursery area.

The area between southern Lake Huron and western Lake Erie is one where fish are most vulnerable to season extension. Extending the navigation season here could have a detrimental effect on walleye stocks. Fish from these waters generally move into rivers along Lake St. Clair in early spring under the ice cover or during breakup to spawn. Disruption of spawning migration is probable since both vessels and fish would use the same waterways for access (Niimi, 1982).

Alteration of the ice cover by ice control activities and vessel operation may alter the distribution of some fish species. A study on Lake St. Clair investigated the distribution of gizzard shad and yellow perch. Perch were most abundant after ice breakup and shad were most numerous under the ice cover. Shad disappeared from the study area after ice breakup. The results of the study suggested that changes in the ice cover could alter the composition and distribution of the fish population. However, biological or other environmental factors may also influence the change in population distribution.

In late autumn and early spring, when other marsh areas are frozen, the Canadian side of the St. Clair River and upper delta areas hold concentrations of waterfowl that are vulnerable to direct impacts. Marshes of the east shore of Lake St. Clair and Walpole Island have had peak waterfowl numbers of 150,000 in autumn and 50,000 in spring, and use of these areas appears to be increasing. This area has the highest goose, Mallard and Black Duck use of all southern Great Lakes areas in autumn and the second highest Canvasback and Redhead use. For the latter two species this is a critical migration stopover and birds are vulnerable to direct impacts and changes in food resources. Over half the eastern population of Tundra Swans passes through the region in early spring. The area of the lower Detroit River and adjacent marshes has second highest Canvasback and Redhead use in spring and is also vulnerable to direct and indirect impacts.

The shoreline areas of the St. Clair River delta and Lake St. Clair are shallow, and extensive habitat damage may result from winter navigation activities. Fisheries stocks may be severely impacted, reducing food sources for some migratory birds and other wildlife. Unique habitats and species may be lost. Many privately owned marshes, the St. Clair National Wildlife Area, and extensive areas in the Walpole Indian Reserve may be affected. Changes in flow in the interconnecting channels could lower Lake Huron and increase Lake Erie lake levels, with widespread flooding and erosion problems along Lake Erie shores.

An extended season will result in the disruption of the critical wintering habitat of birds and waterfowl. The habitat is described as critical, because of the low winter threshold at which severe ecosystem damage can occur. Winter navigation and ice control activities will result in alteration of the water surface area covered by ice. The disruption of the location and size of naturally open water surfaces, which are gathering places for feeding and resting of waterfowl and other water birds, can have a severe impact on the ability of these animals to cope with winter ecosystem stress. These places will also be threatened by the encroachment of broken ice, induced by icebreaking activity and vessel operation, into the open water areas.

In addition to open natural pools, many open water areas have been created by warm waste-water discharges from urban, industrial and utility sources. The discharge areas provide artificially induced feeding habitats for wintering waterfowl. The characteristic migration patterns of many species have been altered by the availability of these warm water areas throughout the winter. During the last 50 years, large populations of wintering waterfowl have developed, which are totally dependent on thermal discharges adjacent to productive littoral and wetland areas. Ice encroachment into these fragile areas has been observed to cause severe malnutrition in waterfowl to the point of death. Surviving members of flocks were observed to be in poor physical condition because of malnutrition (USACE, 1979). The encroachment of ice, induced by winter navigation activity, can cause a substantial reduction in the feeding area. The food available may not be sufficient to support the large wintering population, resulting in high mortality. The St. Clair River maintains large populations of wintering waterfowl and is therefore particularly susceptible to this impact.

Modification of the snow pack and ice cover of wetlands may have a significant impact on mammals, reptiles and amphibians which hibernate in tunnels beneath the surface. Flooding would disturb the animals' hibernation by inundating the tunnels and extending the depth of freeze-down. Muskrats, which dwell at wetland edges, would be particularly susceptible to rapid water level fluctuations. Wetlands are crucial wintering habitats for many forms of wildlife. The disturbance or loss of this habitat, resulting from season extension activities, could decrease biological productivity, thereby creating stress on local foodchains. This stress may be sufficient to degrade the physiological condition of wildlife forms to the extent that reproductive success declines and mortality, caused by disease, increases.

Those species that overwinter in shallow water areas (many turtle and amphibian species) or in tunnels beneath the surface (turtles, amphibians, snakes, and mammals) in or adjacent to wetlands may be killed by crushing if ice packs scour overwintering habitats, by drowning if water levels rise, by freezing if water levels drop or the depth of freeze-down is extended, or by exposure if ice packs adhere to and remove soils and vegetation. Among the species vulnerable to this overwinter mortality are a number of species that are rare, endangered, or threatened in Canada, Ontario, or some of the northeastern states.

Waterfowl use in some western marsh areas in Lake Erie has declined as a result of decreases in aquatic vegetation, largely because of recent high water levels. Increased sedimentation, littoral and shoreline scouring, and erosion from winter navigation activities can be expected to further decrease food availability in these areas. Big Creek/Holiday Beach marshes, Point Pelee National Park, Hillman Creek marshes, Rondeau Provincial Park, and Rondeau Bay would be affected.

The protected waters of the Inner Long Point Bay and surrounding marshes have the highest spring and autumn waterfowl use of all southern Great Lakes areas, and constitute one of North America's major staging areas for migrating waterfowl. Surveys showed that 28% of the world's winter population of Canvasbacks and 23% of the world's winter population of Redheads have been counted at Long Point; even greater proportions pass through the area over the course of the season. The fragile Long Point peninsula's inshore and marsh areas and the Turkey Point marsh shore have suffered extensive losses due to ice scouring and erosion in the recent decade of high lake levels. Increases in ice scouring or long- or short-term lake level fluctuations could open extensive areas of still-protected marsh to erosion, sedimentation, loss of vegetation, and loss of present value to migrant waterfowl. The Outer Long Point Bay also has extensive waterfowl use, primarily by diving ducks, sea ducks and mergansers. Drifting ice could close open water areas, preventing feeding during much of the late fall and early spring when migrant use is high. The Long Point system has been designated under the "Convention on Wetlands of International Importance, Especially for Waterfowl." A number of unique habitats and rare species occupy these littoral and marsh areas. Unique habitats and rare species occur as well in Point Pelee, Rondeau, Pelee Island, and other vulnerable island or shoreline areas. Sites for nesting colonies of fish-eating birds, winter habitat for Bald Eagles and prey species for these birds may be affected (CWS, 1983: correspondence).

Dredging in the St. Clair and Detroit River system in the past have had an effect on the water levels of Lake Michigan and Huron. Since dredging increases the capacity of the channels, the ultimate effect is to lower the long-term average levels on these lakes.

Compensating works to offset the effects of past dredging have been proposed for Stag Island in the St. Clair River and Peach Island in the Detroit River. As well, some 1.2 km (0.75 mi) and 1.2 km (0.77 mi) of shore protection works have been identified for the St. Clair and Detroit Rivers, respectively (USACE, 1979). Regular maintenance dredging through the connecting channels also occurs to keep shipping channels operational. Due to the nature of the sandy/clay soils and elevated levels of contaminants such as mercury in bottom sediments, dredging has been a longstanding concern, both in terms of resuspension and redistribution of contaminants from sediments and long-term disposal and management of dredged material.

Spawning of lake herring, whitefish and burbot (spawn in late winter under ice) occurs in the fall or early winter. Their eggs remain in or on bottom sediments or on shoals for 150 days - that is, throughout the winter months during which time navigation traditionally ceased. Since propellor wash is aggrevated by ice conditions, there exists a significant threat to these species from sedimentation or removal of incubating eggs. In addition to altering the bottom morphology and material composition of the bottom habitat, dredging during incubating periods could increase egg mortality through sedimentation or direct removal. The USACE has acknowledged that winter navigation may be a factor influencing egg mortality and that more studies are required to determine the effects of natural and vessel induced sedimentation.

Most activities of winter navigation will affect the fisheries to some extent. The most serious threat is to the spawning and rearing areas adjacent to islands, shoals and wetlands. Spawning habitats are becoming increasingly limited because of pollution, sedimentation and shoreline development. Such habitats can not be readily replaced and a further reduction in their availability, caused by winter navigation, could lead to reductions in species population. Lake sturgeon spawn in wave action around rocky shoals and islands. Construction activity, such as the installation of compensating works or aids to navigation, would disrupt this spawning habitat. This will be particularly a problem in the St. Clair and Detroit Rivers since compensating works have been proposed in sturgeon spawning areas.

The annual formation of an ice arch across the Lake Huron entrance to the St. Clair River plays a role in the natural regulation of lake levels. This ice retardation reduces the outflow from Lake Huron and results in temporary water storage on Lakes Michigan-Huron. The storage effect is normally dissipated due to higher outflows in the spring and summer months. Maintaining the St. Clair River free of ice by ship passage and ice breaking may result in higher flows in the winter months, thus resulting in the long-term lowering of levels of Lakes Michigan-Huron (Witherspoon, 1982: correspondence).

This ice cover could be broken up by storms, causing heavy ice runs and jams in the St. Clair River.

A severe ice jam on the St. Clair River in April of 1984 played havoc with Great Lakes navigation throughout much of the month. The jam, caused by a heavy ice run out of Lake Huron virtually stopped the passage of ships and also resulted in Lake St. Clair water levels to drop by 0.6m (2 ft.).

Sudden changes in water levels due to vessel passage could be quite damaging in this section's connecting channels, resulting in scouring of inshore areas by surface ice, suspension and redistribution of contaminated sediments, changes in ice and snow characteristics of wetlands, and the freezing-thawing-refreezing of exposed areas. Fluctuating water levels would have pronounced consequences on the biological communities as well as the many recreational winter activities such as icefishing, iceboating, and skiing which depend on a stable ice cover. Wetlands are extremely sensitive to water level changes.

Vessel and icebreaker activity cause ice to come into direct contact with the vegetation of shoreline, littoral and wetland areas. The gouging and scouring action of the ice can damage or uproot and remove the aquatic and terrestrial vegetation of these environmentally sensitive areas. The disruption of this vegetation could have a severe impact on the local foodchain. The St. Clair River delta has been identified as an area particularly susceptible to this type of damage.

Opening the navigation channels to winter use increases risk of spill disasters in Inner and Outer Bays of Long Point and in the open waters created by the thermal discharge from the Nanticoke generating station. Spills in these areas may drift east or west, depending on wind direction. Vulnerable wetlands include Long Point and Big Creek National Wildlife Areas, Long Point Provincial Park and Waterfowl Management Unit, Long Point Company marsh, Turkey Point Company marsh, and several smaller marsh and beach properties.

Large numbers of waterfowl, gulls, and other migratory birds also occupy the Niagara River in spring and autumn. The area has high concentrations of diving ducks and mergansers, and is used by many bird species over the winter. This area is vulnerable to oil spills and increases in contaminants.

3.4 Lower Section

Whereas the majority of concerns identified for the previous sections also apply to the lower section, these concerns are greatly increased, particularly at the outlet of Lake Ontario in the St. Lawrence River, and at the locations of numerous fragile wetland areas potentially affected (Appendix 4).

The St. Lawrence River comprises a large and complex ecosystem. It is composed of deep water, islands, shoals, littoral edge, wetlands, and adjacent uplands linked together by the constancy of river flow and the movements of species in an integrated series of aquatic and terestrial-riverine food webs.

Improvements to the Welland Canal could eventually comprise either lock twinning or enlargement or some combination (Ontario Great Lakes/Seaway Task Force, 1981). The potential impacts of such an undertaking have not been addressed to date. A preliminary feasibility report released in July, 1982 by the USACE (Buffalo District) concluded that the most feasible alternatives for augmenting the capacity of U.S. locks in the St. Lawrence River revolved around construction of additional or replacement locks in concert with Canadian plans for the Welland Canal and remaining St. Lawrence River locks. The report stressed that the Welland Canal was a major constraint in the seaway system.

In the St. Lawrence area, season extension could cause disruptions in hydroelectric generation. The difficult problem to be solved is the maintenance of a stable ice cover in narrow navigation channels of the St. Lawrence which have high water velocities. These channels were designed originally with certain velocity so that navigation could transit them safely during open water conditions. During the period of ice formation, flows in these channels must be reduced to facilitate formation of a smooth and stable ice cover. This would minimize head losses in these channels and would provide adequate depth in downstream reaches. With a normal ice cover on 5 March 1982, the water level at the entrance to Eisenhauer Lock in Lake St. Lawrence was about 0.6 m (2 ft.) below low water datum (i.e., the level which provides full draft throughout Lake St. Lawrence). Further increases in head losses such as described above would worsen conditions at the lock. The only studies which have been done so far are highly theoretical in nature and have not addressed the problems of ship passage in narrow channels with an ice cover and high river velocity, conditions which are very different from those encountered in the St. Marys River during the demonstration program (Witherspoon, 1982: correspondence).

Reduced capabilities of these hydraulic channels would reduce the ability to regulate Lake Ontario and curtail hydroelectric production during the period of peak demand. At present, several ice booms are being employed each winter in the St. Lawrence to promote and maintain a stable ice cover. Winter navigation would require that these booms be modified and their resulting performance could be adversely affected.

The proposed dredging envisaged for the St. Lawrence River will alter current patterns, velocities, water levels and flow distributions. Most dredging will be done to reduce water velocity in those sections of channels where ice does not normally develop. The reduction in velocity will encourage the development of a stable ice cover, thereby reducing the potential for ice jamming. The environmental effects of increasing the area of ice cover in channels are not known. The extensive dredging on the St. Lawrence River is not expected to affect the level of Lake Ontario because its outflow is regulated. Compensating works could be used as a mitigative procedure, in conjunction with dredging, in order to maintain normal water levels throughout the system. The area downstream of Lac St. Francis has also been identified as an area particularly prone to suffer from the effect of increased sedimentation from dredging activities as well as from sediment resuspension during vessel passages.

Artificial islands, constructed in channels as an ice stabilizing tactic, will interfere with the normal water flow. the reduction of water velocity in the vicinity of the islands could induce sediment deposition. This is not anticipated to be a significant problem since the connecting channels and rivers of the system have small sediment loads. Three artificial islands have already been constructed by the St. Lawrence Seaway Authority in Lake St. Louis, north of the navigation channel. Their effectiveness has not yet been fully determined.

During the USACE Winter Navigation Demonstration program, a 32-km (20 mi.) corridor on the St. Lawrence River was selected and monitored for adverse effects. An evaluation of the 14 concurrent studies indicated the probable impacts of ship passage on vegetation, fish, bird, and wildlife habitats, and shoreline damage (New York State Department of Environmental Conservation, 1978). Trial runs of icebreakers and vessels indicated that waves generated could be detected as far as 1.6 km away (Geis, 1978) and that resulting ice pressure waves under ice cause a tremendous disturbance of benthic organisms and sediment in shallow littoral zones of the St. Lawrence.

As with the other sections previously discussed, winter navigation in the St. Lawrence River would result in numerous effects, including losses of and damage to littoral zones and wetlands due to short-term and long-term changes in water levels; damage to aquatic and wetland communities due especially to sediment movement, macrophyte and benthos displacement, and disrupted temperature regimes. Although the variety of specific causes and consequences is great, a common factor is inevitable damage to the Great Lakes ecosystem. Wetland communities and aquatic food sources for wildlife will be degraded and migratory bird populations will suffer. For the Province of Quebec, the Beauharnois to Montreal portion is particualarly vulnerable to winter navigation effects on migratory birds, wintering and nesting habitats and marsh vegetation.

The effects of spills of oil or other hazardous chemicals remain applicable throughout the GL-SLS, however, again more severe impacts would be likely in the St. Lawrence River.

Eastern Lake Ontario has high scaup and merganser use in spring and autumn. Lake St. Francis and other St. Lawrence River areas are also heavily used. The Lake St. Francis area is used extensively for year-round commercial and sports fishing. The eastern Lake Ontario-St. Lawrence River system is fragile and vulnerable to the direct impacts and habitat effects described earlier. Ice scouring and water level fluctuation effects will be severe in the constricted channel areas and around islands. Open water wintering areas, unique shoreline and wetland habitats, and rare species are vulnerable to impact. Populations of species rare in Canada, such as Grey Fox may be threatened by interruptions in opportunities to cross winter ice. The varied concerns raised by New York State Department of Environmental Conservation apply as well to the Canadian side of the system. Eastern Lake Ontario and St. Lawrence River wetlands include several shoreline provincial parks and their associated wetlands, Prince Edward Point National Wildlife area, St. Lawrence Islands National Park, and Upper Canada Migratory Bird Sanctuary.

Specific areas that would be of particular concern to the Great Lakes fisheries resources in Canada would include the Thousand Islands area along the St. Lawrence River, eastern and western sections of Lake Ontario and Lake St. Francis. These areas support major recreational fisheries and in many cases are also used as spawning and rearing areas. Offshore shoals also comprise an integral component of the fisheries issue. Areas such as Charity Shoals (one of the few studied) which, located in eastern Lake Ontario, are used for spawning by lake trout (fall spawners). However, the shoal is located near shipping lanes to the St. Lawrence River where an extended season could affect the success of lake trout. The Iles de la Paix area at the downstream end of the Beauharnois Canal is another location considered to be environmentally sensitive and valuable for conservation interests.

Ice jamming on the St. Lawrence River poses a difficulty in the operation of the hydro-electric generating facilities at Cornwall, Ontario. These facilities are used to regulate the outlfow of Lake Ontario. Since the St. Lawrence Seaway and Power Project was completed in 1958, Ontario Hydro and the New York Power Authority have maintained ice booms to stabilize the ice cover upriver from the Moses-Saunders powerhouse. Similar ice booms are used by Hydro Quebec at its Beauharnois powerhouse near Montreal. The annual placement of these ice booms effectively terminated navigation on the Montreal-Lake Ontario section of the Seaway. Ontario Hydro, Hydro Quebec and the New York (Power Authority), have all expressed concerns about lost generating capacity attributable to ice jams (Warren, 1977 and LBA Consultants, 1978). Traditionally, ice booms are installed upriver from the power dams before the ice formation period. However, the 1976-77 Demonstration Program necessitated a delay in closing the ice booms. Floating ice passed through the gaps in the booms and created ice jams further downstream, thereby reducing the outflow from Lake Ontario. Ice jamming has the potential to reduce the outflow from Lake Ontario to 150,000 cfs (LBA Consultants, 1978). The average outflow from Lake Ontario during the winter months (Jan. through Mar.) is 222,000 cfs. Should jamming occur during years of high supplies to Lake Ontario severe flooding would result. The Demonstration Program has shown the need for modification to the existing ice boom systems at Ogdensburg and Gallop Island to stabilize the ice cover in the navigation channel. The question being asked by the power authorities is who will pay for these improvements and losses from decreased power production?

3.5 Overview of Environmental Issues

The concerns and issues associated with potential environmental effects of winter navigation/season extension of the GL-SLS are considerably far reaching, both in geographic scope and environmental components ultimately affected. As reiterated throughout the preceding discussions, there is a significant dearth of baseline information and knowledge about the Great Lakes winter environment such that many questions and postulations cannot be answered with great certainty.

However, even on the basis of what has been found during demonstration projects and extensions of existing knowledge there should be sufficient reason to seriously question proceeding with season extension. More so, this is the case for Canada where, for example, approximately 60-70% of the total submerged areas of the interconnecting waterways that are most susceptible to adverse effects of extended navigation are found (Niimi, 1982). Moreover, much of the Canadian shore of the Great Lakes and connecting rivers is on the windward side and therefore is subject to greater ice drift, erosion, and sedimentation impacts. The potential to affect large and diverse populations of wildlife and their habitats, fisheries and spawning success, and important food sources could be highly significant for the Great Lakes ecosystem. Reduced biotic resources and wetland habitats, increased shore erosion, threat for flood damage and hydro power production, interference for shorebased recreation in National Parks and National Historic Parks, and interference for lake level regulation pose further problems for a large segment of society residing along or making use of the Great Lakes.

Table 2 provides a summary of environmental effects/issues for each section of the GL-SLS, respectively. An attempt has been made to categorize the duration and severity of impacts involved. At this point, however, it is fairly subjective and does not include season extension activities which may be required for ports and harbours on the Canadian side and for which additional consideration should be given.

TABLE 2. SUMMARY OF ENVIRONMENTAL ISSUES/EFFECTS

Great Lakes Environmental Components \ Winter Navigation Activities (by Section)	System Modification: Construct. (Locks, Other Fac.) – Upper	Construct. – Middle	Construct. – Lower	Dredging – Upper	Dredging – Middle	Dredging – Lower	Compensat. Works – Upper	Compensat. Works – Middle	Compensat. Works – Lower	Ice Control Measures: Ice Boom Operations – Upper	Ice Boom – Middle	Ice Boom – Lower	Air Bubblers – Upper	Air Bubblers – Middle	Air Bubblers – Lower	Artificial Islands – Upper	Artificial Islands – Middle	Artificial Islands – Lower	Vessel Operations/Ice Breaking – Upper	Vessel Ops – Middle	Vessel Ops – Lower	Accidental Spills – Upper	Accidental Spills – Middle	Accidental Spills – Lower
WILDLIFE	✸ ▽		● ▽	✸	● ▽	● ▽							● ▽					▿ ▽	● ▽	● ▽	● ⬤	● ⬤	● ⬤	● ⬤
FISHERIES	● ⬤		● ▽	● ▽	● ▽	● ▽		● ⬤					● ▽					● ▽	● ⬤	● ⬤	● ⬤	● ⬤	● ⬤	● ⬤
BENTHOS	● ▽		● ▽	● ▽	● ▽	● ▽							▿ ▽					● ▽	● ▽	● ▽	● ⬤	▿	▿	▿
VEGETATION & SHORE ENVIRONS			● ▽	▿ ▽	▿ ▽	● ▽		▿ ▽		●		▿		▿				▿ ▽	● ▽	● ▽	● ⬤	● ⬤	● ⬤	● ⬤
WATER QUALITY	● ▽		● ▽	● ▽	● ⬤	● ▽							▿					▿ ▽	● ▽	● ▽	● ⬤	● ▽	● ▽	● ▽
WATER QUANTITY /HYDRAULICS	● ▽		● ⬤	▿ ▽	● ▽	● ⬤		● ▽		● ⬤		● ⬤		▿ ▽				● ⬤	● ▽	● ⬤	● ⬤			
AIR QUALITY/NOISE	✸ ▽		✸	✸	✸	✸ ▽													✸	✸	✸ ▽			
SOCIAL/WATER USERS			● ▽	✸	✸	● ⬤		▿ ▽		●		● ⬤						▿ ▽	● ▽	● ⬤	● ⬤	● ▽	● ▽	● ▽
WATER MANAGEMENT -LAKE LEVEL REGULATION GLWQ AGREEMENT	● ▽		● ▽	▿ ▽	● ▽	● ⬤		● ▽		● ⬤		● ⬤		▿ ▽				▿ ▽	● ▽	● ⬤	● ⬤	● ▽	● ▽	● ▽

✪ UPPER LAKES SECTION ☆ INTERCONNECTING CHANNELS (MIDDLE) SECTION ★ LOWER SECTION

SEVERITY OF ADVERSE EFFECTS

	EFFECTS: SHORT TERM TEMPORARY	EFFECTS: LONG TERM
POTENTIALLY SIGNIFICANT	●	⬤
UNKNOWN EFFECTS OR SIGNIFICANCE	▿	▽
MINOR EFFECT	✸	✸

4. DEPARTMENT OF ENVIRONMENT INTERESTS IN WINTER NAVIGATION

A number of DOE agencies are potentially affected by navigation season extension activities. The purpose of identifying particular concerns related to various services provided by these agencies lies in the fact that navigation extension effects could result in increased costs for additional services or in reduced ability to effectively perform the services required by a given mandate. Certain agencies also have responsibilities for environmental baseline information or environmental research and would consequently become involved in any data collection program related to navigation extension.

4.1 Canadian Wildlife Service (CWS)

The mandate for CWS includes responsibility for management of migratory birds and their habitats and for preserving and maintaining important or unique wildlife habitats. Many migratory birds rely on the fish, invertebrates, and aquatic vegetation of the Great Lakes during breeding, migration, or winter seasons. Wetland and open water habitats that are of critical importance to eastern populations of migrant waterfowl are located in the GL-SLS system. Various activities associated with navigation season extension could affect this waterfowl resource through direct mortality or loss of reproductive potential. Indirect impacts could also result through impacts on food resources and other aspects of aquatic and wetland habitats. Many of these habitats are unique in Canada and support species that are not found elsewhere in Canada. Impacts on critical habitats may cause a loss of species diversity in Canada and may extirpate uniquely adapted northern populations of some species.

While the management of waterfowl and other migratory birds has been CWS's primary responsibility, CWS is also engaged in other areas which may be affected by navigation extension activities, such as monitoring toxic chemicals in Herring Gulls, the rehabilitation of Bald Eagle populations on Lake Erie, and protecting habitats for rare, threatened or endangered species and other wildlife. CWS also administers a number of federally-owned properties (eg., on Lake St. Clair, on Lake Erie) vulnerable to winter navigation impacts.

4.2 Parks Canada

Parks Canada administers and manages National Parks and National Historic Sites (such as the Sault Canal). Since all National Parks and some historic sites in Ontario Region are located on the GL-SLS system, Parks Canada properties and operations can be affected by navigation effects causing changes in water levels and flows, shoreline erosion, flooding, hazardous material spills and water pollution and subsequent impacts on shoreline, wetland habitats and shore-based recreation.

4.3 Atmospheric Environment Service (AES)

Historically, AES has been responsible for aerial ice reconnaissance of the GL-SLS, in coordination with the St. Lawrence Seaway Authority, the U.S. Coast Guard, and other agencies. During the freeze-up and break-up periods, ice reconnaissance flights are made approximately twice a week. In between, ice reconnaissance may be conducted once per two weeks depending on the need for ice information. Several Canadian agencies maintain water temperature programs while at about 30 sites along the length of the Seaway weekly ice thickness measurements are made.

It is estimated that at least two or three extra ice reconnaissance flights would be required for each week's extension. This of course, would vary up or down from year to year according to severity of ice conditions and detail of information required. Existing water temperature and ice thickness measuring networks are likely sufficient to meet present operational needs, but needs of microenvironmental monitoring would require substantial enhancement and augmentation of these data gathering programs.

With respect to historical information available for the Canadian portions of the Great Lakes, concentration of effort has been primarily along the main shipping routes. As a result, both detail of information and frequency of data diminish as one moves away from what could be termed as geographically "economic" zones. In general, the present ice data base is inadequate for environmental monitoring except in the broadest sense.

If winter shipping in the Canadian portion of the Great Lakes area increased to a level comparable to that along the Atlantic seaboard, then a corresponding increase in operational ice information services would be required. This could amount to regular aerial all-weather reconnaissance, or equivalent, of the order of complete coverage once every two days for the Lakes area of interest with more frequent and more detailed information required over inter-connecting waterways.

4.4 Inland Waters Directorate (IWD)

The primary role of IWD is related to the gathering and dissemination of water related information for Ontario with particular emphasis on the Great Lakes and their interconnecting channels. IWD provides technical support to all IJC Great Lakes Boards of Control (for water flows and levels), maintains a network of streamflow, water level, and sediment stations throughout the Great Lakes system, and provides technical support to the IJC Great Lakes Water Quality Board. In addition, IWD implements water management projects under the Canada Water Act relating to flood damage reduction, flood control, and shoreland management. Winter navigation and its attendant effects could have fairly extensive implications for the conduct of IWD activities.

4.5 Environmental Protection Service (EPS)

EPS has been extensively involved in monitoring dredging activities in the GL-SLS, ports and harbours, and ensuring appropriate disposal of dredged materials. It is also responsible for oil/hazardous material spill contingencies and clean-up coordination. Proposals for winter navigation season extension include dredging requirements and increased risk of accidental spills under severe conditions.

4.6 Other Program Areas

DOE has prime involvement in the Canada/U.S. Great Lakes Water Quality Agreement which is intended to enhance the water quality of the Great Lakes and mitigate the effects of transboundary pollution. Winter navigation effects could potentially contribute to water quality degradation in terms of contaminated sediment resuspension and redistribution as well as increasing sediment load through increased erosion and ice scour. This may negate to some extent, the past effort and investment in improving Great Lakes water quality.

5. OUTSTANDING CONSIDERATIONS

The discussion of environmental concerns associated with navigation season extension on the Great Lakes has highlighted a great number of identified potential effects. The severity or significance of these effects cannot, however, be determined given the present lack of environmental baseline data or limited number of observations during the demonstration program. The many criticisms of the USACE's adaptive approach to environmental assessment have been documented elsewhere, as have been those concerning the USACE's economic analysis which totally ignored environmental costs/benefits and costs to Canada.

5.1 Baseline Data Collection

Reviews of the winter navigation proposals from environmental agencies indicated the widespread concern that the information base to decide on the environmental acceptability of winter navigation is sorely inadequate. Many millions of dollars and years of baseline study have been called for in the U.S. - and this given that some work has already been done. Since Canadian interest in winter navigation has never been forthright, Canadian study and data are comparably further behind. The need for a thorough environmental assessment of the sensitive areas like the interconnecting waterways and wetlands would also be more costly for Canada.

It is possible in some cases that some analogue situations could be studied to further delineate some of the concerns identified. For example, the effects of icebreaking activities on shoreline environments and ecosystems could well be studied at a location such as the Miramichi River in New Brunswick. There, the pulp and paper industry has regularly moved cargoes in and out of the Port of Newcastle/Chatham and perhaps impacts have already been documented. Further, proposed icebreaking and tanker traffic associated with Arctic Hydrocarbon exploration and development have resulted in a plethora of baseline studies regarding, for example, oilspill containment in winter conditions, impact on ecosystems, environmental design criteria for structures and operations, etc., (AES, 1983: correspondence). Winter biological studies in the GL-SLS are, however, not extensive and would constitute a major sites-specific undertaking on the part of Canada.

In March of 1973, a Canadian interagency coordinating committee for extension of the navigation season proposed a draft plan of some 23 major studies, to be conducted over about 4 years (no costs given). The proposed studies were, however, predominantly operationally or technically oriented and included only one scientific project of general or long-term interest, two economic studies, and no ecological/environmental studies.

Winter navigation season extension on the GL-SLS touches upon a great number of various jurisdictions, agencies, and public - ranging in interest from resource management mandates to regulatory responsibilities to potentially affected riparian and shore property owner rights and water users. Any sound process of decision-making must necessarily include these sources of interest and concern. If a baseline study program for season extension is contemplated, then the studies should, in part, seek to answer the concerns which have been taken into account in the study design.

Given the international (Canada/US) scope of winter navigation and the great potential for transboundary effects (even under unilateral-U.S. action within their territorial waters), baseline studies and a system-wide environment assessment should be undertaken, either bilaterally or under the aegis of the IJC before considering implementation of navigation season extension. With our present limited understanding, there is no easy way to differentiate impacts resulting from a 10 3/4 month extension or year-round navigation. It may only take a short period of winter navigation operations to inflict lasting environmental damage and certain system modifications must be made regardless of season length options.

Appropriate federal, provincial/state agencies can undertake baseline and assessment studies through their respective programs. However, the jurisdiction of the IJC with regard to regulation and water quality would have to be taken into account. It may be that under certain circumstances the IJC would be the more appropriate vehicle to coordinate studies to assess the effects of winter navigation.

5.2 Economic Analysis

Since it was not the intention of this report to enter into the already well documented shortcomings of the USACE economic analysis of cost/benefit of season extension, the matter warrants some reiteration as to the exclusion of environmental costs. The discussion on environmental effects has identified a great many areas of potential loss or damage (to fisheries, waterfowl and habitats, shore properties, etc.) of which some may be irreplaceable or irrepairable. These costs to the Great Lakes ecosystem cannot be ignored and must be given equal weight in the evaluation of cost/benefit.

The other aspect which also usually fails to be reflected in economic analysis is the cost of conducting baseline studies, particularly in this case of winter navigation. Given the identified need, the costs of such studies in themselves could be exorbitant, not to mention the additional costs incurred in increasing various winter navigation support services. All these considerations of outside costs (outside the proposal itself) must be included in the analysis of cost/benefit.

In terms of additional options to winter navigation season extension, there is no doubt more room to explore other possibilities. For example, the effects of climate variability and climate change on the need for winter navigation were not considered at all in the USACE proposal. Preliminary assessments of CO_2 induced climate change projected over the next 100 years indicate likely winter temperature changes of +3°C (southern Ontario) and +5°C (northern Ontario). Summer temperature increases will be somewhat lower (1.5 + 3°C). Such warming could result in both reduced ice season lengths by up to two months and reduced ice severity on the Great Lakes. On the other hand, diminished water resources could lower Great Lakes water levels (AES, 1983). The entire area of questions dealing with potential interactions of navigation with other speculative events (natural fluctuations, water consumption, diversions, etc.) has not been explored to much extent.

6. CONCLUSION

This report on environmental issues relative to Canadian concerns on the proposed navigation season extension on the GL-SLS has traced briefly the background of the original USACE project, subsequent reviews, current status of the project being considered before the U.S. Congress, and past Canadian involvement and participation in season extension-related activities.

For purposes of a closer examination of environmental concerns identified by both USACE studies and demonstration programs, and reviewing agencies (U.S. and Canadian), the GL-SLS was partitioned into three components: Upper lakes section (Lakes Superior, Huron, Michigan and St. Marys River), Interconnecting channels (middle) section (St. Clair River, Detroit River, Lake St. Clair, Lake Erie), and Lower section (Welland Canal, Lake Ontario and St. Lawrence River). These components were thought suitable to reflect the phasing of winter navigation implementation (beginning at the upper lakes section) as well as the relative degree of environmental sensitivity of these sections to winter navigation effects (i.e., sensitivity increased progressing downstream through the sections). Many of the identified effects are considered to be potentially significant, although the lack of baseline data precludes substantive analysis of impacts and degradation/damage to the Great Lakes ecosystem, other water users, and shore properties. Given the larger proportion of sensitive shore and littoral environments in Canada along the GL-SLS, the potential effects in Canada would be proportionally higher than in the U.S., as would be the costs of providing a thorough environmental assessment.

A partial review of Department of Environment services indicates that many areas of DOE mandates and responsibilities would be affected by winter navigation activities. These ranged from wildlife/migratory birds and habitat management, wetlands ownership, National Parks and Historic site management, shoreline recreation, canal operations to ice reconnaissance support, lake level regulation support and hazardous spill contingency planning. In addition to the costs of acquiring baseline data, the impacts of winter navigation on the conduct of DOE activities and programs (sometimes at conflict, for example, flood damage reduction, shoreland management, Great Lakes Water Quality) must be considered in the overall cost/benefit of navigation season extension.

The requirement for comprehensive baseline information, particularly the winter environment of the GL-SLS, has been expressed from a great many quarters, both in the U.S. and in Canada. A study to coordinate data collection activities and conduct a system-wide environmental assessment, either through the IJC or other bilateral mechanisms would be required to achieve this end, given the international scope of the undertaking and large number of parties having an interest or being affected by the issue. The proposed duration of winter navigation activities (i.e., originally year-round in upper two sections, latest revisal - 10 3/4 months) should not have much bearing on the justification of such a study. If winter navigation is expected to push forward, the scale of Canadian concerns, the stated Canadian position, and the likelihood of significant impacts being initiated regardless of ultimate season length cannot be ignored. Moreover, the U.S. winter navigation proposal is highly dependent on Canadian cooperation, particularly for the Welland Canal through St. Lawrence River section.

Finally, it is recognized that the USACE economic evaluation of cost/benefit of season extension has ignored environmental costs and damages, and the large cost to Canada to undertake what would be its share of season extension required improvements. The additional costs of baseline studies and increased support services also need to be included in a more acceptable evaluation of costs and benefits. The inclusion of these latter categories of additional costs to the public and the environment may cast a substantially different light on winter navigation season extension independent of prevailing economic conditions.

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APPENDIX 1

GREAT LAKES WINTER NAVIGATION SEASON EXTENSION
- EXTENSION PHASES AND REQUIRED ACTIVITIES -

APPENDIX 1

GREAT LAKES WINTER NAVIGATION SEASON EXTENSION - EXTENSION PHASES

	UPPER LAKES (SUPERIOR) HURON, MICHIGAN) & ST. MARYS RIVER	ST. CLAIR RIVER, LAKE ST. CLAIR, DETROIT RIVER, LAKE ERIE	WELLAND CANAL LAKE ONTARIO & ST.LAWRENCE RIVER
NAVIGATION SEASON STUDY BASE CONDITION:	1 Apr.-31 Jan.(±2 wks)	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-15 Dec. 1 Apr.-31 Dec. (Welland)
Proposed Implementation Phases:			
- Phase I	Year Round	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-15 Dec.
- Phase II	Year Round	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-31 Dec.
- Phase III	Year Round	Year Round	1 Apr.-31 Dec.
- Phase IV	Year Round	Year Round	20 Mar.-31 Dec.
- Phase V	Year Round	Year Round	7 Mar.-7 Jan.
- Phase VI	Year Round	Year Round	7 Feb.-7 Jan.
Activities			
Ice Control Structures (ice booms)	St. Marys River-Sugar Island Lower end L. Huron	Lower end L. St. Clair	Ogdensburg, N.Y. Cardinal, Ont. Iroquois Dam - (Modifications to existing ice booms)

APPENDIX 1 (continued)

	UPPER LAKES (SUPERIOR) HURON, MICHIGAN) & ST. MARYS RIVER	ST. CLAIR RIVER, LAKE ST. CLAIR, DETROIT RIVER, LAKE ERIE	WELLAND CANAL LAKE ONTARIO & ST.LAWRENCE RIVER
NAVIGATION SEASON BASE CONDITION:	1 Apr.-31 Jan.(±2 wks)	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-15 Dec. 1 Apr.-31 Dec. (Welland)
<u>Activities</u>: (continued)			
Air Bubbler Systems	Whitefish Bay, Birch Pt. Middle Neebish Channel Lime Island		
Lock Modifications	Soo Locks (-Co-polymer coating & steam hoses; bubbler flusher & system; ice removal by tug; large gate valves) NEW POE SIZE LOCK [1,2]		St. Lawrence R. (coating lock walls & gates; ice removal by tug; gate & equipment heating; gate recess bubbler & flusher) Welland Canal - (Realign approach

APPENDIX 1 (continued)

	UPPER LAKES (SUPERIOR) HURON, MICHIGAN) & ST. MARYS RIVER	ST. CLAIR RIVER, LAKE ST. CLAIR, DETROIT RIVER, LAKE ERIE	WELLAND CANAL LAKE ONTARIO & ST.LAWRENCE RIVER
NAVIGATION SEASON BASE CONDITION:	1 Apr.-31 Jan.($\pm$2 wks)	1 Apr.-31 Jan.($\pm$ 2 wks)	1 Apr.-15 Dec. 1 Apr.-31 Dec. (Welland)
Activities: (continued)			
Lock Modifications (continued)			walls; canal scheduling; widening between bridge 11 & Port Robinson; removal bridge 5 between locks 3 & 4; option to twin or enlarge locks) [3]
Compensating works (for River flow)		St. Clair River - Stag Island Detroit River - Peach Island	
Dredging & Material Disposal	Middle Neebish (3 million yd^3) St. Marys River deepening [2]		St. Lawrence River

APPENDIX 1 (continued)

	UPPER LAKES (SUPERIOR) HURON, MICHIGAN) & ST. MARYS RIVER	ST. CLAIR RIVER, LAKE ST. CLAIR, DETROIT RIVER, LAKE ERIE	WELLAND CANAL LAKE ONTARIO & ST.LAWRENCE RIVER
NAVIGATION SEASON BASE CONDITION:	1 Apr.-31 Jan.(±2 wks)	1 Apr.-31 Jan.(± 2 wks)	1 Apr.-15 Dec. 1 Apr.-31 Dec. (Welland)
Activities: (continued)			
Connecting Channel Operational Plans (Ice breaking assistance; emerg. ferry service; land transport; emerg. medical evac.)	Sugar Island Drummond Island	St. Clair River Detroit River	St. Lawrence River
Island transportation Assistance	Sugar Island Ferry (Dock Bubbler) Lime Island Ice Boat Drummond Island Ferry		Grindstone Island Ferry
Ice Breaking			
Vessel Traffic Control			
Ice Data Collection/ Dissemination			
Ice & Weather Forecast.			
Aids to Navigation (Mini Loran-C;Racon)			

TABLE 1 (continued)

	UPPER LAKES (SUPERIOR) HURON, MICHIGAN) & ST. MARYS RIVER	ST. CLAIR RIVER, LAKE ST. CLAIR, DETROIT RIVER, LAKE ERIE	WELLAND CANAL LAKE ONTARIO & ST.LAWRENCE RIVER
NAVIGATION SEASON	1 Apr.-31 Jan.(±2 wks)	1 Apr.-31 Jan.(±2 wks)	1 Apr.-15 Dec.
BASE CONDITION:			1 Apr.-31 Dec. (Welland)
Activities: (continued)			
Shore Protection & Erosion Structures	St. Marys R.(4.8 mi.)	St.Clair R.(0.75 mi.) Detroit R.(0.77 mi.)	St.Lawrence R. (3.2 mi.)
Water Level Monitoring	St. Marys R.	St. Clair & Detroit R.	St.Lawrence R.
Vessel Speed Control & Enforcement			
Safety/Survival			
Vessel Operation & Design Criteria			
Search & Rescue			
Oil/Hazardous Spill Control			
Vessel Discharge Control			
Pilot Access	Detour + Ice Tugs	Detroit + Ice Tugs	Cape Vincent + Ice Tugs
Harbour Modifications			
New Icebreakers			

NOTES: (Source: USACE, 1979)

1. Items in square brackets derived from outside of original USACE Study.
2. USACE Study of Connecting Channels and Harbours (Jul, 1982).
3. Identified improvements by SLSA & Ontario GL-SLS Task Force Study (1981).

APPENDIX 2

WINTER NAVIGATION ENVIRONMENTAL EFFECTS MATRIX

WINTER NAVIGATION ENVIRONMENTAL EFFECTS MATRIX

ENVIRONMENTAL CONCERNS

WINTER NAVIGATION ACTIVITIES

	WILDLIFE	FISHERIES	BENTHOS	VEGETATION	WATER QUALITY	SHORE EROSION
VESSEL OPERATION	Disruption of wintering waterfowl and shore bird habitat. Ice encroachment into open water feeding areas prohibits channel crossings by land mammals.	Significant increase in macrophyte drift after vessel passage, resulting in localized food shortages. Egg loss by siltation from propeller thrust.	Explosive liquefaction creates unstable benthic habitat. Physical displacement to colder water, resulting in death. Burial by sedimentation from vessel squat.	Scouring of shoreline by vessel induced ice movement can remove critical vegetation, exposing shoreline to severe spring and summer erosion.	Increased turbidity from propeller wash. More oily vessel waste passed overboard. Major threat posed by oil and hazardous substance spills.	Effects of drawdown and surge magnified by ice conditions. Pressure cracks decrease ability of ice to anchor to shore, increasing scour - lateral movement of onshore ice by pull of vessel.
ICEBREAKING	Ice push into warm water discharge areas causes malnutrition in waterfowl.	Disruption of spawning habitat and eggs by strong propeller thrust. Expulsion onto ice surface by water level surges through pressure cracks.	Expulsion onto ice surface by water level surges through pressure cracks. Disruption of habitat by ice scour.	Removal of shoreline, littoral and wetland vegetation by moving ice and wind driven ice push. Significant impact on primary productivity.	Increased turbidity from high thrust propeller wash. Higher bod from resuspended sediments.	Gouging and scraping of nearshore sediments by moving ice - deflection of flows and currents against erodable shoreline by subsurface ice.
BUBBLERS	Attract waterfowl to areas of low food supply.	Air curtain barrier to migration.	Disturbance of natural biological rhythm causing early emergence. Increased circulation may enhance population at bubbler site.		Minimal disturbance of thermal balance. Increase in dissolved oxygen beneficial. May prolong duration of turbidity caused by vessel and ice breaking activity.	
DREDGING AND DISPOSAL	Limited disruption of habitat at land disposal sites. Reduced shallow water feeding area for waterfowl and some mammals.	Destruction of spawning habitat. Burial of eggs. Decreased sight feeding ability resulting from increased turbidity. Creation of favourable lamprey spawning areas.	Long-term impact will be loss of habitat. Burial at disposal sites.	Removal of submerged vegetation. Sedimentation of leaf surfaces, retarding photosynthesis and nutrient absorption.	Increased turbidity at activity site. Limited resuspension of heavy and toxic metals. Chemical and physical changes of water properties at disposal site. Some nutrient loading with potential for higher bod.	Steepening of shoreline increases potential for erosion.
ICE BOOMS		Alteration of species distribution by modification of the ice cover.	Temporary displacement at drill sites for boom anchors.		Localized short-term increase in turbidity at anchoring sites. Effect of increasing area of ice cover on oxygen levels.	
THERMAL ICE SUPPRESSION	Attraction of waterfowl to open water areas. Disruption of migration pattern. Higher demand on limited food resources.	Fish congregation at release site. Fish kill by shock defouling and temperature fluctuations. Interference with spawning of temperature sensitive species.	Encourages early emergence.		Alteration of normal temperature regime.	
ARTIFICIAL ISLANDS		Permanent displacement of species sensitive to increased turbidity.	Severe disruption of habitat.	Local destruction of submerged vegetation.	Induce changes in oxygen content-high turbidity during construction.	
SHORE PROTECTION	Disturbance of shoreline and wetland habitat by construction and modification activities.	Rip-rapping of shore reduces water flow to wetlands, thereby reducing the fall feeding area.	Creates suitable habitat for benthos.	Some methods may result in removal of shoreline and littoral zone vegetation.		Reduction of shore erosion.
AIDS TO NAVIGATION	Displacement of fauna from wetlands and littoral areas.			Removal of shoreline vegetation for installation and maintenance of shore based aids to navigation.	Localized, short-term increase in turbidity during anchoring.	
COMPENSATING WORKS	Disruption of wetland habitat by disturbance of natural water levels and construction activities.	Loss of spawning nursery and feeding habitat by flooding inundation of wetlands. Loss of critical spawning habitat around islands and shoals.	Reduction in aeration of benthos due to interference with natural currents.	Removal of submerged vegetation.	Increased turbidity and nutrient loading at construction sites.	Prevention of high water levels, thereby reducing erosion.

	SEDIMENT TRANSPORT	HYDRAULICS	SHORE STRUCTURES	AIR QUALITY	NOISE	BROADER SOCIAL IMPACT
VESSEL OPERATION	Low winter water levels aggravate sediment movement by propeller induced currents. Pore pressure response to drawdown can combine with velocity to move bottom sediments.	Temporary level changes from drawdown and surge. Ice displacement facilitating ice jam formation.	Ice push onto shoreline recreational areas. Movement of ice attached to structures caused by draw of passing vessels.	Increased fuel consumption and therefore, higher atmospheric loading by vessels that normally would not be operating. Dockside emission for heating and electrical purposes.	Transmission of ship induced vibration to shoreline areas by large areas of grounded ice. Engine thrust noise.	Increased hazard to commercial ice fishermen and recreationists due to unstable ice cover - shoreline structure damage.
ICEBREAKING	Sediment movement by propeller induced currents.	Ice jamming of displaced ice resulting in high upstream and low downstream water levels - reduced summer water levels from disturbance of natural ice blockages.	Ice push onto shoreline of narrow channels crushes structures. Ice pile-up on shore.	Additional atmospheric loading from activities that traditionally ceased at end of the season.	Noise of activity as well as vibration. Noise of high power engine thrust.	Disruption of traditional modes of cross channel transportation and recreational use patterns - shoreline structure damage. Effect of additional noise on shoreline residents.
BUBBLERS	Insignificant sediment resuspension and movement. Increase in duration and distribution of sediments resuspended by propeller wash.					Thin ice hazard to winter recreation activities.
DREDGING AND DISPOSAL	Removal of suspended sediments by natural currents.	Activity on St. Marys and St. Lawrence Rivers will cause velocity reduction, water level changes and current pattern alteration.		Temporary, localized emissions from equipment operation.	Temporary, localized noise of dredging equipment.	Abundance and edibility of fish species influenced by containment of toxic substances in new locations.
ICE BOOMS		Flooding downstream and low levels upstream due to lack of naturally occurring ice jams at some locations - upstream flooding elsewhere because of friction with artificially induced ice cover.				Stable ice cover facilitating crossing channels at new locations.
THERMAL ICE SUPPRESSION						
ARTIFICIAL ISLANDS	Induces sediment deposition around the islands.	Interference with natural flows and velocities.				
SHORE PROTECTION		Restriction of water flow into wetlands.	Interference with normal use of shore structures.			Interference with normal shoreline recreational activities. Decrease in aesthetic value of shoreline area.
AIDS TO NAVIGATION						
COMPENSATING WORKS		Alteration of current patterns with secondary impact on aeration and stability of fish eggs. Interference with natural flows.			Localized and temporary during construction and installation.	

APPENDIX 3

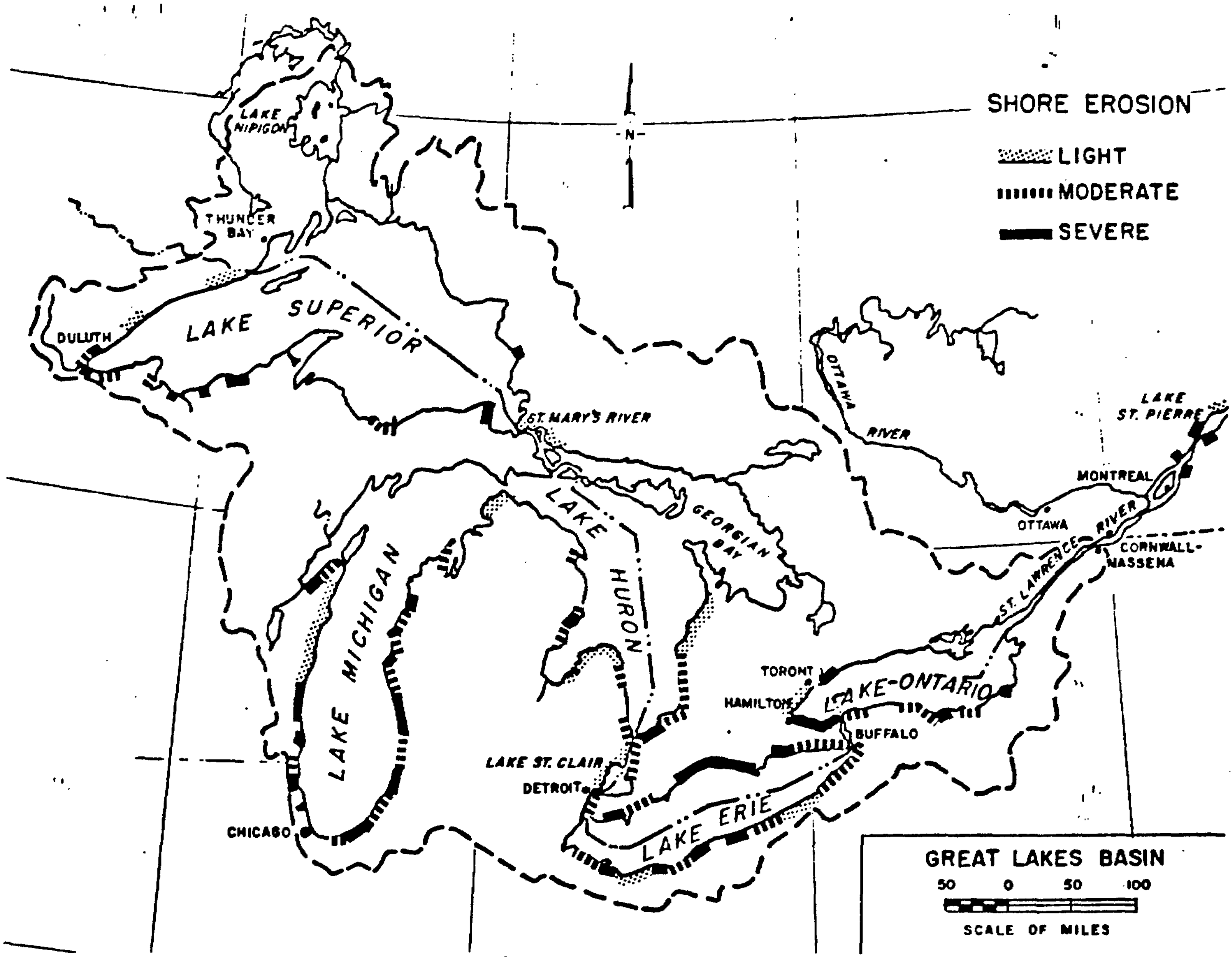

FIGURE A-3.1. Shoreline Subject to Erosion.

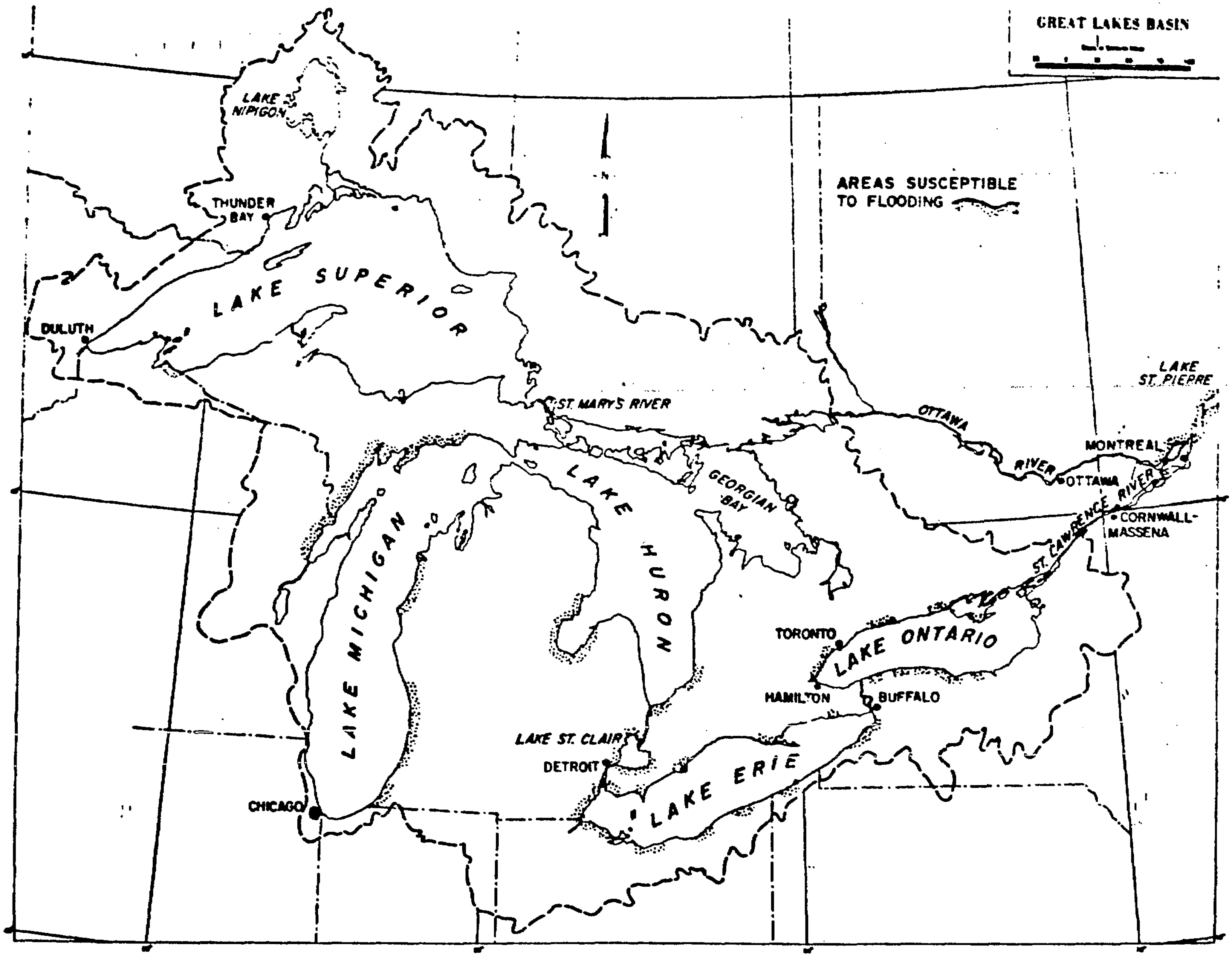

FIGURE A-3.2. Shoreline Subject to Flooding.

APPENDIX 4

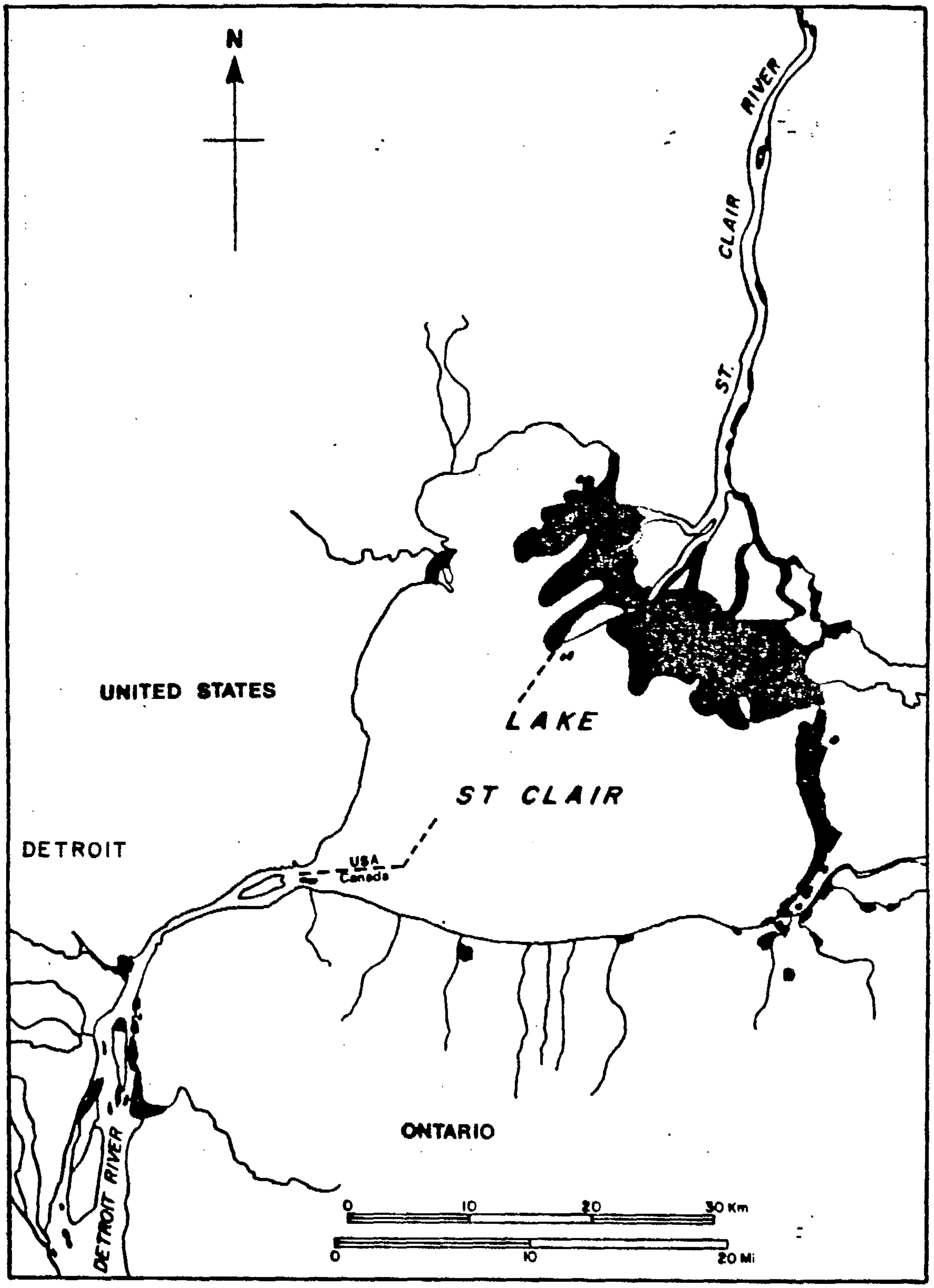

FIGURE A-4.1. Wetlands of Lake St. Clair.

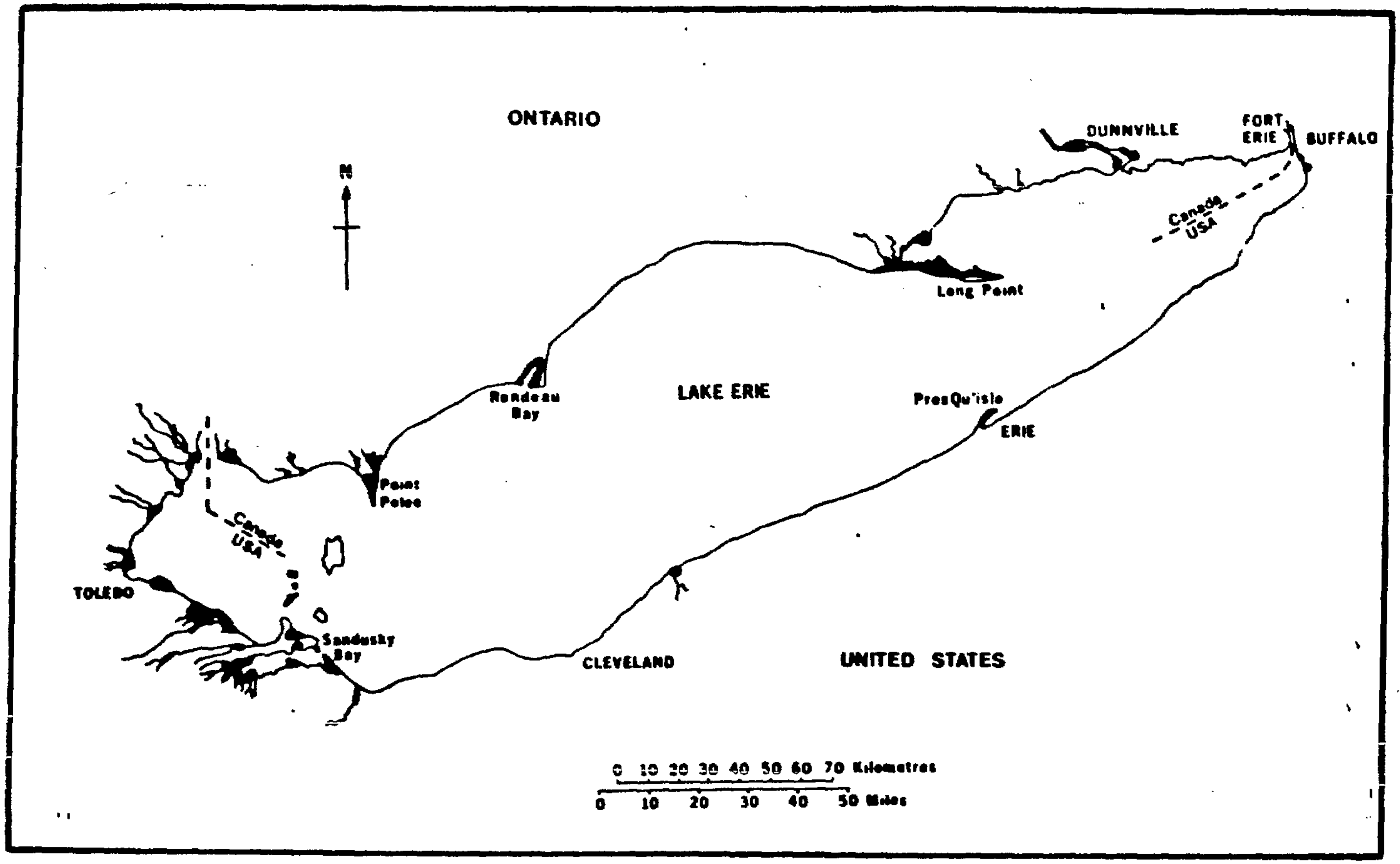

FIGURE A-4.2. Wetlands of Lake Erie.

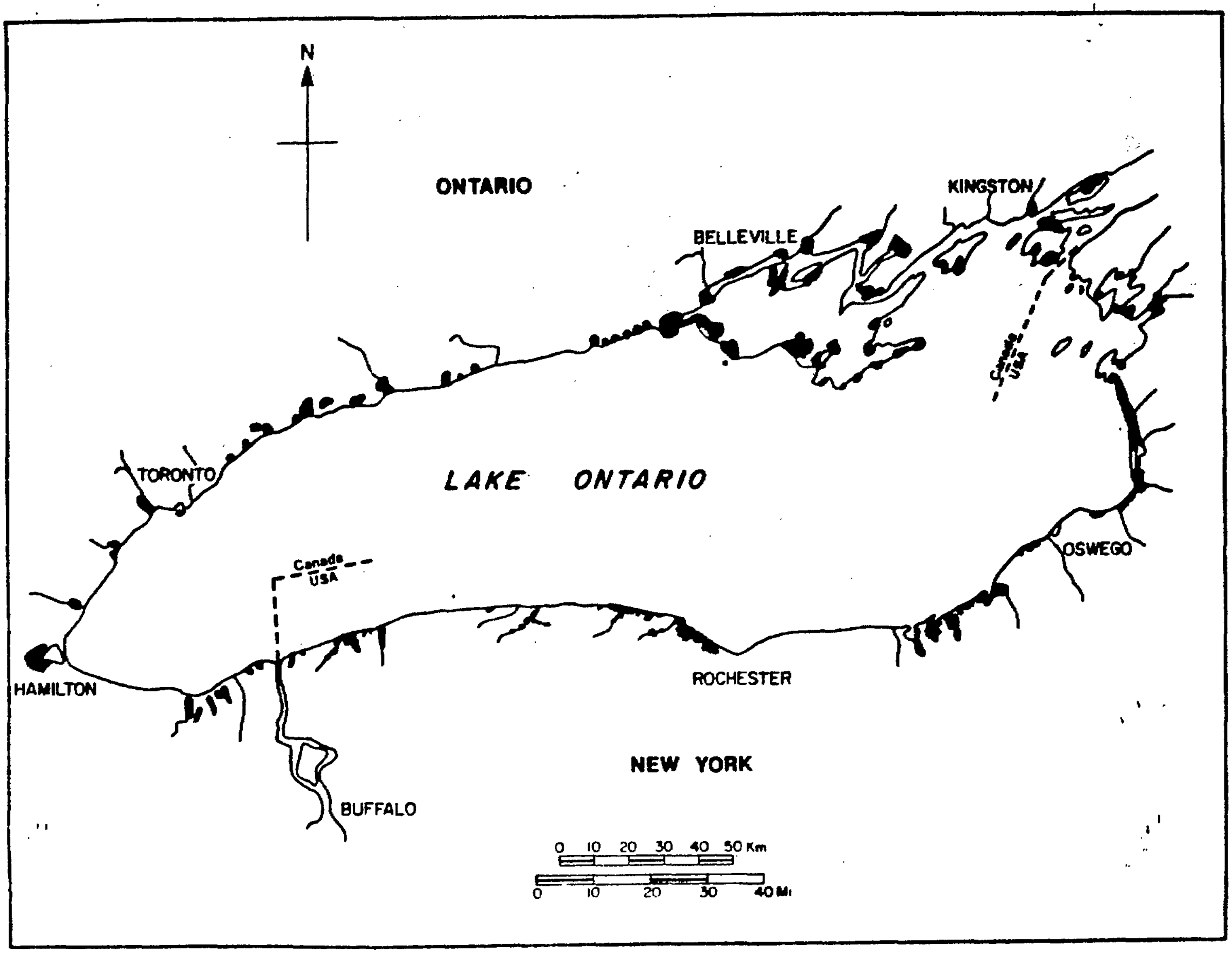

FIGURE A-4.3.. Wetlands of Lake Ontario.

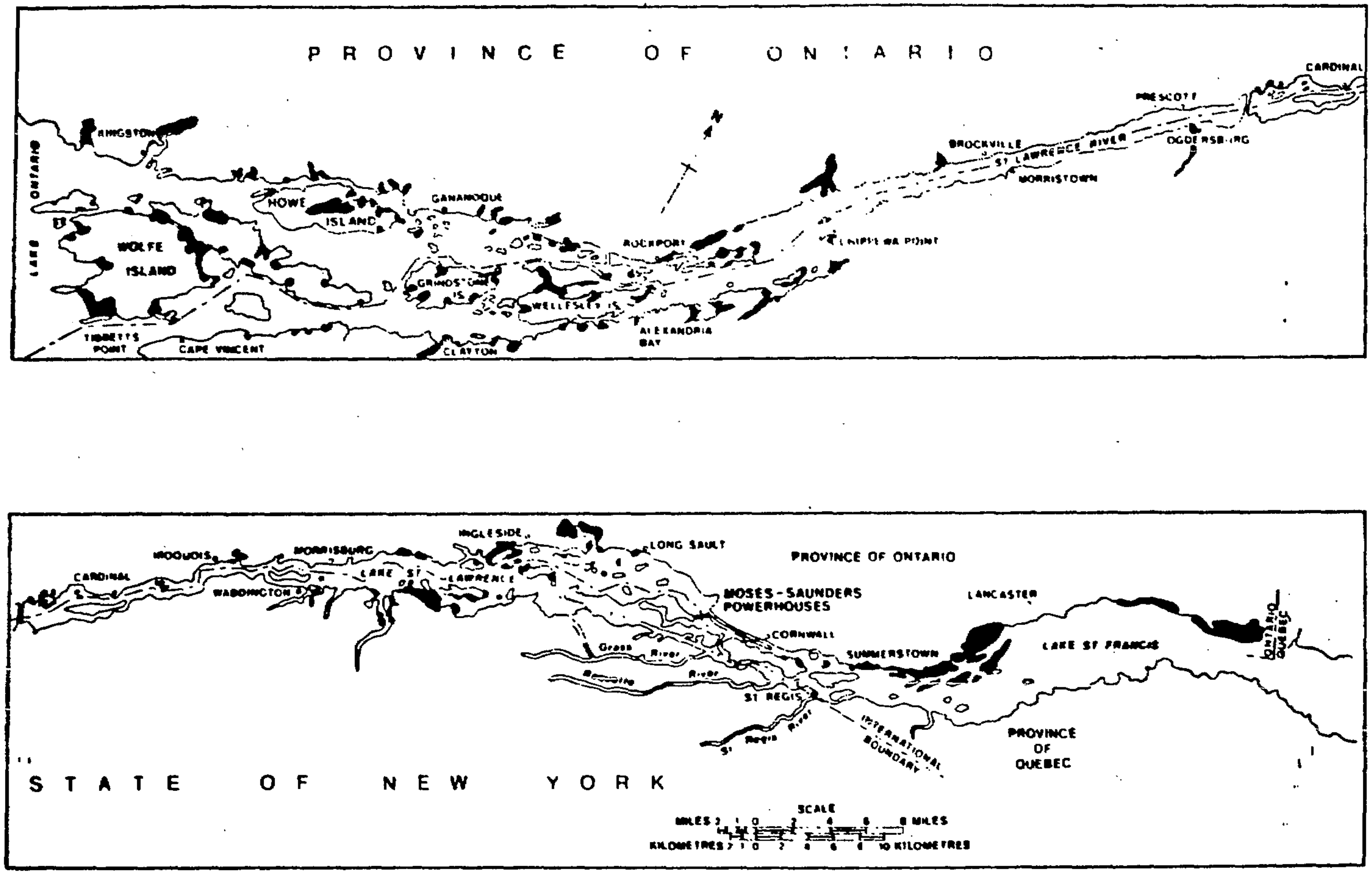

FIGURE A-4.4. Wetlands of the Upper St. Lawrence River.

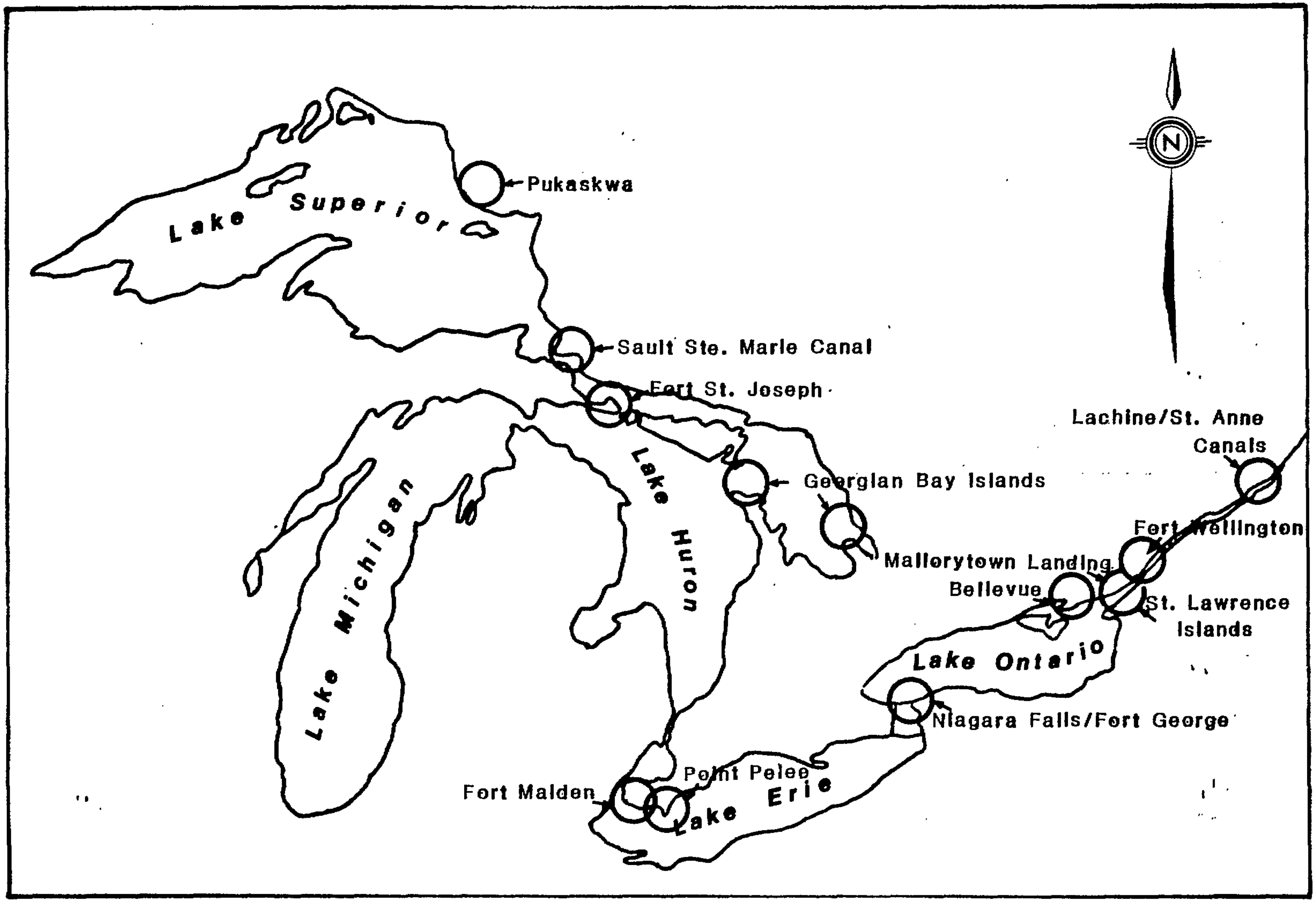

FIGURE A-4.5 National Parks and Historic Sites Along the GL-SLS.

TABLE A-4.1. Wetland Area of the Lower Great Lakes by Wetland Type and Water Body Area in Hectares (Acres).

	1. Open Shoreline	2. Unrestricted Bay	3. Shallow Sloping Beach	4. River Delta	5. Restricted Riverine	6. Lake-Connected Inland	7. Protected	Total
ST. CLAIR RIVER								
Canada	221					15		236
United States								
Total	221					15		236
LAKE ST. CLAIR								
Canada	2,788			16,824	28		12,563	32,203
United States	125			5,848	56	298	3,805	10,132
Total	2,913			22,672	84	298	16,368	42,335
DETROIT RIVER								
Canada	600	123			98		633	1,454
United States	125	135						260
Total	725	258			98		633	1,714
LAKE ERIE								
Canada	516	141	18,195		2,313	5,221	2,637	29,023
United States	2,005	1,618	374		1,569	510	18,236	24,312
Total	2,521	1,759	18,569		3,882	5,731	20,873	53,335
NIAGARA RIVER								
Canada								
United States	57	12				197	26	292
Total	57	12				197	26	292
LAKE ONTARIO								
Canada	1,114	6,353	534		6,035	4,484	590	19,110
United States	280	1,721		90	919	4,401	5,901	13,312
Total	1,394	8,074	534	90	6,954	8,885	6,491	32,422
ST. LAWRENCE RIVER								
Canada (Ont.)	6,910	3,965			1,917	1,333	23	14,148
United States	1,029	1,357			1,609	2,828	455	7,278
Total	7,939	5,322			3,526	4,161	478	21,426
TOTALS								
Canada	12,149	10,582	18,729	16,824	10,391	11,053	16,446	96,174
United States	3,621	4,843	374	5,938	4,153	8,234	29,423	55,586
Total	15,770	15,425	19,103	22,762	14,544	19,287	44,869	151,760