March 1999

CANADA'S NATIONAL PROGRAMME OF ACTION (NPA)
FOR THE
PROTECTION OF THE MARINE ENVIRONMENT
FROM
LAND-BASED ACTIVITIES

Dear Colleague,

Please find enclosed a copy of the draft *Canada's National Programme Of Action for the Protection of the Marine Environment from Land-Based Activities.* This document is currently undergoing a 60 day consultation period. You will also find enclosed, a news release and a backgrounder which provide a brief overview of the development and purpose of the National Programme of Action (NPA).

A consultation survey form has been developed to assist in providing your feedback. If possible please type your response, whether following the survey as a format or providing other comments. Please mail your response to the address provided on the survey form before the end of the 60 day consultation period.

A list of contacts (representatives from the Advisory Committee) is provided in Appendix 3 at the end of the document. These individuals are available to provide additional information or answer any specific queries you may have.

Thank you for your comments

John H. Karau
NPA Advisory Committee Co-chair
Environment Canada

Ron Pierce
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NEWS RELEASE/COMMUNIQUÉ

FEDERAL GOVERNMENT CONSULTS CANADIANS ON DRAFT NATIONAL PROGRAMME OF ACTION TO HELP PROTECT CANADA'S OCEANS

-- OTTAWA, March 26, 1999 -- In an effort to find cooperative solutions to better protect our oceans, Environment Minister Christine S. Stewart and Fisheries and Oceans Minister David Anderson today released Canada's *Draft National Programme of Action for the Protection of the Marine Environment from Land-based Activities* (NPA) for a 60-day consultation period to seek the views of Canadians.

The draft National Programme of Action proposes national and regional programs to protect human health, the environment and to prevent, reduce and control land-based activities that contribute to the degradation of the marine environment. Land-based activities affecting the health of the world's oceans include the following source categories: sewage, heavy metals, persistent organic pollutants, radioactive substances, oils / hydrocarbons, litter, nutrients, sediment and habitat destruction.

"As a maritime nation with the world's longest shoreline, Canadians understand the importance of managing this valuable resource and want their governments to lead the global effort for cleaner oceans," said Minister Stewart. "This draft National Programme of Action is to ensure future generation of Canadians benefit from a cleaner marine environment."

"The oceans continue to be stressed by a wide variety of land-based activities," Minister Anderson said. "The National Programme of Action, and several initiatives being launched by my department under the *Canada Oceans Act*, are a concerted effort by Canada to take a radically different approach to preserve and protect the oceans - one based on sustainability."

Canada's draft NPA has been prepared through the collaborative effort of the federal, provincial and territorial governments, and was co-led by Environment Canada and Fisheries and Oceans Canada. This initiative recognizes that there are important regional variations for the Arctic, Pacific, St. Lawrence and Atlantic regions which necessitate a regional approach and benefit from an overall National Programme of Action.

Canada continues to provide strong leadership for an integrated approach to ocean management and sustainable development, both domestically and abroad. This leadership was instrumental in sponsoring the first Circumpolar Ministerial Meeting of the Arctic Council which adopted a Regional Programme of Action on September 18, 1998.

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While the method of these consultations will vary from region to region, key participants who helped develop the draft NPA and interested Canadians are invited to provide comment. The draft NPA will be highlighted on Environment Canada and Fisheries and Oceans web sites. These web sites will also provide a list of the Federal/Provincial/Territorial Advisory Committee who will be able to provide further details.

Canada's NPA will be an important component of the upcoming Ministerial meetings at the United Nations Commission on Sustainable Development in April 1999.

Degradation of the marine environment is a global problem which needs a concerted international and national effort. Canada's draft NPA meets the national commitment agreed to tackle this global problem through the Global Programme of Action.

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(Également disponible en français)

Note to media: copies of the backgrounder will be available on Environment Canada's Green Lane, http://www.ec.gc.ca and Fisheries & Oceans Canada website http://www.dfo-mpo.gc.ca. Hard copies of the NPA can be obtained through Environment Canada's Inquiry Centre, (1-800-668-6767).

BACKGROUNDER

DEVELOPING CANADA'S NATIONAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES (NPA)

Oceans are critical to all life on Earth. They are an essential source of water, food and oxygen and are a finite source that must be protected. The oceans also have a powerful influence on our climate. The degradation of the marine environment is a global problem that calls for action at national, regional and international levels. The impacts from land-based activities include shellfish closures, degraded beaches, destroyed habitat and contaminated sites.

Given the transboundary nature of ocean-related issues, the goals of Canada's NPA follow those of the United Nations Global Programme of Action (GPA), an international and non legally-binding instrument agreed to by Canada together with 108 maritime nations in Washington in November 1995. The GPA was developed under the auspices of the United Nations Environment Programme (UNEP), and in response to Agenda 21 of the United Nations Conference on Environment and Development (UNCED).

The GPA called on countries to develop national and regional programmes of action to protect human health, the environment and to prevent, reduce and control land-based activities that contribute to the degradation of the marine environment. Land-based activities affecting the health of the world's oceans include the following source categories: sewage, heavy metals, persistent organic pollutants, radioactive substances, oils / hydrocarbons, litter, nutrients, sediment and habitat destruction.

In 1996, the Ministers of the Environment and Fisheries and Oceans released a national discussion paper calling on Canadians to support the development of Canada's NPA, specifically to identify problems and to recommend actions. As the protection of the Canadian marine environment is a responsibility shared among all levels of government, Canada's NPA is being developed and implemented as a full partnership between federal, provincial and territorial governments, in consultation with aboriginal peoples, stakeholders (environmental groups, industry, academia and the private sector) and other interested Canadians.

BENEFITS AND COMMITMENTS FOR CANADA

As a maritime nation, Canada has much to gain from a coordinated national and international effort to protect the marine environment from land-based activities. The NPA will help focus Canada's efforts to protect the marine environment through improved coordination and harmonization of all levels of government .

Canada's NPA addresses the concerns of Canadians about the degradation of the marine environment. Its goals are:

- to protect human health and the environment;
- to reduce degradation of the marine environment;
- to remediate damaged areas;
- to promote conservation and sustainable use of marine resources; and,
- to maintain the productive capacity and biodiversity of the marine environment.

The NPA is based on collaborative planning and decision-making among all levels of government in consultation with aboriginal peoples, stakeholders and other interested Canadians.This initiative recognizes that there are important regional variations for the Arctic, Pacific, St. Lawrence and Atlantic regions which necessitate a regional approach and benefit from an overall National Program of Action.

The NPA will link actions to control land-based activities with conservation, sustainable use and economic diversification. It will complement federal, provincial and territorial initiatives, such as those dealing with integrated management, coastal marine protected areas and pollution prevention.

In order to ensure that the NPA is carried through and implemented, the NPA will continue to monitor and promote existing actions and propose strengthened actions where appropriate. Reports on Canada's progress in implementing the NPA will assist in examining the effectiveness and efficiency of the plan.

Canada is taking affirmative steps toward its international commitment to undertake domestic action to clean up its marine environment by asking the views of all interested Canadians during a 60-day public consultation of a draft National Programme of Action (NPA). The 60-day public review period is expected to begin in early 1999 and will consist of mail-outs of the NPA and providing other background information to a wide range of Canadians. Based on the comments provided, the draft NPA will be revised and released as Canada's National Programme of Action.

With the ultimate release of its NPA, Canada will be among the first of the signatories of the GPA to do so. Among the signatories, Canada remains near or at the forefront of industrialized nations in its treatment and concern for the marine environment. Indeed, when other countries develop their own NPAs, they will, in many cases, highlight the real need for concrete and concerted environmental action. In Canada, many actions are already in place or proposed and Canada's NPA will reflect this reality in the international community.

For more information, please contact:

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NATIONAL PROGRAMME OF ACTION: OVERVIEW

Canada's National Programme of Action (NPA) meets our commitment to protect the marine environment from land-based activities under the Global Programme of Action (GPA) which was adopted by Canada and 108 other nations in November 1995.

Protection of the marine environment from land-based activities is dependent on integrated and coordinated action. In Canada and elsewhere in the world, the coastal zone is the marine area of highest resource-use conflicts, the greatest concentration and diversity of critical habitats and the most serious threats to human health and marine life from land-based activities.

It is recognized that the protection of the marine environment in Canada is a responsibility shared by all levels of government and that numerous initiatives for its protection are either in place or being developed. The NPA offers a mechanism for bringing different levels of government together to find cooperative solutions. It is based on existing resources and finding increased cost-effectiveness, efficiency and cooperation within and among governments.

This initial phase of the NPA focuses on identifying problems, priorities, goals, management objectives, and existing and potential strategies and actions. Further consultations will build on this initial phase to keep priorities current, to develop further concrete actions, and to improve the capability to achieve results.

In order to ensure that the NPA is carried through and implemented, the NPA will continue to monitor and promote existing actions and propose strengthened actions where appropriate. Reports on Canada's progress will assist in examining the effectiveness and efficiency of the plan.

Public input is critical for ensuring that the NPA priorities are relevant and up to date. In addition, the NPA can help provide technical expertise and information for community-based action programmes.

Canada's National Programme of Action (NPA) for the Protection of the Marine Environment from Land-based Activities

PUBLIC CONSULTATION SURVEY FORM

Your input is important to us.

Comments gathered during this consultation phase will assist in refining the NPA.

- You may use the following survey form as a guiding format or provide general comments.
- If possible, please type your response
- Deadline: 60 days past release date
- Please mail or fax your response to:

NPA Consultations
c/o Anne Patton
Marine Environment Division
Environment Canada
Place Vincent Massey, 12th floor
351 St. Joseph Boulevard
Hull, Quebec
K1A 0H3
Tel.: (819) 953-7254
Fax: (819) 953-0913

1. Have the land-based activities contributing to degradation of the marine environment and the related problems been adequately identified and assessed?

2. Based on the two principal considerations (severity of impacts and adequacy of existing controls) used when establishing priorities for action, do you agree with the priority ranking for action or what ranking would you suggest?

3. Have existing and potential strategies and actions been well identified and linked to the priorities for action?

4. Other comments

5. Your name:
   Your occupation:
   Address/phone/fax/e-mail:

NPA Web page: *http://www.ec.gc.ca/nat_action/index_e.html*

DRAFT

Canada's National Programme of Action (NPA) for the Protection of the Marine Environment from Land-based Activities

Prepared by the
Federal/Provincial/Territorial Advisory Committee
on Developing Canada's National Programme of Action
for the Protection of the Marine Environment
from Land-based Activities

March 1999

PREFACE

Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA) responds to an international call to protect the marine environment through co-ordinated actions at local, regional, national and global levels.

The protection of the marine environment in Canada is a responsibility shared by all levels of government, and a number of initiatives for its protection are either in place or are being developed. Keeping in mind the reality of shared responsibility, and the cost-effectiveness of building on existing programmes, the value of the NPA lies in its co-operative and collaborative approach to preventing pollution from land-based sources and protecting habitat in the nearshore or coastal zone.

This discussion paper is the collective effort of a federal, provincial and territorial team. It addresses issues on both regional and national levels, and reflects input from preliminary consultations on preparing a National Programme of Action.

The purpose of this discussion paper is to seek the views of various jurisdictions having responsibilities in the marine coastal environment, as well as the views of Aboriginal peoples, stakeholders and citizens on the proposed initial phase of the NPA. These views will assist in refining this initial phase, which will be provided to respective federal, provincial and territorial governments for approval. Future consultations will be used to keep priorities current, develop further concrete actions and monitor progress.

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CHAPTER 1. INTRODUCTION

1.1 Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities

The major threats to the health, productivity and biodiversity of the marine environment originate primarily from human activities on land, both at home and abroad. It is estimated that approximately 80% of marine pollution stems from land-based activities, and the remaining 20% from sea-based activities. As part of an international initiative to address these major threats in an integrated and co-ordinated manner, Canada and 108 other nations adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) in November 1995. This international agreement calls for participating countries to develop national and regional programmes of action.

Ultimately, Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA) aims to protect the marine environment through co-operative solutions. The NPA is being developed through participation and collaboration among federal, provincial and territorial governments. Consultations involve Aboriginal peoples and stakeholders, including environmental groups, industry, academia, communities and the Canadian public. Canada's goals under the NPA are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

Many programmes are already in place, or are being actively developed, to protect the marine environment. The NPA takes into account the priorities and actions of these existing programmes and recognizes the cost-effectiveness of building on them.

Land-based actions needed to address priority issues are identified in the NPA. However, those priority issues requiring sea-based actions are addressed through other global and national mechanisms.

Annual progress reports on implementing the NPA will assist in examining the effectiveness and efficiency of the plan. Canada's NPA also recognizes the benefit of using a phased or step approach in its development. This initial phase focuses on identifying problems; priorities; goals; management objectives; and existing and potential strategies and actions. Further consultations will build on this initial phase to keep priorities current; to develop further concrete actions; and to develop the capacity to achieve results.

1.1A.Jurisdiction

In Canada, the protection of the marine environment is a responsibility shared by all levels of government and requiring co-operation and collaboration. At least 23 federal legislative acts in Canada address issues of relevance to the marine environment, and 21 federal departments and agencies have a role in the management of the oceans sector. In addition, a multitude of provincial or territorial acts are administered by coastal provinces and territories.

Responsibility for the management of the marine environment and resources in land claims settlement areas is being shared with the Aboriginal peoples involved. It has been

established, as well, that responsibility for protection of the marine environment extends beyond current institutional arrangements to include all stakeholders.

Canada's NPA provides a management framework for co-ordinating the activities and programmes of the various levels of government with responsibilities for nearshore coastal areas. Federal jurisdiction addresses:

- navigation, shipping, oceans management, marine protected areas, fisheries management, marine mammals, migratory birds, ocean disposal, marine environmental quality, lands reserved for Aboriginal peoples, and national concerns related to international treaties, criminal law, peace, order and good government.

Provincial jurisdiction addresses:

- property and civil rights, public lands (dry land, land covered by freshwater inland or by saltwater in certain straits and passages), wildlife, minerals, freshwater, and matters of a local or private nature.

1.2 Background

Canada is a maritime nation:

- Eight of 10 provinces and two (soon to be three) territories border three oceans: North Pacific, Arctic and North Atlantic.
- Canada has the longest coastline in the world (243 789 km, including islands).
- Canada has the second-largest continental shelf (3.7 million km^2), and a total offshore area of more than 6.5 million km^2.
- Canada's coastline extends over 40 degrees of latitude, and includes a vast wealth of geological and ecological diversity (World Coast Conference, 1993; Fraser 1996).
- Complex ecosystems along the coasts, such as estuaries and wetlands, connect inland freshwater systems to nearshore marine waters.

Approximately 23% of Canadians live in coastal areas (defined as areas within 50 km of the coast). Populations on the Pacific coast are rapidly expanding, and populations on the Atlantic coast and sparsely populated Arctic coast are increasing, but more slowly. The total value of economic activity in Canada's coastal areas is estimated at $135 billion per year (World Coast Conference, 1993). However, the importance of the marine environment extends beyond economic value to a social and cultural significance for the people of Canada. For coastal residents of all cultural backgrounds, oceans are often an important source of food. There is an intimate link among the health and well-being of coastal populations, sustainable use of coastal resources, and the health, productivity and biodiversity of the marine environment.

1.3 Global Programme of Action for the Protection of the Marine Environment from Land-based Activities

The goals of the GPA are:

- protection of the marine environment; and
- promotion of the conservation and sustainable use of living marine resources.

Achieving these goals is based on maintaining or restoring the marine ecosystem by preventing its degradation from land-based activities. Implementation involves using sustainable and integrated environmental management, as well as other approaches such as the harmonization of integrated coastal management, river basin management and land-use planning.

The GPA is designed to assist countries in taking action to prevent, control, and/or eliminate marine degradation from land-based activities either jointly in a regional approach (e.g., the Arctic, the Gulf of Maine), or individually in a national approach. Development of programmes of action takes place within a country's (or countries') framework of policies, priorities and resources.

1.4. Developing Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities

1.4A.Background

Canada's first step in developing the NPA was the release of a *National Discussion Paper on Developing Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities*. The discussion paper, released by Ministers of Environment and Fisheries and Oceans on Oceans Day in 1996 (Federal/Provincial/Territorial Advisory Committee on the NPA, 1996), was used as the basis for preliminary consultations with Aboriginal peoples and stakeholders. It was then used as the basis for regional discussion papers and workshops to identify regional priorities and activities. The NPA is the overall umbrella incorporating the individual plans of the regions.

1.4B. Approach

The NPA will assist agencies and jurisdictions in identifying priorities and actions. It will be based on existing commitments under existing laws and policies to prevent and control pollution and protect habitat. Also responsive to emerging policies, priorities and initiatives, the NPA will be based on existing resources and an approach of increasing cost-effectiveness, efficiency and co-operation among existing policies, programmes, resources and legislation.

Canada's NPA is based on the principles of sustainable development, integrated management and the precautionary approach.

The goals of Canada's NPA were first set out in the 1996 discussion paper and are consistent with those endorsed by the GPA. They are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

In Canada, the preservation of traditional foods and way of life for Aboriginal peoples and coastal communities is a special concern. The GPA also calls for food security, recognizing that contaminants entering the marine environment, and the destruction and alteration of marine habitat, have direct implications for food security and the alleviation of poverty worldwide.

The focus for pollution prevention and control in Canada is on land-based sources of:

- sewage;
- persistent organic pollutants;
- radionuclides;
- heavy metals;
- oils/hydrocarbons;
- nutrients;
- contaminated sediments; and
- litter.

The focus for protection of marine habitat is on activities associated with:

- shoreline construction/alteration;
- inter-tidal and sub-tidal alteration;
- mineral and sediment extraction/alteration;
- wetland and saltmarsh alteration;
- marine waters and coastal watershed alteration; and
- biological alteration.

(For definitions of contaminants and types of habitat alteration see Appendix 1.)

In keeping with a phased approach in developing Canada's NPA, the regional sections of this document do not currently address all areas. As well, not all management objectives, strategies and actions are fully developed. The intent of this phase of the NPA is to raise awareness, generate ideas, present initial actions and stimulate further debate. The ultimate objective of the NPA is the development and implementation of concrete actions to protect the marine environment.

Literature Cited

Federal/Provincial/Territorial Advisory Committee on the NPA. 1996. **National Discussion Paper on Developing Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities.**

Fraser, C. 1996. **Integrated Coastal Area Management: A Canadian Retrospective and Update.** Presented to the United Nations Commission on Sustainable Development.

UNEP(OCA)/LBA/IG.2/7. 1995. **Global Programme of Action for the Protection of the Marine Environment from Land-based Activities.**

World Coast Conference. 1993. **Canada Country Description for World Coast Conference 1993, International Conference on Coastal Zone Management, The Hague, The Netherlands, 1-5 November, 1993.**

CHAPTER 2. METHODS

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) offers a framework methodology for establishing national and regional programmes of action. Canada is using this methodology in developing its National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA). This methodology involves a six-step process:

1. Identification and assessment of problems.
2. Establishment of priorities for action.
3. Setting goals and management objectives.
4. Identification, evaluation and selection of strategies and actions.
5. Identification of criteria for evaluation of effectiveness.
6. Development of programme support elements.

2.1 Identification and Assessment of Problems

The nature and significance of impacts from sources of land-based activities are identified and assessed. These activities were examined within 14 categories (defined in Appendix 1) and listed below:

Contaminants

- Sewage
- Persistent organic pollutants
- Radionuclides
- Heavy metals
- Oils/hydrocarbons
- Nutrients
- Contaminated sediments
- Litter

Physical Alteration and Destruction of Habitat

- Shoreline construction/alteration
- Inter-tidal and sub-tidal alteration
- Mineral and sediment extraction/ alteration
- Wetland and saltmarsh alteration
- Marine waters and coastal watershed alteration
- Biological alteration

The GPA recommends that the identification and assessment of land-based activities consider the severity of the problem in relation to:

- food security and poverty alleviation;
- public health;
- coastal and marine resources and ecosystem health, including biodiversity; and
- economic and social benefits and uses, including cultural values.

In addition, consideration is given to the sources of degradation (such as point or non-point) and the specific areas of concern affected (such as critical habitats).

The NPA distinguishes between activities affecting the marine environment that are land-based and those that are of marine origin. "Land-based activities" means directly on land or connected to the land. In this regard, there are a number of sea-based activities in nearshore waters (e.g., coastal dredging for navigation or mining, and harbour developments) that can affect coastal habitat under tidal influence in a fashion similar to that of land-based activities. By association, these could reasonably be included.

For example, in the Arctic, land-fast ice acts as an extension of the land, and yet also acts as a habitat element of the marine environment. Therefore, breaking land-fast ice to lengthen the shipping season is considered a land-based activity. Activities such as disposal of sediments beyond the nearshore sub-tidal zone would not be

considered as land-based for the purposes of consideration under the NPA. A similar case is made for the problem of biological alteration due to the introduction of alien species in ballast water. When ballast water exchange is offshore, it does not fall within the purview of the NPA; however, the Programme does consider species introduced to coastal waters from shipping operations in and adjacent to ports.

2.2 Establishment of Priorities for Action

In keeping with the approach recommended by the GPA, two principal considerations are used when establishing priorities for action.

First, the severity of existing or potential impacts is examined in the context of risk to human health and/or risk to the environment. Priorities for action also consider economic/social/cultural impacts and food security (traditional foods).

Second, the adequacy of existing control measures is factored into the ranking process. In this way, greater attention is focused on the issues that would benefit from strengthened measures, such as regulations, guidelines, partnerships and community actions.

Based on these two principal considerations, categories of land-based activities are ranked as either a **high, medium or low priority**. National priorities for action may differ from regional priorities because they focus on those problems:

- that are commonly found in most or all regions of the country; or
- that are shared by more than one region; or
- that are global in nature and can be best dealt with effectively through national and international actions.

2.3 Setting Goals and Management Objectives

Once national and regional priorities for action are established, appropriate management objectives[1] are assigned to each source of impact. Sources and receiving environments are both considered.

2.4 Identification, Evaluation and Selection of Strategies and Actions

In the context of Canada's NPA, the two primary strategies for protecting the marine environment from land-based activities are pollution prevention and integrated resource and environmental management in the coastal zone. To address priority contaminant and habitat alteration issues, specific actions, either already in place or proposed, are identified. In selecting the best actions for dealing with each priority issue, consideration is given to current best practices. Improved integrated planning and management processes are recommended where appropriate, as are the use of innovative economic instruments and incentives to encourage beneficial action.

2.5 Identification of Criteria for Evaluation of Effectiveness

Recognizing that priorities will change over time, strategies and actions will be assessed periodically to ensure they remain effective and are linked to management objectives. Measures of effectiveness must be practical and cost-effective.

2.6 Development of Programme Support Elements

Support elements specific to the NPA will be required at both the national and regional levels. They are intended to provide the institutional support, guidance and review mechanisms needed to implement the NPA.

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1 In the context of Canada's NPA, management objectives are interpreted as goals. These goals are analogous to the aims of the GPA.

CHAPTER 3. NATIONAL ISSUES

INTRODUCTION

The coastal zone of Canada has the highest resource-use conflicts, the greatest concentration and diversity of critical habitats, and the most serious threats from land-based activities to human health and marine life. Population expansion in the coastal zone brings additional pressures. A number of estuaries and nearshore regions of Canada, particularly near urban centres and major industrial operations, are degraded by chemical contamination and physical or biological disruption. As a consequence, shellfisheries and public amenities are being impaired or lost; consumption of some species of fish and wildlife is being restricted for health reasons; some local populations of species are at risk; and biological diversity is threatened or at least seriously challenged.

The source of problems in the marine environment can also be quite distant. Contaminants that pose risks to human health and living marine resources are transported great distances by river water, by mass movement through global ocean currents and by atmospheric processes.

3.1. Identification and Assessment of Problems

3.1A. Contaminants

Sewage

Sewage-related problems all over the world have a great deal in common. Consequently, domestic waste-water discharges are considered one of the most significant threats to coastal environments worldwide.

The key issue of sewage contamination (in this case human and animal waste) relates to effects on human health and the environment from bacterial and viral contamination of shellfish. Sewage is released to the marine environment from point sources (from municipal discharges) and non-point sources (individual septic systems, storm water and agricultural practices). Within urban areas and during periods of high runoff, combined sewer overflows allow sewage to be transferred from the sanitary sewer system to the storm water system, resulting in significant contamination of nearshore waters.

Closures of shellfish harvesting and swimming areas are both common. Bacteria discharged with municipal waste water are implicated in about half of the areas closed to shellfish harvesting along the Atlantic and Pacific coasts; the other half are closed because of non-point sources of bacteria (Government of Canada, 1996). This problem will escalate with the continued development of coastal regions, unless adequate waste-water treatment measures are adopted and non-point sources are reduced.

Data on available sewage treatment is presented below for urban coastal communities (greater than 1000 people) in 1996 — the year of the most recent national census. This data was extracted for communities within 60 km of a marine shoreline from Environment Canada's Municipal Water Use Database, and may differ from other sources cited in this document that include communities of less than 1000 people.

Extent in 1996 of Municipal Sewage Treatment Serving Urban Coastal Communities (greater than 1000 people) in Canada (Lacelle, 1998)

	Percentage of urban population served by							
	Municipal sewage with no treatment %	On-site disposal systems %	Municipal ponds %	Municipal primary %	Municipal secondary %	Municipal tertiary %	Population reporting	No. of communities
Newfoundland	73	16	3	3	5	0	400 455	83
Nova Scotia	40	29	4	4	22	0.6	663 057	39
Prince Edward Island	0	7	13	68	12	0	63 528	9
New Brunswick	9	17	20	27	27	0	349 079	60
Quebec	11	20	63	0	6	0	210 357	37
Northwest Territories	0	0	94	0	6	0	20 420	13
British Columbia	2	14	3	67	14	0.2	2 780 808	76
Canada	15	17	8	46	15	0.2	4 487 704	317

Persistent Organic Pollutants

On entering the environment, persistent organic pollutants (POPs) can alter the normal biochemical and physiological functions of plants and animals, including humans. Effects may include molecular changes (enzyme activity, DNA damage), cellular changes (tumour formations), tissue changes (eggshell thinning, organ functioning), individual changes (behaviour, deformities), population changes (mortality, abundance, distribution), and community changes (numbers of species and their interactions).

POPs include organochlorine pesticides and their metabolites, industrial chemicals, and anthropogenic and natural combustion products. Sources can be local, regional or distant.

Contamination by POPs found in harvested species of fish and wildlife can be a significant concern in certain marine environments. The long-range transport of POPs to the Arctic is considered one of the most significant threats to environmental quality in a region where there is a heavy reliance on traditional foods.

Radionuclides

Radioactive materials can present hazards to human health and to the environment. Radiation can alter essential cellular components and genetic material (DNA), causing a range of problems including cancer.

In Canada, Point Lepreau in New Brunswick is the only nuclear generating plant located in the coastal zone. Releases to freshwater may or may not result in downstream effects in marine environments. Inputs of radionuclides to the marine environment from Canadian sources are monitored and are very low.

The majority of radionuclides that have entered Canada originate from atmospheric fallout of nuclear weapons testing that took place between 1952 and 1978, and the accident at the Chernobyl nuclear power plant in 1986. Although current radionuclide levels are low, the potential exists, through long-range transport, for impacts on the marine environment from accidental releases in other parts of the world.

Heavy Metals

Metals and metallic compounds entering the marine environment may pose a risk to human health through the consumption of seafood in areas of significant contaminant content and exposure. Like POPs, heavy metals may also alter the normal biochemical and physiological functions of plants and animals. Heavy metals may adversely affect specific tissues, reproduction and development. They may also cause anemia, nervous system disorders and depressed immune systems, resulting in mortality and effects on population levels.

Major local sources of heavy metals are mining, smelting, urban settlements and industrial complexes (such as pulp mills, chemical industries, docks and shipyards). Mineralization of natural geological deposits can also contribute local inputs of heavy metals. Distant sources include smelters and coal-fired generating stations, which contribute to the atmospheric transport of heavy metals.

Mercury and cadmium have been found in fish, polar bears and other marine mammals. High concentrations of these metals in the tissues of some species pose a concern for human consumption. As with POPs, metals with origins in industrialized regions of Europe, Asia and North America are found in the Arctic, and to some degree in other parts of the Canadian marine environment. Some heavy metals found in biota may also originate from naturally occurring geological sources.

Oils/Hydrocarbons

Oils may be toxic to aquatic life when ingested or absorbed through skin or gills and can interfere with respiratory systems. They can also foul fur and feathers, taint seafood, contaminate water supplies and smother aquatic communities, habitats and bathing beaches.

Oil pollution from urban settlements and industrial complexes is primarily of local concern. Oil pollution in ports varies with the volume of ship traffic and the tonnage of oil handled at oil handling facilities. The risk from onshore oil and gas operations, including pipelines and refineries, is associated with the accidental release of oil or chronic discharges.

Non-point source discharges of oil/hydrocarbon products are common. In dense urban areas, the concentration of automotive hydrocarbons in storm water may contribute significantly to the presence of these contaminants in the nearshore habitat. Other releases into the marine environment result from spills during the transfer and storage of fuel during coastal community resupply (a particular problem in the Arctic).

Nutrients

Eutrophication of coastal waters may result from natural processes or from the introduction of excessive nutrients caused by human activity.

The effects of enhanced biological productivity can result in excessive algal growth, decreased dissolved oxygen, anoxia and associated fish kills (especially during the summer months), loss of habitat and changes in species diversity. It is also suspected that enhanced biological productivity causes an increased prevalence or frequency of toxic algal blooms, and eutrophication that may impair aesthetic and economic value.

On a national basis, nutrient inputs to the marine environment are not considered a significant problem. Exceptions include situations where localized eutrophication may result from nutrient inputs, as in the case of some point and non-point sewage sources, or non-point source agricultural runoff.

Contaminated Sediments

Sediments can be repositories for some contaminants that can accumulate over time. Once chemicals are in sediments, they are generally considered to be less of a threat to organisms. Moreover, they are not transported to other areas unless the sediments are

disturbed and resuspended. However, bottom-feeding organisms can be subject to contamination and become a major pathway for contaminants to enter food chains.

Elevated concentrations of contaminants (heavy metals, POPs and polycyclic aromatic hydrocarbons) are associated with major seaports as a result of shipping and land-based activities. Dredging and inter-tidal disposal of contaminated sediments can lead to increased dispersion of these contaminants. The problem of contaminated harbour sediments will continue until land-based sources are better controlled.

Sediments can also have a physical impact on habitat. The section on habitat ateration provides an examination of the physical impact of sediments.

Litter

Litter or marine debris is any persistent, manufactured or processed solid material which is discarded, disposed of or abandoned in the marine and coastal environment.

Litter threatens marine life through entanglement, suffocation and ingestion. It degrades the visual amenities of marine and coastal areas, resulting in negative effects on tourism and general aesthetics. Litter in the marine environment can also damage coastal habitats, foul fishing and aquaculture gear, and create navigational hazards.

Sources include poorly managed or illegal waste dumps adjacent to rivers and coastal areas, windblown litter from coastal communities, resin pellets used as industrial feedstocks, and litter channelled to the marine and coastal environment through municipal storm water systems and rivers. Marine litter is also caused by dumping of garbage into the marine and coastal environment by coastal communities and recreational and commercial vessels.

3.1B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

Most loss or degradation of shoreline habitat is from many small-scale activities by individuals, small industries or local utilities. Considered on their own, these activities may appear benign. The net consequence over many years, however, is a cumulative loss of these critical habitats. Areas where population growth is at its highest (e.g., the Lower Mainland of British Columbia) are of particular concern.

Large-scale alterations of shoreline habitats are infrequent but significant in their impact. They are generally related to port development, larger industrial expansion, or attempts to harden shorelines against natural erosion to protect existing shoreline communities, businesses and amenities. Such alterations, both large and small, occur mainly in the harbours, inlets and estuaries that are among the most productive and important marine habitats. The impacts are therefore related more to ecosystem integrity than to human health or the economy, although the fishing industry can also experience losses. Affected areas also cease to provide sources of traditional foods, affecting local populations that have depended on these sources for part of their livelihood.

Inter-tidal and Sub-tidal Alteration

This category of habitat alteration includes effects related to fixed fishing gear, docks and piers and certain types of land-based aquaculture devices and facilities. Concerns involve the loss of key habitats for native fish species, including areas required for migration, spawning and nurseries. Log holding and transport on the West Coast causes loss of habitat in the holding areas, but it also results in degradation of benthic habitats because of the accumulation of bark.

Ice breaking of land-fast ice associated with shipping near Arctic ports and harbours

creates unsafe conditions for over-ice travel and interferes with subsistence hunting. It also has an effect on seal pups and other sea mammals.

Human health and the economy are not generally affected to a significant extent by this category of activity, but some impacts on the safety of northern over-ice travel and traditional food sources may occur. The greatest concern for this type of activity is for the preservation of ecosystem integrity.

The harvesting of marine plants from the inter-tidal and sub-tidal zone can result in alteration or loss of habitat for other species, decreased biodiversity, or unsustainable use of the resource.

Mineral and Sediment Extraction/Alteration

Harbour dredging and sediment disposal are common on all three Canadian coasts, but existing controls limit the severity of impacts. The National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA) is concerned with cases where dredging and disposal occur in the inter-tidal or nearshore zone.

Sand and gravel extraction has not yet become a prevalent activity, mostly because of limited distribution of economically extractable deposits. Nevertheless, in the areas where it does occur, there can be localized habitat destruction.

Coastal mining (e.g., the extraction of minerals from coastal deposits) is not a widespread activity in Canada. However, land-based mines and mills have occasionally disposed of tailings and other wastes into the marine environment, resulting in significant alteration through burial of habitats.

These forms of habitat alteration do not generally result in impacts on human health, the economy or traditional foods, but they may cause some environmental impact.

Wetland and Saltmarsh Alteration

Since the earliest coastal settlement in Canada by Europeans, wetlands and marshlands have been altered or destroyed. Today, less than 70% of the original habitat remains. Losses are greatest in areas of intense urbanization and agriculture. Other forms of alteration continue, such as harvesting of marsh grasses and other vegetation, draining to control insect populations, and engineering works to create waterfowl habitat.

Wetlands are highly productive habitats that play an essential role in critical life stages of fish, amphibians, reptiles, birds and mammals. They serve as spawning grounds and nurseries for fish and as nesting grounds, staging areas and migration stop-overs for waterfowl and other birds. The effects of loss and degradation of such habitats are principally related to ecosystem integrity, biodiversity and marine resource productivity. Human health is not normally endangered, and economies, with the exception of those based upon the fishing sector, are generally unaffected. Local sources of traditional foods, however, can be severely limited, creating economic hardship for coastal communities. Other economic losses can result, such as a decline in ecotourism.

Marine Waters and Coastal Watershed Alteration

Localized impacts can result from entrainment and entrapment of fish and other marine organisms in saltwater intakes at power plants or intakes for industrial use. For similar reasons, there are concerns over thermal, gas pressure and salinity alterations in coastal and estuarine habitats caused by impoundment, cooling water outflows, and major hydroelectric watershed diversions.

Although the state of scientific knowledge on the effects of such alterations is limited, the resulting impacts are viewed to be primarily of ecological concern — with limited direct

effects on human health, economic well-being or availability of traditional foods.

Biological Alteration

Biological alterations in coastal waters are caused by the accidental transport of exotic or non-indigenous species of plankton, crustaceans, pathogens and parasites in the bilge and ballast water of large tankers and freighters on international routes. Much of this problem results from ballast water exchange offshore, and does not fall within the purview of the NPA. However, the NPA addresses species introduced from ballast water discharges within ports.

Another form of biological alteration can result from accidental or deliberate movement of organisms in land-based or nearshore aquaculture operations. In most cases, the introductions are inadvertent (e.g., non-indigenous salmonids escape when nets are damaged by seals or climatic conditions, and parasites or pathogens from cage-reared fish transfer to wild fish populations).

In the temperate to Arctic waters off the coasts of Canada, introductions of this kind have had some impact on locally sensitive ecosystems, though not enough to alter biodiversity. Impacts on availability of traditional foods are moderate, except in some temporary closures for shellfish harvesting because of toxic algal blooms (e.g., Domoic acid problem). Similarly, human health impacts have been restricted to the dangers posed by harmful algal blooms, and are subject to stringent monitoring efforts.

3.2. Establishment of Priorities for Action

Using severity of risk to human health and the environment, and the adequacy of existing controls, various land-based activities affecting the marine environment are assigned priorities for action (see Chapter 2). An overview of national priorities is found in Table 3-1 (see page 14). National priorities for each contaminant or habitat category may not necessarily be the same as regional priorities, as detailed in later regional chapters, since national priorities for action are those that are viewed as common, shared or global in nature.

3.2A. Contaminants

Sewage

Sewage inputs to the marine environment are a common resource-use conflict and public health problem found in all regions of Canada. More effective point and non-point source control measures are required, supporting a need for **high priority** attention.

Persistent Organic Pollutants

POPs are a serious environmental and public health problem shared by all regions in Canada and the global community. In addition to severity of impact, there are immense difficulties and expenses in cleaning up contaminated sites. National point source control measures are considered effective; however, strengthened remedial measures and non-point source controls are needed. Controlling inputs from international sources would benefit from further regional and global agreements. POPs are in need of **high priority** attention.

Radionuclides

Radionuclides are a shared and global problem. However, radioactive contamination in Canada is low, and sources are well regulated. On a national basis, a **low priority** is recommended. The management of radioactive wastes is a major concern in the Russian Federation, and is a priority for the circumpolar countries.

Heavy Metals

Heavy metals are also a shared and global problem. Metals such as mercury and cadmium are of particular concern because of their human health impacts. National controls on point sources are considered effective. International measures on long-range

transport are improving and are supported. Additional national controls on non-point sources are necessary. A **medium priority** is assigned.

Oils/Hydrocarbons

Oils/hydrocarbons are viewed as a common problem resulting in resource-use conflicts such as degraded fish habitat, oiled beaches and tainted seafood. Fish kills, oiled seabirds and hydrocarbon contamination in harbours are also of concern. Improved measures are needed for urban runoff, spill response, and proper handling and storage. A **medium priority** is assigned.

Nutrients

Nutrients can cause eutrophication in all regions of Canada. Much of the concern related to nutrients can be addressed at the regional level through improved sewage treatment and good agricultural practices. On a national basis, a **low priority** is assigned.

Contaminated Sediments

Contaminated sediments are a common problem found in all regions with impacts mainly limited to sediments found in harbours and adjacent areas. The current regulatory controls on disposal of dredged sediments are considered effective. The long-term solution is to improve the control of discharges to water from which dredged material is taken, and thus a **medium priority** is assigned.

Litter

Input of litter from land-based sources is also common to all regions and results in reduced amenities, property damage and entanglement of marine life. Enhanced public awareness and adequate disposal facilities are effective measures to reduce litter. A **medium priority** is considered appropriate.

3.2B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

Shoreline construction and alteration activities are a common problem resulting in a cumulative, wide-scale loss of valuable foreshore habitat with losses measured in both environmental and economic terms. They are given a **high priority**.

Inter-tidal and Sub-tidal Alteration

Inter-tidal and sub-tidal alterations can be severe on a local scale. In most cases controls are available, although not always employed. The consequences of such impacts are largely environmental rather than economic. For these reasons, this category of habitat alteration is accorded a **medium priority.**

Mineral and Sediment Extraction/Alteration

Mineral and sediment extraction and alteration are fairly ubiquitous activities but generally well regulated. Impacts associated with these activities are usually of lesser environmental importance and often temporary. They are consequently considered a **low priority** for further action.

Wetland and Saltmarsh Alteration

Activities altering wetland and saltmarsh habitat are assigned a **high priority** because of the limited availability of these habitats and their high value for numerous species at various life stages. Losses of wetlands also have significant economic consequences, particularly for the fisheries sector.

Marine Waters and Coastal Watershed Alteration

Alterations to marine waters and coastal watersheds can be severe on a local scale. Impacts are primarily environmental rather than economic. Controls are available in most cases, although sometimes not employed. For these reasons, such alterations are given a **medium priority**.

Biological Alteration

Biological alterations are accorded a **medium priority** on a national basis. Biological introductions from aquaculture and hatchery operations are subject to stringent regulation. At this time, species introductions from ballast water exchange are not well controlled. However, from the perspective of the NPA, only a fraction of the potential impacts from this activity can be considered land-based.

Table 3-1. National Priorities

Sources	Criteria		Priorities	
	Common*	Shared*	Ranking	Rationale
Contaminants				
Sewage	✔		high	• demonstrated effects on humans/animals • restrictions on shellfish harvesting • affects all regions • additional point and non-point source control measures required
POPs	✔	✔	high	• demonstrated effects on humans/animals • affects all regions • serious difficulties for cleanup • effective point source control; non-point source control measures need to be strengthened
Radionuclides		✔	low	• Canadian contamination low • sources well regulated
Heavy metals	✔	✔	medium	• demonstrated health impacts • national point source controls are effective • international measures on long-range transport are improving • additional non-point source controls are required
Oils/ hydrocarbons	✔		medium	• degradation of marine organisms and habitat • improved measures for urban runoff, spill response, and proper handling and storage are required
Nutrients	✔		low	• affects most regions (eutrophication) • impacts can be predominantly addressed by improved sewage treatment and good agricultural practices
Contaminated sediments	✔		medium	• impacts usually localized (contamination of harbour sediment) • regulatory controls on disposal of dredged sediment are effective • controls on discharge of source materials (i.e., POPS and heavy metals) from non-point sources are required
Litter	✔	✔	medium	• land-based sources are common to all regions • health hazard to humans/animals; environmental impacts • public awareness and increased disposal facilities can reduce litter

Sources	Criteria		Priorities	
	Common*	Shared*	Ranking	Rationale
Physical Alteration and Destruction of Habitat				
Shoreline construction/ alteration	✔		high	• cumulative, wide-scale loss of habitat • environmental and economic losses
Inter-tidal and sub-tidal alteration	✔		medium	• locally severe • control available but not always employed • environmental impacts primarily
Mineral and sediment extraction/ alteration	✔		low	• generally well regulated • impacts frequently temporary • impacts usually of lesser environmental importance
Wetland and saltmarsh alteration	✔		high	• limited habitat which is extremely valuable • significant economic losses, esp. fisheries
Marine waters and coastal watershed alteration	✔		medium	• locally severe • control available but not always employed • environmental impacts primarily
Biological alteration	✔	✔	medium	• high risk factor • generally stringent regulation

*See Chapter 2 on ranking priorities and description of "common" and "shared".

3.3. Setting Goals and Management Objectives

Under the NPA, Canada's goals are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

The following are specific management objectives for each source category.

3.3A. Contaminants

The general management objective for most of the contaminants is to reduce their presence in the marine environment, primarily through pollution prevention. Where contaminants are released to or occur in the marine environment, the management objective is to apply life-cycle management or remediation to address the problems.

Specific management objectives for each of the contaminants of concern at the national level are:

Sewage — reduce contamination from sewage; maintain and improve estuaries, coastal water and marine ecosystem quality for all users; maintain and restore shellfish growing areas.

Persistent Organic Pollutants — reduce/ virtually eliminate anthropogenic inputs and apply life-cycle management to remaining inputs.

Radionuclides — reduce inputs where they are likely to cause pollution; apply radiological protection.

Heavy Metals — reduce inputs where they are likely to cause pollution; apply life-cycle management.

Oils/Hydrocarbons — prevent spills and establish contingency plans; apply life-cycle management.

Nutrients — reduce inputs where they are likely to cause pollution.

Contaminated Sediments — reduce sediment contamination at source.

Litter — reduce litter/debris found in the marine environment.

3.3B. Physical Alteration and Destruction of Habitat

The primary management objectives are to mitigate or avoid harmful alteration and destruction of habitats, and to restore those habitats already degraded. For some categories of harmful alteration (e.g., mineral and sediment extraction or alteration; alteration of marine waters and coastal watersheds), it is also necessary to identify critical habitats to ensure that such activities occur in areas of lesser environmental sensitivity or significance. Finally, there are some specific management objectives that apply to unique problems. For instance, the objective is to eliminate the accidental or deliberate introduction of exotic species to the marine environment from land-based activities.

Specific management objectives for each of the habitat categories of concern at the national level are:

Shoreline Construction/Alteration — minimize habitat loss and balance these losses by restoring or creating equivalent replacement habitat.

Inter-tidal and Sub-tidal Alteration — identify critical habitats and prevent loss or degradation of these areas while restoring those already degraded.

Mineral and Sediment Extraction/Alteration — identify and protect sensitive habitats and marine resources.

Wetland and Saltmarsh Alteration — prevent any further loss or destruction of critical habitats and, where feasible, restore valuable areas previously drained or altered.

Marine Waters and Coastal Watershed Alteration — protect key habitats for all life stages of marine resources.

Biological Alteration — prevent all inadvertent or inappropriate introductions of alien species and pathogens and protect sensitive coastal ecosystems.

3.4. Identification, Evaluation and Selection of Strategies and Actions

Two key strategies employed in Canada for the protection of the marine environment from land-based activities are pollution prevention and control, and integrated management of the coastal zone and coastal watersheds. Both these strategies involve using sustainable and integrated environmental management, and other approaches such as the harmonization of integrated coastal management, river basin management and land-use planning.

Pollution prevention reduces the risk to human health and the environment by using processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste. It focuses on eliminating the cause of pollution, rather than treating the symptoms.

The purpose of integrated coastal zone management (ICZM) is to maximize the benefits provided by the coastal zone while minimizing the harmful effects of resource use activities. Its goals are conservation, sustainable use and economic diversification in the coastal zone, and it focuses on collaborative planning and decision making.

For all land-based activities in Canada there are common national actions that are ongoing or emerging in support of the goals under the NPA. It is inherent in the NPA that the most cost-effective approach is to build on these existing or emerging programmes. National actions take the form of:

1. monitoring existing actions when they are deemed adequate,
2. strengthening existing actions when they are deemed inadequate; and
3. proposing new actions for immediate preventive and remedial actions based on existing knowledge, resources, plans and processes.

Using this approach, the following sections itemize specific national actions.

3.4A. Contaminants

Sewage

- promote compliance with existing regulations;
- upgrade infrastructure (including storm water infrastructure) (proposed);
- maintain and restore shellfish growing areas (existing measures should be strengthened);
- promote adequate installation and maintenance of septic systems and manure storage systems (existing measures should be strengthened);
- employ economic instruments for upgrading infrastructure (proposed);
- promote research and development of alternative technologies for small communities and those with special geographic considerations;
- apply sound land-use planning practices (existing measures should be strengthened);
- develop, promote and monitor implementation of best management practices (proposed); and
- use education to inform the public of their roles/potential contributions (existing measures should be strengthened).

Persistent Organic Pollutants

- implement the Toxic Substances Management Policy;
- ensure/promote compliance with existing regulations;
- remediate "hot spots";
- promote the ARET (Accelerated Reduction and Elimination of Toxics) Programme and other voluntary control measures;
- promote sound pesticide use;
- promote alternatives to harmful chemicals;
- promote the use of appropriate environmental indicators; and
- continue to participate in the development and implementation of international agreements such as the POP Protocol under the UN-ECE LRTAP (United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution) Convention and the UNEP (United Nations Environment Programme) Global Initiative on POPs.

Radionuclides

- promote safe processing, storage, conditioning, transportation and disposal of radioactive substances;
- assist the Russian Federation in treating and disposing of radioactive wastes (existing measures should be strengthened).

Heavy Metals

- ensure/promote compliance with existing regulations;
- promote clean technology for industries and utilities (e.g., metal mining/milling,

metal plating, thermal generation) (proposed);
- promote best management practices, such as ISO 14000; and
- continue participation in international efforts to establish and implement regional agreements (e.g., UN-ECE LRTAP Convention).

Oils/Hydrocarbons

- ensure reporting of oil spills;
- ensure/promote compliance with existing legislation;
- promote proper waste oil handling and disposal (existing measures should be strengthened);
- increase public understanding and awareness of the problems associated with oils/hydrocarbons (existing measures should be strengthened); and
- establish adequate contingency plans (proposed).

Nutrients

- apply sound land-use planning practices (existing measures should be strengthened);
- promote sound application practices for fertilizer use;
- promote adoption of best management practices to address the release of nutrients and contaminated sediments from agriculture;
- promote the use of appropriate environmental indicators;
- improve treatment of sewage (existing measures should be strengthened).
- inform consumers of sound product uses through education/awareness (existing measures should be strengthened); and
- continue participation in the development and implementation of international agreements, such as the Multi-Pollutants, Multi-Effects Protocol under the UN-ECE LRTAP Convention, that address the release of specific nutrients into the environment.

Contaminated Sediments

- ensure/promote compliance with existing regulations (e.g., Canadian Environmental Protection Act (CEPA) provisions for ocean disposal);
- increase the use of best management practices in agriculture and ports (proposed);
- promote the use of appropriate environmental indicators;
- upgrade municipal infrastructure for storm water treatment (proposed); and
- apply sound land-use planning practices (existing measures should be strengthened).

Litter

- ensure/promote compliance with local bylaws and provincial regulations for waste management;
- establish proper waste management/ disposal facilities (existing measures should be strengthened); and
- promote public education and awareness (existing measures should be strengthened).

3.4B. Physical Alteration and Destruction of Habitat

There are several actions that can assist in preventing impacts from all forms of habitat disrupting activities. These include:

- ensure/promote compliance with provincial regulations on land-use practices;
- ensure/promote compliance with federal regulations on fish habitat protection under the Fisheries Act;
- establish integrated planning and management mechanisms involving all Aboriginal peoples and regulatory and public stakeholders (proposed);
- institute a national framework and support mechanisms for locally implemented ICZM (proposed); and

- implement marine protected areas within local integrated management plans where appropriate (Oceans Act; other federal and provincial acts) (proposed).

There are also specific or unique actions that apply to individual categories of habitat disruption. These include:

Shoreline Construction/Alteration

- ensure/promote compliance with local bylaws for residential and industrial construction along shorelines (existing measures should be strengthened);
- improve scientific knowledge of distribution and sensitivity of resources and ecosystems; and
- promote public education and awareness.

Inter-tidal and Sub-tidal Alteration

- ensure/promote compliance with federal and provincial laws governing fisheries and aquaculture (existing measures should be strengthened); and
- promote public education and awareness.

Mineral and Sediment Extraction/Alteration

- ensure/promote compliance with federal laws on dredging and disposal (CEPA); and
- ensure/promote compliance with provincial regulations on coastal mineral and aggregate mining, and mine waste disposal.

Wetland and Saltmarsh Alteration

- improve scientific knowledge of distribution and sensitivity of resources and ecosystems; and
- promote public education and awareness.

Marine Waters and Coastal Watershed Alteration

- comply with federal and provincial regulations on water diversions, intakes and extraction.

Biological Alteration

- comply with provincial regulations on aquaculture (existing measures should be strengthened);
- comply with federal regulations on introduction and movement of marine organisms (Fisheries Act) (existing measures should be strengthened); and
- continue work with the International Maritime Organization (IMO) toward international standards for the prevention of accidental introductions of alien species in ballast water (proposed).

3.5. Identification of Criteria for Evaluating Effectiveness

The following criteria and indicators are recommended for evaluating the effectiveness of actions:

3.5A. Contaminants

Sewage — improved level of sewage treatment; compliance with standards; reduced shellfish closures and beach closures; and restoration or improvement of appropriate indicator species and/or biodiversity.

Persistent Organic Pollutants — reduced level of contaminant releases; compliance with standards; level of remediation; results of environmental effects monitoring (EEM) programmes; restoration or improvement of appropriate indicator species and/or biodiversity; progress on the development of international agreements and compliance with national regulations.

Radionuclides — compliance with standards and national regulations.

Heavy Metals — reduced levels from anthropogenic sources into the marine environment; progress on the development of international agreements and compliance with standards and national regulations.

Oils/Hydrocarbons — adequate reception facilities in place; compliance with standards and national regulations; adequate contingency plans in place.

Nutrients — reduced shellfish closures; compliance with standards.

Contaminated Sediments — reduced harbour contamination; compliance with national and provincial regulations; maintain natural sediment loads.

Litter — reduced level of marine debris; adequate number of waste management/ disposal facilities in place.

3.5B. Physical Alteration and Destruction of Habitat

Most of the specific categories of physical alteration and destruction of habitat share a common criterion for evaluating effectiveness.

Shoreline Construction/Alteration, Inter-tidal and Sub-tidal Alteration, Mineral and Sediment Extraction/Alteration, Wetland and Saltmarsh Alteration, and *Marine Waters and Coastal Watershed Alteration* — size and productive capacity of key habitats that are either lost or degraded, compared with the size and productive capacity that are restored or created in these habitats.

Biological Alteration — number of alien species introduced; species diversity in coastal ecosystems; productivity of native species.

3.6. Programme Support Elements

The principle support elements for Canada's NPA include:

- institutional support
- clearing house mechanisms for pollution prevention and habitat protection; and
- monitoring (reports on implementation and effectiveness).

3.6A. Institutional Support

At the initial stages of the NPA, the key programme support elements are the organizational and technical arrangements to implement and further develop the NPA as a co-operative management arrangement among federal, provincial and territorial governments in consultation with Aboriginal peoples and other relevant stakeholders. In particular, a number of NPA committees and consultation networks/mechanisms are in place to carry out this work at the national and regional levels. Secretariat support is also provided to the various committees. These committees include:

- The Federal/Provincial/Territorial Advisory Committee on Developing Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities (which agrees to meet annually). This committee is responsible for developing the NPA.

- The Federal Interdepartmental Committee on the Protection of the Marine Environment from Land-based Activities.

- This committee is responsible for federal activities under the NPA.

- Federal/provincial/territorial technical review committees for developing clearing house mechanisms, guidelines and codes of practice.

3.6B. Clearing House Mechanisms for Pollution Prevention and Habitat Protection

Clearing house actions include:

- developing Canadian data directories, with components organized by source category, and containing information on current sources of information, practical experience and technical expertise;

- maintaining directory and delivery mechanisms and feedback functions to identify and respond to information gaps and training requirements for clearing house users; and
- recognizing the need for compatibility with other (national/provincial/territorial) clearing house mechanisms.

3.6C. Monitoring (Reports on Implementation and Effectiveness)

Recognizing the need for open and transparent reporting actions includes:

- providing annual reports on progress in implementing the NPA;
- developing additional indicators for monitoring the implementation and effectiveness of the NPA;
- providing periodic reports on land-based activities and their effects;
- promoting regular consultations with Aboriginal peoples and other key/relevant stakeholders; and
- providing periodic (approximately every 3-5 years) national reports to the international community (e.g., UNEP, Commission on Sustainable Development) on Canada's progress in implementing the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).

3.7. International Considerations/ Linkages

Canada has also made significant progress toward international implementation of the GPA:

- The Arctic Council was established in 1996 as a high level forum to promote co-operation and co-ordination among the eight Arctic states on issues of sustainable development and environmental protection. Part of the Council's mandate is to oversee and co-ordinate the Arctic Monitoring and Assessment Programme (AMAP), Conservation of Arctic Flora and Fauna (CAFF), Protection of the Arctic Marine Environment (PAME), and Emergency Prevention, Preparedness and Response (EPPR).
- The first Ministerial Meeting of the Arctic Council in Iqaluit, September 17-18, 1998, adopted a Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities (RPA). The RPA will contribute substantially to meeting GPA commitments in the Arctic; it also has a particular focus on regional co-operation and capacity building to address the regional priority pollution sources found in the Russian Federation.
- At the April 1997 Meeting of the Commission on Sustainable Development (CSD), Canada highlighted the importance of the protection of the marine environment from land-based activities and its commitment to develop a National Programme of Action.
- Under the North American Agreement on Environmental Cooperation (NAAEC) of the NAFTA Commission for Environmental Cooperation (CEC), two sub-regional coastal areas were selected for pilot projects to implement the GPA: the Gulf of Maine and the Bight of the Californias. Also under the NAAEC, North American Regional Action Plans (NARAPs) are being developed and implemented for specific substances such as mercury and DDT.
- Under the Asia-Pacific Economic Cooperation (APEC), an Action Plan for Sustainability of the Marine Environment encourages member economies to implement the GPA at a domestic/regional level. Other related initiatives include protocols under the UN-ECE LRTAP to manage POPs, Heavy Metals and some nutrients (e.g., ammonia), and the UN Convention on Biological Diversity.
- To raise general awareness about the plight of the world's oceans, Canada is sponsoring "The Ocean Charter," to be signed by world leaders. A companion

document entitled "My Ocean Charter" is being signed by millions of concerned individuals around the world, including those who attended Expo '98 in Lisbon, Portugal.

- In the context of financial assistance for developing countries, official development assistance (ODA) should play a catalytic role in the implementation of national programmes of action. The purpose of Canada's ODA is to support sustainable development in developing countries and to help them protect marine environments. In addition, multilateral funds can help support implementation of the GPA, and the Global Environmental Facility can help cover the extra incremental costs involved in addressing regional and global concerns.

Governments can also play a catalytic role in supporting the growth of the environmental industries. Part of this commitment relates to providing opportunities for environmental industries in export and development assistance programmes.

3.8. Conclusions and Next Steps

3.8A. Conclusions

- The goals for the NPA are to:
  - protect human health;
  - reduce the degradation of the marine environment;
  - remediate damaged areas;
  - promote the conservation and sustainable use of marine resources; and
  - maintain the productive capacity and biodiversity of the marine environment.
- The NPA recognizes the cost-effectiveness of building on existing programmes that address many of the GPA-related commitments and the NPA priorities.
- The NPA also recognizes the benefit of a phased approach beginning with immediate priorities and moving toward addressing all priorities.
- The NPA will be based on existing resources and an approach of increasing cost-effectiveness, efficiency and co-operation among existing policies, programmes, resources and legislation. This does not preclude development of improved integrated planning and management processes where appropriate, nor the use of novel economic instruments and incentives to encourage beneficial action.
- Priorities for actions have been developed based on the severity of risk and the adequacy of existing measures. High priority for action is assigned to sewage, POPs, shoreline construction/alteration, and wetland and saltmarsh alteration.
- Point source controls for contaminants originating within Canada appear to be adequately addressed with the exception of sewage. The associated pollution control and prevention programmes should continue to be monitored to ensure desired NPA goals are met. Non-point sources of contaminant input from within Canada are not considered as adequately addressed.
- Contaminant sources from outside Canada, such as long-range transport of air pollutants, are nearly all addressed through ongoing international negotiations. The adequacy of these will need to be assessed as part of ongoing evaluation.
- To achieve the goals of the NPA, responsible authorities need to further develop common processes and decision-making strategies to integrate the management of activities impacting on the coastal zone. The development of a national approach to ICZM by Canada would be a major step toward achieving NPA objectives.
- The NPA addresses land-based activities and in the future will be integrated into a broader integrated management framework that will address both land-based and marine activities.

- The key programme support elements at the initial stages of the NPA are the organizational and technical support arrangements. These will help implement and further develop the NPA as a co-operative management arrangement among federal, provincial and territorial governments, in consultation with Aboriginal peoples and other relevant stakeholders.

3.8B. Next Steps

The NPA calls for a variety of actions.

As stated in the introduction to this document, the NPA aims to protect the marine environment through co-operative solutions. Such co-operation can be achieved through the participation and collaboration of federal, provincial and territorial governments. Reporting on the progress of actions identified in the NPA is a collective initiative that is co-ordinated at the national level. Such actions include:

- Monitor existing actions that are deemed adequate. Point source controls for contaminants originating within Canada appear to be adequately addressed with the exception of sewage. Regulations and controls on dredging and disposal, water diversions and land-use practices also appear adequately addressed.
- Strengthen existing actions when they are deemed inadequate. Measures for public understanding, awareness and involvement need to be strengthened. One tool is an information clearing house for pollution prevention and habitat protection.
- Undertake proposed new actions for immediate preventative and remedial action. These include upgrading infrastructure for sewage treatment and storm water runoff, and developing guidelines and codes of practice for reducing non-point sources of contaminants.
- Institute a national framework and support mechanisms for coastal zone management.
- Conduct applied research to obtain knowledge needed for appropriate action.
- Develop reporting requirements and provide annual progress reports on NPA implementation.
- Continue collaboration and consultations to keep priorities current, and develop further concrete actions and capacities to achieve the goals of the NPA.
- Use regional ecosystem initiatives to pursue collaborative regional actions.
- Expand NPA coverage to address drainage in the Quebec Arctic, Hudson Bay and James Bay.
- Promote regional and global controls on POPs and Heavy Metals.

Literature Cited

Government of Canada. 1996. **The State of Canada's Environment 1996.** Ottawa: Public Works and Government Services.

Lacelle, D. 1998. **1996 Municipal Water Use Database.** Ottawa: Environment Canada.

CHAPTER 4. PACIFIC REGION

INTRODUCTION

Highly diverse habitats and significant aquatic resources make up the over 27 000 km of Canada's Pacific coastline. The physical features of the British Columbia (B.C.) coastal zone are also diverse and include over 6500 small islands.

One of the most distinctive oceanographic features is the many fjords or inlets; there are over 60 inlets exceeding 10 km in length, and some can be as long as 150 km, mostly located along the mainland coast and the west coast of Vancouver Island. The amount of freshwater that flows into the inlets depends on the topography, the time of year, and whether the river is fed primarily by rainfall or snowmelt.

Most Vancouver Island rivers are fed by rainfall and reach peak flows during the rainy winter-spring season. Snowmelt-fed rivers predominantly drain into the larger mainland inlets, with freshwater inputs reaching maximum volumes during the freshet, or snowmelt period, beginning in May. Freshwater runoff flows seaward in a brackish surface layer formed by low-density freshwater mixing with, and entraining, heavier seawater from below. The seaward-flowing surface layer of brackish water is offset by an inflowing layer of high-salinity seawater. This two-layer system, commonly known as estuarine circulation, is a prevalent feature of the B.C. coastal zone. Swift tidal currents are also a ubiquitous feature of the B.C. coast. They play an important role in mixing freshwater and seawater, especially in the many constricted passages, channels and narrows on this coast.

The B.C. coast also has several large straits and sounds: from north to south, Dixon Entrance, Hecate Strait, Queen Charlotte Sound, Strait of Georgia and Juan de Fuca Strait. Coastal water structure and circulation are controlled by tides, winds and freshwater from the coastal straits and inlets.

The Strait of Georgia is probably the most socio-economically important region of the province. B.C.'s largest river, the Fraser River, discharges into the southern end of the strait. Its discharge is highly seasonal, peaking with the snowmelt in late May to early June. The freshwater leaves the strait mostly via the southern route, undergoing substantial mixing in the swift tidal outflows (Boundary Passage and Haro Strait) through the Gulf Islands before it proceeds out to the open Pacific Ocean through Juan de Fuca Strait. The northern route is more constricted, mainly through Discovery Passage, then Johnstone Strait and Queen Charlotte Strait.

The continental shelf regions of the B.C. coast, like many other shelf regions of the world, support highly productive fisheries. With the exception of the basins of Hecate Strait and Queen Charlotte Sound, the continental shelf is usually not wider than 95 km and typically is much less. Off the west coast of the Queen Charlotte Islands the shelf is almost non-existent.

Approximately 75% of B.C.'s 3.9 million people live within 50 km of the coast (Figure 4-1), and over 70% of the province's economic activity is related to the coastal area. Estuaries are often the location of towns and their associated activities (e.g., pulp, paper and saw mills, marinas, factories). In addition to its economic role, the coast has cultural significance, particularly for Aboriginal peoples.

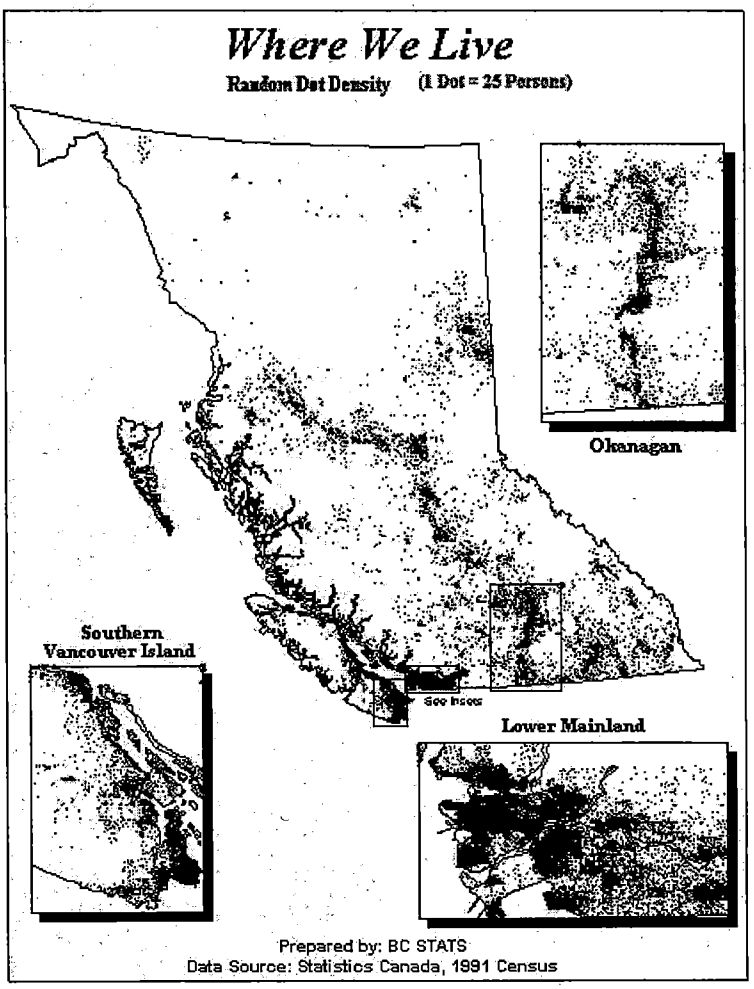

Figure 4-1. Population Density in British Columbia (Statistics Canada, 1991 Census; prepared by BC STATS)

Although most of B.C.'s coastal population is concentrated in three regional districts at Vancouver, Victoria and Nanaimo, there are opportunities to protect the marine environment from land-based activities all along the coast.

In the Georgia Basin-Puget Sound area (Straits of Georgia and Juan de Fuca, Puget Sound, Figure 4-2), rapid urban growth is a major issue with potentially large impacts on coastal ecosystems, such as the use of shellfish resources. The present population of 6 million in the Basin-Sound area is expected to grow to 9-11 million by 2020. Population growth and associated development have been identified as key challenges to sustainable development.

4.1. Identification and Assessment of Problems

4.1A. Contaminants

Sewage

On the Pacific coast, bacterial and viral contamination of shellfish is a human health concern. Approximately 25% of the classified shellfish growing area, south of the northernmost end of Vancouver Island, is closed to harvesting of shellfish because of fecal contamination.

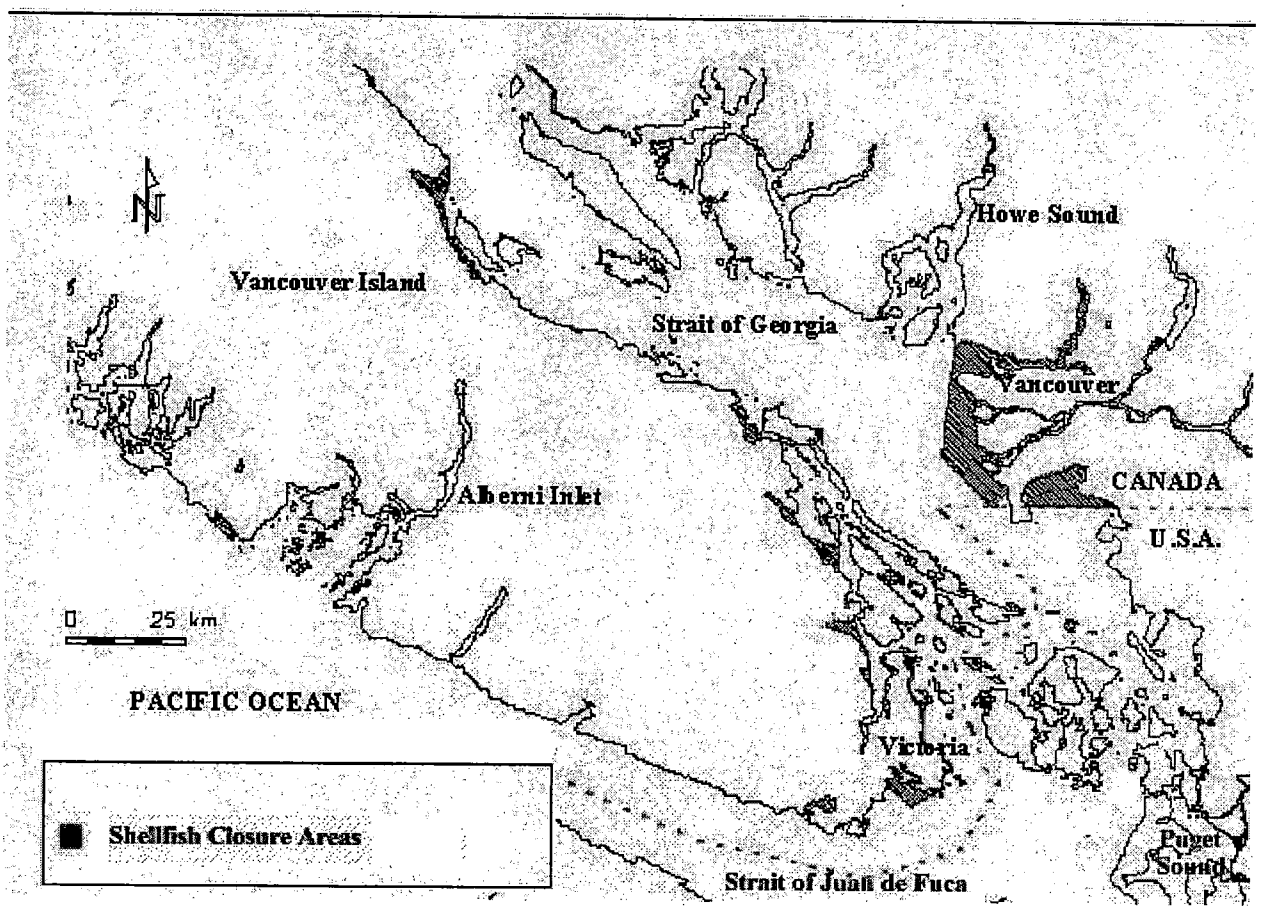

Figure 4-2. The Georgia Basin-Puget Sound Area Showing Contaminated Shellfish Closures (Environment Canada, 1997)

There are approximately 180 closure orders in B.C under the Management of Contaminated Fisheries Regulations pursuant to the Fisheries Act. The majority of these closures are in response to non-point source contamination (e.g., urban runoff including septic seepage, agricultural drainage and boat sewage discharges).

Other locally significant fisheries-related impacts are associated with agricultural runoff and degradation of water quality (acute toxicity because of ammonia, reduced dissolved oxygen and eutrophication).

Most communities on the Pacific Coast dispose of liquid waste into marine waters. For residents without access to municipal sewage collection, septic systems are the norm. Many communities treat their sewage to some degree — primary treatment reduces suspended solids and floatables; secondary treatment reduces suspended solids, oxygen-demanding substances, and acute toxicity. Sewage effluent contains organic matter which, when degraded, can deplete the dissolved oxygen in poorly flushed waters. Under permit from the B.C. Ministry of Environment, Lands and Parks, most communities discharge treated effluent through deep outfalls, using diffusers for rapid dispersion. Sludge produced from treatment may be sent to landfills, although the recent trend is for reuse as a soil amendment. Most sewage effluent discharged into the ocean in B.C. currently receives only primary treatment.

A common and ongoing challenge is fecal coliform contamination from non-point sources such as poorly maintained septic systems and inappropriate agricultural practices. In urban areas during periods of high runoff, combined sewer overflows allow sewage to be transferred from the sanitary sewer system to

the storm water system, and can result in significant contamination of local waters. Other sources of bacteriological contamination include raw sewage discharges from recreational boats in embayments.

A priority issue is the possible effects of endocrine-disrupting compounds such as nonylphenols and natural estrogens (Henderson, 1997) in municipal, agricultural and industrial wastes. Recent concerns have highlighted the disruption of the reproductive characteristics of fish, thought to be caused by high concentrations of hormones or hormone mimics in sewage effluent and in agricultural runoff. Gender ratios in fish populations can be altered with unknown consequences to local populations. Recent Environment Canada data (Sekela et al., 1997) confirm the presence of a known endocrine disrupter (4-nonylphenol) in sewage effluent and downstream of a municipal outfall in the Fraser River estuary. Effects on fish are under investigation.

Persistent Organic Pollutants

There has been significant contamination in shellfish by persistent organic pollutants (POPs) on the Pacific coast. Less well understood are the potential biological effects of these compounds. Point sources of POPs are well documented, but the loadings and impacts of non-point sources have yet to be addressed.

Nine coastal kraft pulp mills historically used chlorine for bleaching, resulting in effluents containing many chlorinated by-products, including dioxins and furans. Beginning in 1988 and peaking in 1995, about 1200 km^2 of shellfish harvesting areas (crab, prawn, shrimp, oysters, clams) were closed because of contamination by these chemicals. The B.C. pulp and paper industry spent over a billion dollars to modify its bleaching processes, and stopped using chlorophenate-contaminated wood chips and defoamers that contain dioxin and furan precursors. This expenditure, coupled with the introduction of new provincial and federal regulations, has created an environmental dividend: the burden of dioxins and furans has been reduced by over 97%, and nearly half of the area where harvesting was restricted because of contamination has been reopened (Hagen et al., 1997).

The Canadian Wildlife Service has been monitoring organochlorines in seabird eggs since the early 1970s on the Pacific coast. For this monitoring programme, indicator seabird species were selected to represent coastal, continental shelf and offshore ecosystems. Eggs are collected every four years at a number of colonies and analyzed for organochlorine pesticide and polychlorinated biphenyl (PCB) contaminants. Concentrations of organochlorine pesticides and PCB concentrations have generally declined since the early 1970s in species such as double-crested cormorants (*Phalacrocorax auritus*) nesting in areas such as the Strait of Georgia, where they are exposed to industrial and agricultural runoff.

In contrast, organochlorine pesticides such as dichloro-diphenyl-trichloroethane (DDT) and hexachlorocyclohexane (HCH)-related compounds have remained relatively stable, particularly in alcid (e.g., rhinoceros auklet [*Cerorhinca monocerata*]) and hydrobatid (e.g., Leach's storm-petrel [*Oceanodroma leucorhoa*]) species which forage in offshore locations. Concentrations of those particular compounds are also substantially higher in west coast populations, and are thought to reflect atmospheric transport from areas of ongoing use in Asia. Long-range atmospheric transport appears to play a major role in delivering organic pollutants to seabird food chains.

Agricultural pesticides are another source of POPs in estuaries where upstream use is high. The use of disinfectants and antibiotics in the aquaculture industry also needs to be properly controlled.

Radionuclides

Although there are no Canadian sources (e.g., nuclear reactors) in the Pacific Region, there is concern with any accidental release of stored nuclides at the Hanford, Washington, nuclear facility. The fallout signal from the

onset of 1950s atmospheric weapons testing peaked in the early 1960s. Chernobyl inserted a brief but detectable pulse of atmospheric nuclides in 1986. Sediments around the Strait of Georgia generally reflect the fallout signal with some augmentation (focusing) from land runoff (Carpenter and Beasley, 1981). This signal is worldwide, and the main nuclides of concern are cesium-137(s) and strontium-90(Sr). Although these nuclides can enter the food web, they do not biomagnify and levels in marine organisms have not been a concern.

Heavy Metals

Although monitoring data is sparse, non-point sources such as storm water are considered significant. The result is that sediment quality criteria are exceeded locally in harbours and nearshore urban areas.

Two abandoned mines are significant sources of metals and environmental degradation. Acid rock drainage from the abandoned Britannia copper mine on Howe Sound is one of North America's largest unconfined point sources of copper and zinc contamination. Acidity is generated by the bacterial oxidation of sulfides to sulfates and sulfuric acid on exposure to air and water. Leachate continues to enter the marine environment 24 years after mining activity ceased. Metal-laden water drains into Howe Sound from extensive underground workings that penetrate the deposit. The adjacent shoreline is severely degraded and hazardous to juvenile salmon from the Squamish River. Algae are notably absent near the mine, and for 1.5 km along the shore of Howe Sound in both directions (EVS, 1997). The Department of Fisheries and Oceans (DFO) is conducting a two-year assessment of the impact of the discharge on nearshore fish and fish habitat. Preliminary results indicate that the numbers of juvenile salmon are much reduced in the area (Levings, 1997).

Mount Washington, on Vancouver Island, is the site of a small open-pit mine that operated from 1964 to 1967. The exposed rock has oxidized and releases toxic concentrations of copper into the Tsolum River. Until 1985 the Tsolum River supported valuable runs of pink, coho and chum salmon, and was famous for steelhead — a prized sportfish. Toxic levels of copper have reached the river and have been a major impediment to restoring the depleted salmon runs. DFO calculates that losses to the fishery could exceed $2 million a year.

Oils/Hydrocarbons

Non-point source discharges of oil or hydrocarbon products are common. In dense urban areas the concentration of automotive hydrocarbons in storm water is often high and represents a significant source of these contaminants to nearshore habitats.

A local concern is the tainting of eulachon in the Kitimat River and estuary downstream of an unbleached kraft pulp mill. This migratory, smelt-like fish is culturally important to coastal Haisla people. Fish flavour was impaired at relatively low effluent concentrations in laboratory and field exposures (Colodey et al., 1998). The suspect compounds (terpenes) are hydrocarbons of plant origin, but are only part of a complex effluent and may not be solely responsible for the effects on fish flavour.

Nutrients

Sewage plays only a minor role in the nutrient budget of the Strait of Georgia-Puget Sound system. All anthropogenic sources (point source, non-point source and atmospheric loadings) of nitrogen in this area are very small compared with natural nitrogen inputs from the entrainment of nutrient-rich, deep ocean water. Although no priority locations are identified, there is local concern in poorly flushed bays and inlets — especially in the June-to-August period. The areas most sensitive to eutrophication are inlets with low flushing rates that adjoin urbanized shorelines, mainly located along the south and west margins of Puget Sound in Washington State (Mackas and Harrison, 1997).

Contaminated Sediments

There is strong evidence that contamination from PCBs is decreasing in marine sediments in the Strait of Georgia (MacDonald et al., 1992). However, at more contaminated sites, PCBs remain at levels of concern. PCBs have

been linked to reproductive problems in English sole in Puget Sound (Casillas et al., 1991; Johnson et al., 1997).

Liver lesions in sole from contaminated coastal areas (e.g., Burrard Inlet) have been previously correlated with high concentrations of polycyclic aromatic hydrocarbons (PAHs) in sediments (Goyette and Boyd, 1989). At Kitimat, PAHs from combustion and spillage of pitch and coke have accumulated in bottom sediments, and levels decrease with distance from the aluminum smelter. Although liver abnormalities in English sole collected from Kitimat Harbour have been demonstrated, the PAHs in the harbour sediments appear to have limited bioavailability (perhaps because of the fine particle size of the associated sediments). They are not acutely toxic to invertebrates and documented effects on the benthic community are minimal (Paine et al., 1996). Health Canada is conducting a human health hazard assessment of PAH levels in clams collected from Kitimat.

Litter

Although there is widespread aesthetic concern about litter, particularly in coastal parks, the level of biological impact associated with this type of contamination is not well documented. Most of the litter debris is polystyrene foam and plastic, including bait bags, oil and water bottles, and food packaging (Environment Canada, 1996). Results of a pilot project conducted between 1995 and 1996 by the National Marine Debris Surveillance Programme indicate that most debris originates from land or land-based activities.

4.1B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

A significant source of habitat alteration and loss is coastal development, including urbanization, commercial ports, small craft harbours and marinas. Other habitat changes are related to agricultural practices, including water storage and flood control structures (dykes) that alter physical dynamics of the system such as current velocities and sediment transport regimes. Historically much habitat has been lost, and each new development can cause direct habitat loss and lead to decreased ecosystem integrity.

Inter-tidal and Sub-tidal Alteration

Eelgrass beds perform an important ecological function along the Pacific Coast. They support a variety of organisms including salmon, herring, kelp greenling, sea anemones, jellyfish, snails, sea slugs, small clams, crabs, sea stars, sea cucumbers and isopods. The eelgrass community provides important rearing habitat for juvenile salmon, herring and crabs, and the leaf blades support a wide variety of microscopic and macroscopic fauna and flora, which flourish particularly during the late spring and summer. Eelgrass is also critical for survival of birds migrating along the Pacific Flyway. Threats to the health of this critical habitat include sedimentation from adjacent land use, destruction from coastal developments, marinas and log rafts (causing shading and smothering), and changes in hydrodynamics (affecting distribution and growth patterns). Logging and log-handling activities also cause significant habitat loss and degradation through benthic bark deposits and changes in water quality.

Fish farms are a source of organic material from waste food, feces and organisms cleaned off nets. Issues include habitat smothering, blanketing beneath salmon net pens, and the use of antibiotics and pesticides. Currently, there are approximately 80 net pen operations on the B.C. coast producing 25 000 tonnes of salmon annually. Impacts from organic deposits on the sea floor are generally restricted to the immediate vicinity of the farm site. Following an extensive environmental assessment process, a number of actions will be taken by B.C. to minimize net pen impacts. These include establishing performance-based standards for organic deposits. DFO is in the process of updating draft regional net pen siting guidelines to ensure the protection of coastal habitats and fishery resources in the vicinity of aquaculture operations.

Mineral and Sediment Extraction/Alteration

Sediment dredging in rivers and ocean disposal activities are regulated under the Fisheries Act and the Canadian Environmental Protection Act respectively. Because of tight controls, ecological impacts in recent years have been minimal. Habitat alteration and loss (smothering) from submarine mine tailings disposal have been caused by historical activities (e.g., Island Copper, Vancouver Island). In other areas (e.g., Britannia and Mount Washington), historical mine activity has resulted in ongoing releases of toxic concentrations of dissolved metals (acid rock drainage), as discussed in the heavy metals section above.

Wetland and Saltmarsh Alteration

Biologically, estuarine marshes are the most productive habitat type on the coast. The Fraser River estuary acts as a nursery ground for juvenile fish, and its marshes support the highest density of wintering waterfowl, shorebirds and birds of prey in Canada (Environment Canada, 1996). The Puntledge River at Courtenay (on the east coast of Vancouver Island) forms an estuary that has been progressively affected by land-based activities. Several factors have contributed to its degradation, including urban encroachment, poor land-use practices, dredging and unco-ordinated responses to non-point source pollution issues such as failing septic systems and agricultural runoff. Water quality has declined not only in the estuary, but also in the Puntledge River. Here the effect has been caused by acid rock drainage from the abandoned Mount Washington mine and by a BC Hydro dam that alters flow and temperature regimes. Hundreds of smaller estuaries are healthy, particularly along the central and northern coasts. However, they are at risk from development pressures, including future forestry activities.

Marine Waters and Coastal Watershed Alteration

The major land-based activities affecting coastal watersheds in B.C. are forestry, agriculture, and urban and industrial development. Impacts associated with forestry are mostly sedimentation or erosion of fish spawning and rearing habitat, along with alteration of flow regimes in streams.

Urban development alters stream hydrology, and many urban streams have been eliminated by storm water systems, or they have been channelled or dyked. These effects will increase without careful planning and rigorous compliance monitoring. Of the approximately 300 significant salmon spawning streams in the Fraser River system, about half are located in or flow through the urbanized area of the lower Fraser Valley. These streams provide spawning and rearing habitat for salmon, trout and other fish. Over 80 species of fish frequent the river's estuary and tributary streams. The lower Fraser River's tributaries produce one-half of the coho in the Georgia Strait.

This productive fish habitat has been degraded by development and settlement activities for over 100 years. A 1996 assessment indicates that of the 2000 km of streams in the urban area of the lower Fraser River, 588 km (approximately 30%) have been routed into culverts and are covered. Sediment discharges associated with most developments have also been found to clog the clean gravel required by spawning salmon.

Indirect impacts from urbanization continue to contribute to losses in riparian zones. There has been increased sediment loading to streams, and a spread of impervious surface areas causing degradation of hydrology and water quality.

The Fraser River supports the largest salmon runs in the world. The most significant agricultural impacts on coastal watersheds are in the lower Fraser River valley. One of the most productive agricultural regions of Canada, this area supports intensive hog, poultry, beef and dairy farming, and vegetable, berry and grain operations. A large system of dykes and flood control structures protects valuable agricultural land, but these structures have also resulted in the loss of over 80% of the natural saltmarsh in the delta

(Levings and Thom, 1994). A major challenge in the region is improving agricultural practices to minimize further habitat loss, protect groundwater resources and achieve fish habitat restoration.

Coastal habitat alteration can have an impact on a variety of foreshore, inter-tidal and sub-tidal habitats through urban development, coastal infilling, marina construction and log handling facilities. Eelgrass beds show low tolerance to increases in water turbidity from dredging, high foreshore sedimentation rates, increased waste-water discharges and other bottom disturbances. Cumulative effects of many land-use impacts are contributing to a trend of fewer ecologically productive nearshore habitats.

The recent assessment of 10 years of compensation habitat projects in the estuary (Kistritz, 1996) determined whether foreshore development projects in the Fraser River estuary were achieving the guiding principle of "no net loss" (DFO, 1986). Results suggested that, in areas where compensation was required as a component of the development permit, only 50% of the compensation habitat that had to be replaced at a 2:1 ratio was functioning successfully. The assessment showed that replacing 1 ha of habitat required the construction of 2 ha of replacement marsh habitat (Langer, 1997).

Biological Alteration

Exotic (non-indigenous) species are those that enter ecosystems beyond their natural range through deliberate or inadvertent introduction by humans. Examples on the Pacific coast include the Pacific oyster (*Crassostrea gigas*), deliberately introduced from Japan in the early 1900s for commercial mariculture. It now forms the mainstay of B.C.'s oyster industry.

Accidentally introduced along with the Pacific oyster were the predatory Japanese oyster drill (*Ceratostoma inornatum*) and the seaweed *Sargassum* sp. The Pacific oyster spread rapidly from culture sites and has virtually displaced the native Olympic oyster, (*Ostrea lurida).* The oyster drill and *Sargassum* sp. have also become widely established. A 1994 arrival in the Georgia Strait was the dark mahogany clam (*Nuttalia nuttalia*), expected to compete with native clam species but too small to be of commercial value.

Habitats of Special Regional Concern

Over 6500 small islands dot the waters along B.C.'s coast. Because of their size they present different management challenges and require different treatment than large islands or the mainland. Larger islands are affected principally by forestry and increasingly by urbanization in the south. Small islands are more vulnerable to stresses such as private land clearing, ecotourism, boating, recreational shellfish harvesting and introduced predators (rats and raccoons). Land development on small islands may be constrained by limited freshwater, poor access, and in some areas by the development controls of B.C. Islands Trust. These controls are not applied coast-wide. However, where they do apply there is no consistent protection of rare and endangered ecosystem types on land, nor is there sufficient conservation of significant marine areas. For these reasons, small islands are included as a regional concern within the NPA framework.

4.2. Establishment of Priorities for Action

4.2A. Contaminants

Sewage

Sewage discharges (point) and agricultural and urban storm water runoff (non-point) are a **high priority**. They have the potential to affect public health and restrict fishery resource use. Year-round closures of shellfish harvesting and seasonal closures of swimming areas are both common. Shellfish harvesting closures because of bacterial contamination occur in almost all areas adjacent to urban and semi-urban development (Figure 4-2), and now total nearly 1000 km^2, up from 710 km^2 in 1989.

Persistent Organic Pollutants

POPs are a **high priority**. The control of the use of tributyltin (TBT) antifouling paints is an important objective. There is international concern related to the toxicity of this compound, and additional national and international controls are required. The discharge of chlorinated dioxins and furans from pulp and paper mills to the marine environment has been virtually eliminated. Nonetheless, these compounds continue to be an issue with ongoing crab harvesting closures on the B.C. coast and further monitoring is being conducted. Storm sewers, combined sewer overflows and agricultural inputs (pesticides, endocrine disrupting compounds) are emerging issues that require further research and monitoring. Long-range transport of POPs is an identified concern.

Radionuclides

Radionuclides are a **low priority** concern for the Pacific coast as there are no significant local land-based sources (e.g., nuclear power plants).

Heavy Metals

Certain sources of heavy metals are a **high priority**. Acid rock drainage from abandoned mines causes significant ecological impact on adjacent receiving environments. Metal loadings from storm water inputs in urban harbours have caused local impacts.

Oils/Hydrocarbons

Oils and hydrocarbons are a **medium priority**. Spill prevention initiatives are in place and designed to prevent large-scale spills. Chronic low-level contamination from urban storm water and combined sewer overflows causes moderate, localized damage.

Nutrients

Nutrients are a **low priority** issue in marine waters. Local concern exists for poorly flushed bays, and the overall marine ecosystem impact is low.

Contaminated Sediments

Contaminated sediments are not widespread and are therefore of **medium priority**. Industrial and urban harbours often contain localized areas of contaminated sediments (e.g., PAHs, metals, PCBs) requiring remediation.

Litter

A **low priority** is given to litter based on its aesthetic impact, although the local biological impact has not been documented.

4.2B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

The historical habitat losses that have occurred, and the need to prevent new losses, call for a **high priority**. Urbanization and construction of ports, harbours and marinas contribute to the loss of shoreline habitat.

Inter-tidal and Sub-tidal Alteration

Sedimentation impacts of land-use practices can alter important eelgrass beds and are a **medium priority**. Logging and log-handling activities can contribute to habitat loss and degradation through log grounding and deposition of bark.

Mineral and Sediment Extraction/Alteration

Controls on dredging have reduced potential impacts. As a result, this activity is given a **low priority**. Historical submarine disposal of mine tailings has caused habitat alteration and destruction.

Wetland and Saltmarsh Alteration

Agriculture, forestry and urbanization (dyking, draining and infilling) have caused significant direct losses of fish and wildlife habitats and are assigned a **high priority**.

Marine Waters and Coastal Watershed Alteration

Significant watershed alteration is a **high priority** and has occurred through urbanization, agriculture and forestry activities. Dyking, draining, infilling and stream alteration

(including channelization, changes to the hydrography and sedimentation, and the installation of culverts) have resulted in fewer productive stream habitats, especially in the Georgia Basin. An independent binational review of the shared waters of British Columbia and Washington State identified seven priority actions, the highest being to minimize estuarine wetland habitat loss and establish marine protected areas (British Columbia/Washington Marine Science Panel 1994).

Biological Alteration

The introduction of exotic species via various pathways has the potential for significant ecological impact. Several species introductions have been documented, and prevention is the best approach. A **high-medium priority** has been assigned to this category.

4.3. Setting Goals and Management Objectives

Under the National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA), Canada's goals are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

In addition to the national objectives, the following are specific regional objectives.

4.3A. Contaminants

For most of the contaminants, the management objective for taking action is to reduce the contribution of contaminant sources to the marine environment, primarily through pollution prevention. Where contaminants are released to or occur in the marine environment, the management objective is to apply life-cycle management or remediation to address the problems. Specific management objectives for each of the contaminants of concern at the national level are as follows:

Sewage — Reduction of contamination from sewage and restoration of polluted shellfish growing areas is of particular importance on the Pacific coast.

Persistent Organic Pollutants — The primary objective is to reduce the anthropogenic inputs of POPs and apply life-cycle management to remaining sources.

Radionuclides — Radionuclides were not identified as being a concern for the Pacific coast since there are no significant local land-based sources.

Heavy Metals — Reduce the discharge of acid rock drainage, and reduce the impact of storm water discharges.

Oils/ Hydrocarbons — Reduce inputs to improve coastal water and ecosystem quality.

Nutrients — Nutrient input into the marine environment was not identified as being a major concern in the Pacific Region.

Contaminated Sediments — The main objective is to reduce sediment contamination at source.

Litter — Increase public awareness to reduce the debris entering the marine environment.

4.3B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration — Through a process of integrated coastal zone management (ICZM), new proposals for shoreline development are more widely reviewed, and decisions are influenced by community objectives.

- Where shoreline developments occur, harmful alteration is prevented or mitigated.

- Where residual harmful alteration will occur, compensation will be implemented and monitored for efficacy wherever feasible.

Inter-tidal and Sub-tidal Alteration — Pursuant to ICZM objectives, there will be more inventories of habitats. Sensitive marine areas will be identified and protected from developmental impacts wherever feasible.

Mineral and Sediment Extraction/Alteration — Restrict dredging and dumping activities in timing and location to ensure protection of valued habitats.

Wetland and Saltmarsh Alteration —
- Halt damage in these valuable areas by directing development elsewhere.
- Assess where dykes can be breached to increase productive estuarine habitat.

Marine Waters and Coastal Watershed Alteration — Achieve net gain through a reversal of continuing loss and degradation of important habitats, strategic enhancement and habitat restoration.

Biological Alteration
- Prevent inappropriate ship deballast activities nearshore.
- Prevent the accidental escape and introduction of non-indigenous marine species including pathogens.

4.4. Strategies and Actions

Many laws, regulations, policies and programmes of both the B.C. government and the federal government are already in place to meet the goals and objectives of protecting the marine environment from land-based activities. The successful outcome of the strategies and actions designed to meet the stated goals and management objectives will require participation from all levels of government, industry, communities and other non-government sectors.

The following strategies and actions are designed to address the goals and management objectives in the Pacific Region.

4.4A. Contaminants

Sewage
- Introduce a new provincial regulation that updates standards to protect water quality and ultimately recreational uses of water, human health and fish habitat as well as streamlining the authorization process
- Continue to apply existing regulations and ensure compliance and enforcement.
- Promote infrastructure planning for point source discharges.
- Promote the development of liquid waste management plans by municipalities and regional districts.
- Facilitate community action, support land-use planning processes and promote a community-based approach to address point and non-point sources to aid in protecting and restoring shellfish growing areas.
- Encourage implementation of pleasure craft sewage pollution prevention regulations in designated areas, and promote the installation of pump-out facilities.
- Encourage implementation of best management practices for farms and identify areas sensitive to non-point sources of pollution originating from on-site sewage, agriculture and urban storm water.
- Promote improved collection, treatment and disposal, and support innovative technologies for non-point sources (septic systems, agriculture, urban storm water).
- Promote public education.

Persistent Organic Pollutants
- Continue international and national efforts to eliminate use of TBT. Continue dioxin/ furan monitoring of affected fisheries to determine when consumption restrictions can be removed.
- Encourage efforts by industry to apply better management practices with regard to the use of pesticides, and promote use of integrated pest management in agriculture operations.

- Develop source controls to eliminate POPs in sewage, storm water and combined sewer overflows.
- Encourage development of pollution prevention strategies for industries and municipalities.
- Promote the implementation of new treatment strategies and technologies to eliminate tainting from the unbleached pulp and paper mill at Kitimat.
- Encourage increased biological effects measurements as a monitoring approach that might identify problems to be addressed through analytical chemistry.

Radionuclides

- Further action is not required to deal with radionuclides in the Pacific Region.

Heavy Metals

- Encourage stakeholder and community involvement to reduce impacts of acid rock drainage from abandoned mines through collection and treatment of discharges.
- Promote site and habitat restoration at abandoned mines.
- Develop source controls to eliminate heavy metals in sewage, storm water and combined sewer overflows.

Oils/Hydrocarbons

- Reduce chronic loading of oil and other hydrocarbons through better storm water management.
- Protect identified sensitive areas from impacts of oil spills.
- Ensure fully operational response strategies for major oil spills, and develop new response plans and decision systems as required.
- Educate the public and marine industries about proper oil and fuel handling, recycling and engine maintenance practices.

Nutrients

- Further action is not required at this time to deal with nutrients entering the marine environment in the Pacific Region. However, vigilance is needed for the potential problem of localized eutrophication.

Contaminated Sediments

- Develop priority site listings for characterization and remediation where appropriate.

Litter

- Increase public education programmes to reduce the amount of litter entering the marine environment.

4.4B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

- Develop and implement co-ordinated coastal land-use planning processes.
- Apply existing codes of practice; develop new codes specifically focusing on marine foreshore protection.
- Develop and implement stewardship programmes (e.g., shorekeepers) and associated educational packages.
- Carry out regular audit and enforcement activities.

Inter-tidal and Sub-tidal Alteration

As stated in a prior chapter, the purpose of ICZM is to maximize the benefits provided by the coastal zone while minimizing resource-use conflicts and the harmful effects of activities. Goals are conservation, sustainable use and economic diversification in the coastal zone, with a focus on collaborative planning and decision making.

- Implement ICZM; continue co-ordinated environmental project reviews to prevent habitat loss (e.g., Burrard Environmental Review Committee, Fraser Environmental Review Committee).
- Develop guidelines to protect marine sensitive zones (e.g., from logging and log-handling activities).
- Consider findings of the Salmon Aquaculture Review (1997) for policies on net pen siting and operational guidelines.

- Establish marine protected areas to conserve and protect marine resources and habitats. Protect critical habitats (e.g., eelgrass beds) from sedimentation and other habitat alterations through habitat inventory development, heightened public awareness and enforcement.

Mineral and Sediment Extraction/Alteration

- Ensure channel maintenance dredging is not degrading habitats.
- Ensure that contaminated sediments not meeting Canadian Environmental Protection Act ocean disposal criteria are disposed in approved on-land facilities.

Wetland and Saltmarsh Alteration

- Protect remaining wetlands through integrated area planning, education and stewardship, and development of wetland conservation strategy and guidelines.
- Restore priority habitats wherever possible.
- Establish co-operative working relationships with the agriculture community to ensure development and implementation of best management practices for operations, including the maintenance of farm drainage systems.

Marine Waters and Coastal Watershed Alteration

- Establish and implement estuary management plans and associated technical committees for habitat restoration and prevention of further habitat loss.
- Protect estuaries and foreshore habitats to at least the same degree as upland riparian areas.
- Designate estuaries and other important habitats as "marine sensitive zones" (B.C. Forest Practices Code Act).
- Engage in integrated land-use planning processes.
- Incorporate environmental objectives into Regional Growth Strategies.
- Continue support of the Pacific Estuary Conservation Programme.
- Protect riparian zones and biodiversity through a watershed planning approach that embraces best management practices.
- Contribute to the implementation of the Georgia Basin Ecosystem Initiative to manage growth for healthy, productive and sustainable communities.

Biological Alteration

- Minimize introductions of exotic species through establishment of requirements, in co-operation with Washington State, for ballast water exchange at sea.
- In addition to regulatory approaches, prevent introduction of exotic marine species through education programmes directed at aquaculture and live seafood industries, research facilities and the import pet industry.

4.5. Next Steps

Addressing regional priorities will require co-ordinated efforts from all levels of government, individuals, communities and other non-government sectors of society. This will involve a basin or watershed ICZM approach. In addition to the Georgia Basin Ecosystem Initiative (GBEI), there will be opportunities to address priority issues through federal participation in established provincial land-use planning processes such as Land and Resource Management Plans (for Crown lands) and Regional Growth Strategies, as well as new federal/provincial coastal area planning processes under development.

Many of the issues identified in this chapter are associated with population growth and density. They are common to the lower Fraser River and Georgia Basin area. These problems will be addressed in part through the multi-agency GBEI. The purpose of the Initiative is to engage communities, and enhance co-ordination and collaboration among the many government and non-government stakeholders, while achieving measurable improvements in:

- conditions affecting environmental health and human well-being; and the

- capacity of individuals and families, businesses, organizations, and all orders of government to deal with issues of sustainability.

The vision statement for the Initiative — "managing growth to achieve healthy, productive and sustainable ecosystems and communities" — reflects the enormous challenge we face to protect ecosystems from unprecedented growth in the region. Application of action plans through an ecosystem approach will afford a real opportunity for governments and stakeholders to tackle these challenges in a manner that is holistic, long-term, consensus-based and inclusive. The GBEI will provide a framework for co-ordinating federal, provincial and regional government support of several existing and developing programmes. For example, the B.C. Ministry of Environment, Lands and Parks is taking a number of actions aimed specifically at reducing non-point source pollution in partnership with federal and local agencies. This will be key to addressing many issues identified within the NPA.

A proposed provincial municipal sewage regulation will update standards to protect water quality and streamline the authorization process. An independent binational review of the shared waters of B.C. and Washington State identified seven priority actions, the highest being to minimize estuarine wetland habitat loss, and establish marine protected areas (British Columbia/Washington Marine Science Panel,1994). The Puget Sound–Georgia Basin International Task Force depends significantly on Canadian and American agency support and involvement to achieve its objectives, many of which have been identified in the NPA.

Rapid urban growth along the south coast of B.C. is bringing a shift toward greater awareness among local governments for effective and co-ordinated environmental action. National and provincial programmes must therefore increasingly provide support and guidance to local governments in order to meet their environmental objectives within the larger framework of the coastal zone. There will be a learning curve to build more effective working relationships, a task particularly difficult in multi-use coastal settings such as the Georgia Basin (NRTEE, 1997).

Literature Cited

British Columbia/Washington Marine Science Panel. 1994. **The shared waters of B.C. and Washington.** Province of B.C., State of Washington. 119 p.

Carpenter, R., and T.M. Beasley, 1981. **Plutonium and Americium in Anoxic Marine Sediments: Evidence Against Remobilization.** Geochimica et Cosmochimica Acta, 45: 1917-1930.

Casillas, E., D. Misitano, L. Johnson, L. Rhodes, B. McCain, and U. Varanasi. 1991. **Spawning and Reproductive Success of Female English Sole (*Parophrys vetulus*) from Urban and Non-urban Sites of Puget Sound, Washington.** Marine Environmental Research, 31: 99-122.

Colodey, A., M.E. Hagen, J. Boyd, and A. Redenbach. 1998. **Pulp and Paper Environmental Effects Monitoring (1993-1996): British Columbia Cycle 1 Synopsis and Cycle 2 Changes.** Environment Canada report, Environmental Protection, Pacific and Yukon Region.

Department of Fisheries and Oceans. 1986. **Policy for the Management of Fish Habitat.** Ottawa. 28 p.

Environment Canada. 1996. **The State of Canada's Environment.** Ottawa: Public Works and Government Services Canada.

Environment Canada. 1997. Unpublished data.

EVS Environmental Consultants. 1997. **Summary and Overview of Environmental Effects of the Anaconda Britannia Mine on Juvenile Salmonids and the Marine Environment in Howe Sound.** Report prepared for Environment Canada, Environmental Protection Service, Pacific and Yukon Region. North Vancouver: EVS Environmental Consultants.

Goyette, D., and J. Boyd. 1989. **Distribution and Environmental Impact of Selected Benthic Contaminants in Vancouver Harbour, British Columbia, 1985-1987.** Environment Canada, Regional Programme Report No. 89-02. North Vancouver.

Hagen, M.E., A.G. Colodey, W.D. Knapp, and S.C. Samis. 1997. **Environmental Response to Decreased Dioxin and Furan Loadings from British Columbia Pulp Mills.** Chemosphere, 34 (5-7): 1221-1229.

Henderson, S. 1997. **Culprits Identified for Sewage's Oestrogenic Effects.** Marine Pollution Bulletin, 34 (1): 5.

Johnson, L.L., S.Y. Sol, D.P. Lomax, G. Nelson, and E. Casillas. 1997. **Fecundity and Egg Weight in English Sole (*Pleuronectes vetulus*) from Puget Sound, Washington: Influence of Nutritional Status and Chemical Contaminants.** Fisheries Bulletin No. 92: 232-250.

Kistritz, R.U. 1996. **Habitat Compensation, Restoration and Creation in the Fraser River Estuary: Are We Achieving a No Net Loss of Fish Habitat?** Prepared for DFO, Fraser River Action Plan. Canadian Manuscript Report of Fisheries and Aquatic Sciences. 2349.

Langer, O.E. 1997. "No Net Loss in the Fraser River Estuary: Assessment of Methodology". In: DFO. **Fraser River Action Plan. Workshop proceedings. No net loss of habitat. Assessing achievement.** February 26-27, 1997. Kwantlen University College. Richmond, B.C.

Levings, C.D. (DFO, Pacific Region). 1997. Personal Communication.

Levings, C.D., and R.M. Thom. 1994. "Habitat Changes in the Georgia Basin: Implications for Resource Management and Restoration." In: R.C.H. Wilson, R.J. Beamish, F. Aitkens, and J. Bell, eds. **Review of the Marine Environment and Biota of the Strait of Georgia, Puget Sound and Juan de Fuca Strait.** Proceedings of the B.C./Washington symposium on the marine environment: January 13-14, 1994. Canadian Technical Report of Fisheries and Aquatic Sciences. 1948. p. 300-349.

MacDonald, R.W., W.J. Cretney, N. Crewe and D. Paton. 1992. **A History of octachlorobenzo-p-dioxin, 2,3,7,8-tetrachlorodibenzofuran, and 3,3',4,4'-tetrachlorobiphenyl Contamination in Howe Sound, British Columbia.** Environmental Science and Technology, 26: 1544-1550.

Mackas, D.L., and P.J. Harrison. 1997. **Nitrogenous Sources and Sinks in the Juan de Fuca Strait/Strait of Georgia/Puget Sound Estuarine System: Assessing the Potential for Eutrophication.** Estuarine and Coastal Shelf Science, 44: 1-21.

National Round Table on the Environment and the Economy (NRTEE). 1997. **Task Force on Oceans Environment and Resources.** Draft discussion paper. http://www.nrtee-trnee.ca/english/info/task-force/oceans/ocean.htm

Paine, M.D., P.M. Chapman, P.J. Allard, M.H. Murdoch, and D. Minifie. 1996. **Limited Bioavailability of Sediment PAH near an Aluminum Smelter: Contamination Does Not Equal Effects.** Environmental Toxicology and Chemistry, 15 (11): 2003-2018.

Sekela M., R. Brewer, G. Moyle, and T. Tuominen. 1997. **Occurrence of an Environmental Estrogen (4-nonylphenol) in Sewage Treatment Plant Effluent and the Aquatic Receiving Environment.** Poster presented at International Association on Water Quality Specialized Conference on Chemical Process Industries and Environmental Management. September 8-10, 1997. Cape Town, South Africa.

CHAPTER 5. ARCTIC REGION

INTRODUCTION

The Canadian Arctic, for the purpose of the National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA), includes that portion of Canada north of 60° and all of Hudson Bay and James Bay. This area encompasses 24% of Canada, and its coastline stretches 179 950 km. The Arctic coast features diverse habitats including tidal flats, saltmarshes, cliff shorelines and the ice edge.

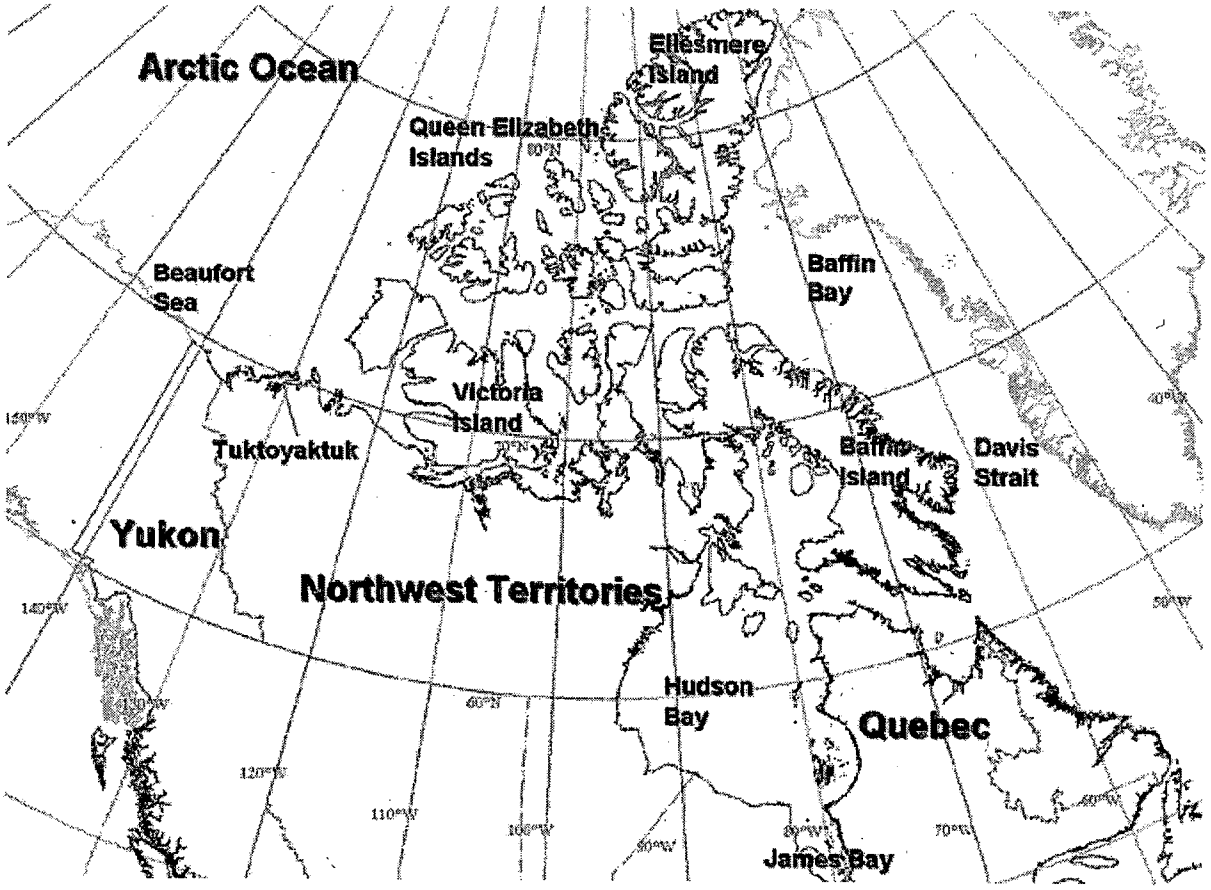

Figure 5-1. The Canadian Arctic

While it is vast, it is also the most sparsely populated part of the country, with only 76 communities and a total population of approximately 69 000. The majority of these communities (approximately 50) are either located directly on the coast or in the Mackenzie River watershed, a major riverine input to the Arctic Ocean. The other major riverine input to the Arctic is the Hudson Bay drainage system, extending southward more than 2 000 km. Scheduled for the future in the NPA workplan are the assessment of land-based sources of marine pollution in the Quebec Arctic, and the Hudson Bay and James Bay drainages.

Canada's Arctic differs from the rest of the country in many ways. Although its climate is

harsh, its ecosystems are fragile. The assessment of impacts on Arctic marine habitat from land-based activities includes an element not found in other oceans: the ice platform. Much of the Canadian Arctic also has a unique administrative structure that involves co-management by aboriginal land claimants, communities and government. A prominent feature of the co-management bodies is their application of traditional ecological knowledge to regulatory processes (see box). Compared with the rest of the world, Canada's Arctic is relatively pristine and unpolluted. However, land-based sources of marine pollution do exist within the Canadian Arctic. It is also highly susceptible, through long-range transport of contaminants, to land-based activities outside Canada.

Arctic concerns are addressed in the Arctic Chapter of Canada's NPA, and in the Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities (RPA). The RPA was developed under the Arctic Council by the Working Group on the Protection of the Arctic Marine Environment and adopted at the first Ministerial Meeting of the Arctic Council in September 1998. Thus, Arctic concerns are dealt with in a Canadian context in the NPA, and in a circumpolar regional context in the RPA.

Land-based activities in the Arctic are associated with both communities and remote industrial sites and facilities. Communities in the Arctic are relatively small. Mining and oil and gas exploration/development are the predominant industrial land-based activities with potential marine impacts; others include hydroelectric development and a growing tourist industry. Government facilities such as weather stations and Distant Early Warning (DEW) Line sites are also points of past and ongoing land-based activity.

Traditional Ecological Knowledge

An important feature of environmental impact assessments in the North is the use of traditional knowledge. It is always costly to monitor environmental issues in the Arctic. Furthermore, it is extremely difficult to document environmental changes which result from the transitory effects of environmental noise and human disturbance. Local knowledge of habitats and wildlife behaviour is often extremely detailed and accurate, and should be used wherever possible to assess, interpret and monitor environmental impacts such as these. Similarly, conservation management plans that integrate wildlife protection with development activities require detailed knowledge of species, their life cycle, and their habitat requirements. In these instances, traditional ecological knowledge can provide much of this detail.

5.1. Identification and Assessment of Problems

5.1A. Contaminants

Sewage

Disposal of liquid and solid wastes is a concern in all coastal communities because of the harsh climate and the presence of permafrost. Conventional sewage treatment systems do not work well in these communities, and the presence of permafrost forces some communities to dispose of solid wastes in open sites. Sewage concerns are often closely tied to problems related to solid waste dumps.

About 50 communities, with an average population of about 740, are situated on the Arctic coast. Although overall volumes of municipal waste are not large, waste water is more concentrated than in the south (UMA Engineering, Ltd., 1993). On the other hand, northern sewage does not contain significant volumes of industrial or institutional wastes,

so the total release of metals and other inorganic wastes into the marine environment is low. Some communities, such as Resolute, discharge raw or primary-treated sewage directly into the ocean. Others have sewage lagoons (e.g., Iqaluit and Tuktoyaktuk), but these frequently do not operate properly or overflow. Raw or primary treated sewage may enter the marine environment directly (during fall decant), by percolation through lagoon substrates, or by leaching into surface drainage waters. Finally, some communities dispose of sewage in plastic bags that are placed in solid waste disposal sites. These wastes take years to degrade because of the slow rate of decomposition in the Arctic environment. They also present the potential for leaching into the marine environment. The effects of sewage are very localized, and there is currently no direct evidence of cumulative effects in coastal waters.

Persistent Organic Pollutants

Over the last 30 to 40 years, the Arctic has been subjected to point source contamination from local activities, such as DEW Line sites, and to pollutants transported over long distances from the industrialized regions of the world. The long-range transport of persistent organic pollutants (POPs) to the Arctic is viewed as one of the most significant threats to environmental quality. Studies of their composition and geographic distribution indicate that they are transported to the Arctic primarily by air currents (Jensen et al., 1997). However, ocean currents and north-flowing rivers also contribute. Contamination with toxicants is already evident in some wildlife populations, and concerns about the safety of traditional foods have been raised in several areas of the Arctic. Health advisories have been issued recommending limits in the consumption of some traditional foods (Jensen et al., 1997).

Abandoned waste sites have been identified throughout the Arctic, some of which are known to contain toxic chemicals, including polychlorinated biphenyls (PCBs). While about 500 sites have already been cleaned up, much more remains to be done to address problems from the past. The contaminants at the DEW Line sites have been identified, and steps are being taken to clean up these sites. Studies at Cambridge Bay, Iqaluit and other sites in the Arctic have not identified any significant sources of contamination resulting from ocean dumping (Bright et al, 1994, 1995); however, the potential impacts of past ocean disposal practices remain a major public concern.

Radionuclides

There are no land-based activities in Canada that contribute radionuclides to the Arctic marine environment. The majority of radionuclides that have entered the Arctic originate from atmospheric fallout of nuclear weapons testing that took place between 1952 and 1978, and the accident at the Chernobyl nuclear power plant in 1986 (Nilsson, 1997). The current levels of radioactive contamination in the Arctic seas (water and sediment) and biota are relatively low, and cause no concern for human health or the environment (Nilsson, 1997). Potential radioactive threats include accidents connected with the operation of nuclear-powered vessels, and the long-range transport of radionuclides from re-processing plants and radioactive waste storage sites outside the Canadian Arctic. Although present radionuclide levels are low, long-range transport presents the potential for significant impacts on the Arctic marine environment from accidental releases in other parts of the world.

Heavy Metals

Anthropogenic sources of metal pollution in the Arctic marine environment include oil and gas drilling and related shore-based facilities, mines, DEW Line sites, dumps, hydroelectric developments, and atmospheric inputs. Concerns related to hydroelectric development will be addressed in the future

work programme of the NPA, with the inclusion of Hudson Bay and James Bay.

The major concern related to land-based oil and gas drilling is the accumulation of metals (and other contaminants) from drill wastes in soils and plants around sumps. Drilling activities have been drastically reduced over the last few years in areas where impacts from heavy metals could reach the marine environment, while environmental management practices of ongoing drilling activities have improved. Many abandoned sumps are, however, potential sources of various environmental contaminants. Studies indicate that accumulation of contaminants in soils and plants around sumps is usually confined to the area within 100 m (Hardy and BBT Ltd., 1988). In flood plains and coastal areas, erosion of sumps can also result in the release of heavy metals to the marine environment.

The operation of shorebases to support offshore oil and gas drilling also has the potential to affect the marine environment. Chronic fuel spills and runoff from workyards appear to be the primary sources of contamination. Measurements indicated elevated levels of chromium, copper, mercury, nickel and lead (Wells and Rolston, 1991).

Two lead-zinc mines operate near the Arctic coast: Polaris Mine on Little Cornwallis Island in the High Arctic and Nanisivik Mine near Arctic Bay on the north coast of Baffin Island. Both mines discharge effluents containing heavy metals to the marine environment. Although these discharges cause local elevations of metal concentrations in sediments and biota, they are not a major ecological concern. Assessment of mining impacts in the Hudson Bay and James Bay drainage will be part of the NPA's future work programme.

At DEW Line sites, the most common inorganic contaminants detected were copper and zinc from plumbing and paints, and lead from fuels. Contaminated soils from these sites may release heavy metals to the marine environment. DEW Line contamination issues are being addressed in ongoing cleanup activities.

In summary, metal discharges from land-based sources within the Arctic seem to have, at most, localized biological effects. Some metals may be present in sewage and solid waste, but these occur only in small quantities because of the relatively low volumes of waste produced. Abandoned sumps and mine sites may be a source of metals, but impacts have not been documented. Hydroelectric developments are known to be a source of mercury when lands are flooded. Several hydroelectric projects have been constructed on the Hudson Bay and James Bay drainage basins, and will be addressed in the NPA's future work programme.

Metals that are transported to the Arctic by way of long-range transport (in particular, mercury, cadmium and lead) create a more significant concern because of their apparent presence throughout the Arctic marine environment (Jensen et al., 1997; Nilsson, 1997). As with POPs, these metals originate in industrialized regions of Europe, Asia and North America. Elevated levels of mercury have been found in polar bears, and high levels of cadmium have been found in the kidneys and livers of other marine mammals. This remains a major health concern to all Northerners.

Oils/Hydrocarbons

There is little or no exploratory drilling currently under way in or near the marine environment. During the last 30 years, however, numerous oil and gas exploratory wells have been drilled in the Mackenzie Delta-Beaufort Sea region. The major concern related to land-based drilling is the accumulation of contaminants in soils and plants around sumps (see Heavy Metals).

The major land-based source of hydrocarbon release into the Arctic marine environment is spillage from fuel storage and transfer facilities at coastal communities, and from former oil and gas drilling, production and associated staging operations (Dobrocky Seatech Ltd., 1985). Natural sources may also contribute significant amounts, particularly from seeps along the Mackenzie River.

Nutrients

The addition of nutrients to the marine environment is not a problem in the Arctic, except where input of sewage may lead to localized over-productivity and eutrophication.

Contaminated Sediments

Relatively little is known about the distribution and kinetics of sediments in the Arctic marine environment. Dredging activity is limited, so sediment inputs result mainly from natural sediment transport. Any contaminants associated with these sediments are dealt with in preceding sections.

Litter

During the early 1980s, shoreline litter surveys conducted on the southern Beaufort Sea indicated that over 90% of the wastes sighted along the Beaufort Sea shoreline had originated from oil and gas exploration activities. The studies concluded that the wastes had minimal biological impact but did have a negative aesthetic effect. In 1990, additional surveys showed that the most commonly found items were polystyrene foam and polypropylene rope. With the decline in oil and gas activities, the largest source of debris now seems to be domestic waste, presumably from solid waste sites of coastal communities.

5.1B. Physical Alteration and Destruction of Habitat

Physical habitat alterations result in changes to the biological structure and function of the estuarine, coastal and ice environments. There is the potential for impacts on the social systems of humans living in these environments. Some of the biological impacts on the these environments include lowered spring primary productivity, lowered benthic invertebrate productivity, changes in ice characteristics and the timing of breakup, and changes in the distribution and survival of fish (larval, juvenile and adult stages), marine mammals, coastal waterfowl and seabirds. All of these changes can impact negatively upon people who rely on the aquatic environment for subsistence.

The assessment of impacts on Arctic marine habitat from land-based activities includes an element not found in other oceans: the ice platform. The ice platform provides habitat for the pupping of seals and the denning of polar bears, and is an important winter transportation route for local people and caribou. Open cracks (leads) in the ice are breathing habitat for marine mammals. Seabirds are totally dependent for food on open water in leads and polynyas (areas where open water can be found year-round) within a 150 km radius of the breeding colonies. The undersurface of the ice is also an important habitat for the epontic community, which consists of ice algae and other micro-organisms, amphipods that graze on these algae, and a fish community that feeds on the amphipods. This is thought to be an important habitat for Arctic cod, a key ecological species in the Arctic eaten by many bird, fish and mammal species. Underwater noise must also be considered as a significant habitat element because of its potential to interfere with important vocalizations of some marine mammals.

Shoreline Construction/Alteration

The construction of port facilities and structures to stabilize shorelines can affect local nearshore current patterns and marine physical features. This may alter fish habitat or prevent fish from following their normal migration routes, where they are traditionally

harvested. The disturbance of shoreline granular material for port construction, in certain areas where the granular material has a high ice content, is likely to result in significant shoreline erosion. Removal of the insulating overburden exposes the shoreline to modification by wave action and the longshore current transport of granular material.

Impacts from current construction activities tend to be very localized, and good management practices are in place for ice road construction and harbour development, minimizing sediment-related problems.

Inter-tidal and Sub-tidal Alteration

Ice-breaking activities are required for sea transportation in the Arctic, but pose three major problems: interference with transportation over ice, the potential harm to animals hunted for subsistence, and the disturbance of animals in traditional hunting areas.

Transportation over ice among Inuit communities and camps is essential for social interaction and subsistence hunting. The passage of an ice-breaking ship leaves a rough track which interferes with and endangers sea-ice transportation. Ice-breaking activities may also accelerate the separation of large ice pans at the ice edge during spring breakup, endangering hunters who may be positioned there.

Ice breaking may also harm animals hunted by the Inuit. Seals raise their young on the ice, and narwhal may be attracted by the temporary open water created by ice-breaking. When the open leads close again, narwhal may become trapped without access to air. The migration of caribou over ice may also be affected.

The underwater noise generated by ice-breaking activities may disturb animals and drive them from traditional hunting areas. Concerns have been raised in both the western and eastern Arctic about the effects of underwater noise and ice breaking on the migration patterns of whales, particularly in the vicinity of polynyas, such as those in Amundsen Gulf and eastern Lancaster Sound.[2] Polynyas are critical habitats because they provide feeding areas for many overwintering marine mammals and sea birds. Other regions of concern are those where the ship passage through inlets is likely to bring ships close to communities and hunting areas.

Mineral and Sediment Extraction/Alteration

Dredging in the Arctic is primarily associated with the maintenance of ferry crossings, navigation channels and harbours in the shallow bays and estuaries of the Mackenzie Delta. Dredging is also associated with the extraction of granular deposits such as sand and gravel for the construction of artificial islands, and with the laying of undersea pipelines. There are several concerns associated with dredging activities.

There is a potential impact on bowhead and beluga whales if underwater noise and increased suspended sediments disturb feeding or migrating activities. Another concern is the impact on plankton and fish populations in nearshore environments, where particularly productive coastal embayments support large populations of fish. More severe impacts can be expected on benthic communities because of the direct mortality of infauna and some epifauna in areas of dredge spoil removal and deposition. In other areas, ocean disposal of dredge spoils from harbour maintenance may impact on seaducks and shellfish beds that have commercial potential, or are important feeding grounds for bearded seals.

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[2] Beluga whales react to ship noise at a distance of 40 km, and their response to being startled is rapid flight, herd formation, loss of pod integrity, asynchronous, shallow dives and "alarm" calls usually associated with fear of killer whales. They may return to the site while ship noise is still present, but "belugas in the high Arctic are extraordinarily sensitive to shipping activity in the spring."

Wetland and Saltmarsh Alteration

Large areas of the Mackenzie Delta consist of wetlands that are important habitat for waterbirds and fish. The inshore zone is an important nursery, feeding and overwintering site for both nearshore and offshore organisms. It is especially important to those anadromous species forming the basis of the domestic and commercial fishery in the Delta: broad whitefish, Arctic char, Arctic cisco and inconnu. Standing stocks of fish are greatest nearshore, since the anadromous species tend to frequent shallow coastal waters during the summer months rather than move offshore.

Areas of significant hydrocarbon potential exist within these habitats, ranging from the outer Beaufort Sea coast to the upper Arctic Red River, and the potential still exists for the laying of a gas pipeline. Impacts on fish could result from changes in the smaller food organisms and the exclusion of fish from important habitats. There may also be changes in the habitats themselves, such as oxygen depletion, and sedimentation of spawning and overwintering areas.

As industrial development proceeds, fuel and other toxic substances may be spilled, and there will be more people in the area to increase sport, domestic and commercial fishing. In years when the north slope of the Yukon is snow-covered, at the time snow geese arrive, up to 325 000 birds use the Mackenzie Delta as a staging area. The birds are extremely vulnerable to aircraft overflights, and to the kinds of disturbance associated with construction on land and sea. Large areas of tidal flat and coastal marshland are also found in the lower Hudson Bay and James Bay. These areas are used extensively by migrating shorebirds in fall, by geese in spring, and by both waterfowl and shorebirds for nesting in summer. They are also important for the subsistence harvesting of wildlife and waterfowl. Communities in these areas have expressed concern about the impact of hydroelectric development on changes in the pattern of freshwater runoff, which in turn may cause significant changes in wetland vegetation and wildlife use.

Marine Waters and Coastal Watershed Alteration

Water storage for power production and inter-basin water diversion produces changes in the natural hydrological cycle. Unless some effort is made to operate upstream facilities in a way that mimics natural hydrologic flows, these upstream changes can extend thousands of kilometres downstream and last a very long time. The possible physical impacts on habitat brought about by altering seasonal freshwater flow include (a) desiccation of wetlands, increased offshore salinity, and upstream saltwater intrusion because of reduced flows; (b) collapse of natural deltaic levees and subsidence of coastal deltaic areas because of reduced sediment inputs; (c) overall reduction of spring nutrient inputs to estuaries; and (d) changes to the characteristics of sea ice and the timing of ice breakup near estuaries.

Significant hydroelectric development and water diversion projects have taken place in the north, notably the large-scale damming and diversion of drainage systems flowing into the James Bay and Hudson Bay. An assessment of hydroelectric developments will be included in the NPA future work plan. At present, problems associated with the input of sediment are not a major concern in the Arctic.

Biological Alteration

The introduction of pathogens to the marine environment by aquaculture operations is not a significant factor in Arctic waters, and there has been little study of the introduction of exotic marine species into Arctic waters via the discharge of ballast water from vessels originating in southern ports. Recently, the disposal at sea of offal from a commercial muskox harvest raised the issue of

pathogen/parasite introduction to the marine environment. This issue also may require further examination.

5.2. Establishment of Priorities for Action

Sources of contaminants and physical alteration of habitat were evaluated in terms of their potential or actual impacts on environmental quality, human health and traditional food sources. The adequacy of existing controls was also considered in the setting of priorities. A source that has severe potential impacts, but is well regulated, is thus given a lower priority than one that has fewer known impacts but is not adequately controlled.

5.2A. Contaminants

In the Arctic, sewage/solid wastes and POPs are considered to be **high priorities**, while heavy metals and oils/hydrocarbons are **medium priorities**. At present, radionuclides, nutrients, sediment and litter are **low priorities**.

Sewage

The effects of sewage on the marine environment are very localized; however, municipal effluents are a **high priority** because of:

- the potential for impacts on traditional food sources. A public health concern may exist in communities that harvest shellfish from contaminated waters or process fish and marine mammals on contaminated shorelines. Overall, the relationships among sewage disposal practices, consumption of contaminated meats, and the incidence of enteric diseases in northern residents are largely unknown; and
- the potential for improving existing control measures.

Persistent Organic Pollutants

In the Arctic, POPs are viewed as a **high priority** from both local and international perspectives. POPs have the potential to affect human health and traditional food sources in the Arctic. The international sources are the greatest concern because they cannot be controlled domestically, and long-range inputs could potentially increase. Moreover, there is evidence of bioaccumulation at levels that raise human health concerns. Locally, all DEW Line sites have been assessed and targeted for cleanup by the responsible departments (Department of Indian Affairs and Northern Development [DIAND] and Department of National Defence [DND]). Cleanup is ongoing or complete at four stations, and will continue at the remaining sites as resources permit. There is public opposition to the amendment of PCB legislation to permit burial of PCB-contaminated paint on-site, and further discussions will be required to resolve this issue.

Although historical ocean dumping practices and the identification of land-based sources of contaminants have raised concerns about potential effects on the nearshore fisheries, measurements of PCBs, metals, polycyclic aromatic hydrocarbons, and pesticides in biota at historical dumpsites have not been found to exceed the levels requiring restrictions on consumption (Bright et al., 1994, 1995).

Radionuclides

Radionuclides are a **low priority** concern as there are no substantial local sources from land-based activities in the Arctic. However, long-range inputs of radionuclides into the Arctic remain an ongoing concern.

Heavy Metals

Metal discharges from land-based sources within the Arctic seem to have only localized biological effects. Some metals may be present in sewage and solid waste, but these occur only in small quantities because of the

relatively low volumes of waste produced. Impacts from abandoned sumps and mine sites have not been documented. Local sources of heavy metals are therefore a **medium priority**.

Metals that are transported to the Arctic by way of long-range transport create a more significant concern because of their apparent presence throughout the Arctic marine environment. Long-range transport of heavy metals is viewed as a **high priority**, because industrial sources outside the Arctic could affect human health and traditional food sources.

Health advisories have been issued recommending limited consumption of some traditional foods. Furthermore, some knowledge gaps remain. Most studies have investigated bioaccumulation of metals in marine mammals and fish, and little is known about lower trophic levels. More knowledge of potential chronic physiological effects (as opposed to acute effects) is needed in order to determine acceptable limits of contamination. In this respect, it will be necessary to conduct individual studies on various metals (especially mercury, cadmium and lead). Knowledge gaps have been identified and included in the work programmes of the Arctic Monitoring and Assessment Programme (AMAP) and the Northern Contaminants Programme (NCP).

Oils/Hydrocarbons

Hydrocarbons and oil handling facilities are considered to be a **medium priority** in the Arctic. Except for the immediate area around a spill, hydrocarbons in the Arctic marine environment are generally found in such low concentrations that they do not pose a threat to marine life. However, where hydrocarbon levels are elevated, some species have shown hydrocarbon uptake, which may lead to health effects. Long-term concerns centre on the threat of large oil spills posed by oil drilling and production activities, and how such spills could affect marine wildlife.

Nutrients

The input of nutrients into the marine environment is a **low priority** concern in the Arctic. Any concerns associated with nutrients can be addressed through improvements in the way sewage is treated.

Contaminated Sediments

The input of contaminated sediments into the marine environment is a **low priority** concern in the Arctic. Sediment inputs result mainly from natural sediment transport, and any contaminants associated with these sediments are dealt with in their respective sections.

Litter

Litter is primarily a solid waste-related issue in the Arctic. Although it is not likely to have significant effects on human health or traditional food sources, litter does have an adverse effect on the growing tourism industry in the Arctic, and is therefore included as a **low priority**.

5.2B. Physical Alteration and Destruction of Habitat

Certain marine habitats are more important than others for particular animal and plant species. Cliff shorelines that host seabird breeding colonies are critical habitats, as are the polynyas in which seabirds feed early in the breeding season. Tidal flats and estuarine areas are critical feeding habitats for shorebirds and some waterfowl. Saltmarshes form critical breeding areas for Brant geese. Ice edges, polynyas, and areas that are free of ice early in the season are of paramount importance to a variety of marine wildlife.

Canada's Arctic marine environment is home to six species of endangered, threatened or vulnerable wildlife species (World Wildlife Fund, 1996). Human activities and degradation of habitat are present or potential threats to these species. To minimize future declines in endangered

species populations, their habitats must be identified and then protected from abuse.

Shoreline Construction/Alteration

The impact of harbour works on fisheries also affects food security, but is considered a **medium priority** because it is highly localized. The erosion of coastlines caused by removing granular overburden from gravel shores is an issue mainly associated with possible future port developments on the Yukon North slope, related to hydrocarbon extraction in the Beaufort Sea.

Inter-tidal and Sub-tidal Alteration

Environmental noise and ice-breaking impacts on marine mammals and hunting activities, as well as wildlife disturbance, are considered to be a **high priority** concern because these impacts are ongoing, and they are perceived to threaten food security and public safety.

Mineral and Sediment Extraction/Alteration

Mineral and sediment extraction and alteration are relatively **low priority** concerns in the Arctic marine environment. Gravel removal is currently dormant, and the smothering of benthic communities by dredging activity is localized with short-term impact.

Wetland and Saltmarsh Alteration

Wetland and saltmarsh alteration is a **medium priority** concern in the Arctic marine environment. The two main industrial developments affecting wetlands are hydrocarbon exploration and extraction (mostly in the Mackenzie Delta) and hydroelectric development (mostly in Hudson Bay and James Bay). These industries can have significant effects on coastal wetlands, and although both are currently dormant, there is strong potential for further development.

Marine Waters and Coastal Watershed Alteration

No substantial sediment-related problems have been identified, and good management practices are in place to prevent future problems. Impacts associated with hydrocarbon and hydroelectric industries, such as the alteration of river delta habitat resulting in changes to drainage patterns, are **medium priority** because these industries are not in an expansion phase at the present time. (A more detailed assessment of hydroelectric development will be included in the future NPA workplan.)

Biological Alteration

Biological alteration is a relatively **low priority** concern in the Arctic marine environment. The introduction of pathogens into the sea via slaughter wastes is an issue that needs more study. However, the disposal at sea of such wastes is infrequent and very localized.

5.3. Setting Goals and Management Objectives

Under the NPA, Canada's goals are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

The following are specific management objectives for each source category.

5.3A. Contaminants

For most of the contaminants, the management objective is to reduce the contribution of contaminant sources to the marine environment, primarily through pollution prevention. Where contaminants

are released to or occur in the marine environment, the management objective is to apply life-cycle management or remediation to address the problems.

Specific management objectives for each of the contaminants of concern at the national level are:

Sewage — reduce contamination; maintain and improve estuaries, coastal water and marine ecosystem quality for all users; maintain and restore shellfish growing areas.

Persistent Organic Pollutants — reduce/virtually eliminate anthropogenic inputs and apply life-cycle management to remaining inputs.

Radionuclides — reduce inputs where they are likely to cause pollution, and apply radiological protection.

Heavy Metals — reduce inputs where they are likely to cause pollution, and apply life-cycle management.

Oils/Hydrocarbons — prevent spills, establish contingency plans and apply life-cycle management.

Nutrients — reduce inputs where they are likely to cause pollution.

Contaminated Sediments — reduce sediment contamination at source.

Litter — reduce the incidence of litter/debris found in the marine environment.

5.3B. Physical Alteration and Destruction of Habitat

The primary management objectives are to lessen or avoid harmful alteration and destruction of habitats and to restore those habitats already degraded. For some categories of harmful alteration (e.g., mineral and sediment extraction or disposal; alteration of marine waters and coastal watersheds), it is also necessary to identify critical habitats to ensure such activities take place in areas of lesser environmental sensitivity or significance. There are also some specific management objectives that apply to unique problems such as the accidental or deliberate introduction of exotic species to the marine environment from land-based activities — where the actual objective is to eliminate such introductions.

Specific management objectives for each of the habitat categories of concern at the national level are:

Shoreline Construction/Alteration — minimize habitat loss and balance losses by restoring or creating equivalent replacement habitat.

Inter-tidal and Sub-tidal Alteration — identify critical habitats and prevent loss or degradation of these areas while restoring areas already degraded.

Mineral and Sediment Extraction/Alteration — identify and protect sensitive habitats and marine resources.

Wetland/Saltmarsh Alteration — prevent any further loss or destruction of critical habitats and restore valuable areas previously drained or altered where feasible.

Marine Waters and Coastal Watershed Alteration — protect key habitats for all life stages of marine resources.

Biological Alteration — prevent all inadvertent or inappropriate introductions of alien species and pathogens and protect sensitive coastal ecosystems.

5.4. Strategies and Actions

In addition to the national strategies and actions identified in Chapter 3 (National Issues), the NPA management objectives will be addressed in the Arctic with the following regional strategies and actions.

5.4A. Contaminants

Sewage

- in partnership with the Government of the Northwest Territories' Municipal and Community Affairs (MACA), Health Canada and NWT Waste & Wastewater Association:
    - use a community-based approach to identify and assess sewage-related problems and treatment requirements;
    - improve the operation of sewage facilities by increasing training;
    - consult and provide expertise to communities to assist in focusing on priorities and monitor progress in sewage treatment;
    - report on assessments of required improvements;
    - promote investment in the implementation of these improvements;
    - provide training and public education; and
- work toward complete community licensing and compliance.

Persistent Organic Pollutants

- promote continued monitoring of POP levels in the Arctic environment;
- monitor the progress of current cleanup activities;
- keep local source issues under continuing review;
- assess the need for further investigations based on anecdotal information on a case-by-case basis;
- participate in international initiatives to control POPs (e.g., Arctic Council); and
- monitor progress in other initiatives for the control of foreign sources of POPs.

Radionuclides

- promote and report on the circumpolar initiative of the Arctic Council.

Heavy Metals

- promote monitoring at abandoned sumps and assist in assessing the need for remediation at abandoned sumps by identifying and consulting key stakeholders;
- identify, review and report on ongoing studies;
- monitor regulated mine effluents;
- assess extent and effects of long-range transport; and
- determine acceptable limits of contamination.

Oils/Hydrocarbons

- promote regular review and revision of spill response plans by operators;
- promote regular training of all personnel for spill response plans;
- assist in developing appropriate regulations for prevention of hydrocarbon spills;
- contribute to the level of preparedness in the Arctic by promoting the work of EPPR (Arctic Council Working Group on Emergency Prevention, Preparedness and Response) and AREET (Arctic Regional Environmental Emergencies Team);
- determine in future the monitoring and assessment support from the NPA;
- promote increased spill reporting;
- assist in development of emergency plans for oil spills;
- assist in setting minimum standards for oil spill cleanup and test procedures; and
- improve on-ice cleanup technology.

Nutrients, Contaminated Sediments and Litter

- existing strategies and actions are adequate to achieve management objectives.

5.4B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

- establish and improve review, assessment and approval mechanisms;
- integrate renewable resource management with regional land-use planning;
- develop policy and regulations for coastal construction;
- support integrated planning for coastal zone management through the provisions of the Canada Oceans Act;
- establish protection of habitats for key species harvested for subsistence or commercial use; and
- support the following activities:
    - inventories of critical habitats and species;
    - mapping of development plans and resource-use areas; and
    - protection of important natural resources from negative impacts of development.

Inter-tidal and Sub-tidal Alteration

- improve the safety and efficiency of ice travel by Inuit;
- protect wildlife used for subsistence or commerce from disturbance, particularly during sensitive periods of the life cycle;
- control seasonal/geographic activities of ice breaking/seismic surveys;
- encourage co-operation between the transportation industries and coastal communities to investigate the impacts of ice breaking and to devise means for mitigation; and
- facilitate the plan for a federal/territorial framework for marine protected areas, which may be used to protect certain activities in marine areas.

Mineral and Sediment Extraction/Alteration

- encourage the integration of development scenarios into development plans to minimize environmental impacts;
- improve site selection for nearshore dumping of dredged materials;
- rank known sources of granular material with respect to removal impact on coastal integrity; and
- develop restoration conditions for licensing of development.

Wetland and Saltmarsh Alteration

- support the formation of integrated land-use plans that consider all impacts of developments on a watershed;
- encourage the integration of land-use planning among jurisdictions;
- assist in development of new guidelines for reservoir design and management;
- use existing mechanisms to assess cumulative impacts prior to development;
- identify drainage patterns for marshlands; and
- establish a system for evaluating cumulative impacts of overall development plans.

Marine Waters and Coastal Watershed Alteration

- promote integrated coastal planning with watershed development plans;
- develop effective inter-governmental environmental impact assessment (EIA) procedures with consultation of all stakeholders; and
- develop guidelines for reservoir management.

Biological Alteration

- obtain further information on introduction of pathogens from slaughter wastes on beaches; and
- support research to examine pathways of pathogenic or exotic species introduction.

5.4C. Linkages

International

Ministers of the Arctic countries recently agreed to continue joint efforts to develop, implement and improve the Arctic Environmental Protection Strategy (AEPS) programmes under the auspices of the Arctic Council. These programmes include Conservation of Arctic Flora and Fauna (CAFF), Protection of the Arctic Marine Environment (PAME), Arctic Monitoring and Assessment Programme (AMAP), Emergency Prevention, Preparedness and Response (EPPR), and Sustainable Development and Utilization (SDU), all of which contribute to meeting commitments under the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) in the Canadian Arctic.

The RPA was adopted at the first Ministerial Meeting of the Arctic Council in Iqaluit, September 17-18, 1998. The RPA supports national and sub-regional efforts in the Arctic through capacity building and harmonized measures where appropriate.

National

- Northern Ecosystems Initiative (NEI) — The NEI is one of a family of Environment Canada ecosystem initiatives. Programme development and approval will be followed by the implementation of a five-year plan in April 1999. The NEI will use a collaborative and co-operative approach to address, in partnership with stakeholders, northern research priorities related to climate change, biodiversity, toxins and contaminants, and the impacts of major developments.
- Northern Contaminants Programme 2 (NCP2) — The Northern Contaminants Programme was established in 1991 as part of the six-year Arctic Environmental Strategy. Funding for the NCP has been extended for five more years. The NCP is managed by a partnership of northern Aboriginal peoples and federal and territorial departments. It focuses on human health; education, communication, and community-based strategies; monitoring the health of Arctic people and ecosystems; and development of international controls.
- Northern Sustainable Development Strategies — Following amendments to the Auditor General Act in 1997, all federal departments were required to prepare a sustainable development strategy (SDS) to integrate sustainable development principles into departmental decision making. Northern consultations to obtain input for departmental SDSs were led by DIAND with co-operation from other key departments. One of the recommendations of northern stakeholders was the development of a consolidated northern SDS.

Other initiatives, strategies, policies and acts that contribute to meeting GPA commitments are identified and described elsewhere. Of central importance are the co-management bodies established pursuant to the Western Arctic Inuvialuit Final Agreement and the Nunavut Land Claims Agreement. These are:

Western Arctic Inuvialuit Final Agreement

- Wildlife Management Advisory Council
- Fisheries Joint Management Committee
- Environmental Impact Screening Committee
- Environmental Impact Review Board

Nunavut Land Claims Agreement

- Nunavut Wildlife Management Board
- Nunavut Planning Commission
- Nunavut Impact Review Board
- Nunavut Water Board
- Nunavut Marine Council

The NPA can contribute to environmental management in the Arctic by supporting co-management institutions with scientific and technical expertise, and by building human capacity in the north for improved environmental decision making.

5.5. Next Steps

An assessment of Northern Quebec and the Hudson Bay and James Bay drainages is part of the NPA's future work plan. This examination will complete the process of identifying and assessing land-based activities that affect the Arctic marine environment.

In the Arctic, as elsewhere, the impact of land-based activities on the marine environment raises inter-jurisdictional issues. Most land in the Northwest Territories is owned by the federal government, except for lands transferred to the Government of the Northwest Territories (GNWT), to the Yukon Territorial Government (YTG), or to Aboriginal peoples under specific land claims agreements. Within the federal government, DIAND has jurisdiction over most matters, except where that matter is assigned by law to another federal department or agency. Some legislative authority is delegated to the territorial governments under various administrative agreements, acts and other legislation. The land claims agreements in the north establish various classes of land ownership. Most importantly for the NPA, these agreements establish resource co-management boards with the rights to participate in land and water management. At the international level, Canada is a member of the Arctic Council. These considerations largely determine the strategic direction of the next steps that Canada should take toward implementation of the NPA objectives.

Federal Inter-agency Integration

The federal government plays a central role in land and oceans management in the north. Therefore, in all future steps designed to further the objectives of the NPA, there should be a better mechanism for integration of federal programmes relating to oceans management and to the integration of land-based activities with oceans management. This mechanism should primarily involve the agencies most closely associated with resource use and marine transportation: the departments of Indian Affairs and Northern Development, Fisheries and Oceans, Environment, Natural Resources, Canadian Heritage, and Transport, and the Canadian Environmental Assessment Agency. Some progress in interdepartmental integration has already been made in response to the Canada Oceans Act, and further efforts are required.

Co-management

In the future, most coastal areas in the north will be subject to land claims which have provisions for resource co-management. Land and ocean management directed toward the objectives of the NPA in the north must be pursued within the context of co-management. Therefore the land claims boards, agencies and commissions need to be drawn more closely into the NPA process as co-management partners. Given the limited capacity of many of these boards to address the priorities of the NPA, the federal government should raise the awareness of the NPA in the north and help build capacity within the land claims organizations to address the issues defined by the NPA.

Aquatic Ecosystem Health and Monitoring

The impact of land-based activities on the Arctic marine environment comes from three major sources: local, shore-based development activities; airborne pollutants; and riverine inputs and influences. In the Canadian Arctic the main riverine influence on the marine environment at present is through the Mackenzie River watershed. The departments of Indian Affairs and Northern Development, Environment, Fisheries and Oceans, and the Canadian Environmental Assessment Agency all provide regulatory

control for most water-borne pollution. Consequently, the objectives of the NPA could be significantly advanced by encouraging a special degree of co-ordination among these agencies. The Department of Fisheries and Oceans (DFO) has the primary role for aquatic ecosystem health and monitoring, and should take the federal lead in fostering aquatic ecosystem health in the Arctic.

Ecosystem Conservation and Protection

A major component of the NPA strategy is to protect and conserve important marine ecosystems subject to negative impacts from land-based activities. A variety of tools are available to protect marine ecosystems and the land-based ecosystems upon which they depend. The GNWT has announced a Protected Areas Strategy which primarily focuses on terrestrial ecosystems. At the same time, three federal departments have legislation to protect marine, coastal and marshland ecosystems: Environment Canada with its marine wildlife areas and migratory bird sanctuaries; Canadian Heritage with its national marine conservation areas; and DFO with its marine protected areas. The Canada Oceans Act gives DFO the lead in developing a national strategy for marine protected areas, and DFO can use this mandate to advance the objectives of the NPA by working co-operatively with the GNWT and within the co-management framework established by the land claims agreements in the Arctic.

Integrated Coastal Zone Planning

Coastal activities that affect the marine environment in the Arctic fall under a wide range of jurisdictions: municipal to territorial and provincial, land claims and federal. These activities and their management also require the application of many disciplines, including those based in science, sociology, economy and traditional knowledge, driven at the same time by a wide variety of coastal marine users such as subsistence hunters, coastal communities and multinational resource companies. Each has unique viewpoints, requiring a higher level of integration among jurisdictions, disciplines and user viewpoints for the type of planning that will protect marine ecosystems from land-based activities.

Circumpolar Arctic

The Arctic Ocean is the only ocean for which the riparian states have established (in 1996) a council with a mandate for sustainable development. The Arctic Council is a high-level intergovernmental forum that deals with the common concerns and challenges faced by the Arctic governments and people. In 1997, the AEPS programmes were integrated into the Arctic Council. These programmes include:

Protection of the Arctic Marine Environment (PAME) — PAME addresses policy and non-emergency response measures related to protection of the marine environment from land- and sea-based activities. Its activities include implementing the RPA; promoting the application of guidelines for offshore petroleum activities; gathering information on current and future shipping activities and associated environmental effects; and maintaining an overview of the adequacy of existing international agreements.

Conservation of Arctic Flora and Fauna (CAFF) — CAFF was established to address the special needs of Arctic species and their habitats in the rapidly developing Arctic Region. CAFF's main goals are to conserve Arctic flora and fauna, their diversity and their habitats; to protect the Arctic ecosystem from threats; to seek to develop improved conservation management, laws, regulations and practices for the Arctic; to collaborate for more effective research, sustainable utilization and conservation; and to integrate Arctic interests into global conservation fora. The majority of CAFF's activities are directed at species and habitat conservation, and at integrating indigenous peoples and their knowledge into CAFF.

Emergency Preparedness, Prevention and Response (EPPR) — The main goal of EPPR is to provide a framework for Arctic country co-operation in responding to environmental emergencies. The EPPR Working Group was established to evaluate the adequacy of existing arrangements and to recommend the necessary system of co-operation.

Arctic Monitoring and Assessment Programme (AMAP) — The primary objectives of AMAP are to measure the levels of anthropogenic pollutants in all compartments of the Arctic environment, and to assess ecosystem and health effects; to document trends of pollution; to examine the impact of pollution on Arctic flora and fauna, especially those used by indigenous people; to report on the state of the Arctic environment; and to give advice on priority actions needed to improve the Arctic condition.

The objectives of the NPA can be furthered by strengthening the linkages among Canada's conservation and protection programmes and those of the other Arctic countries.

Literature Cited

Bright, D., P. Fortin, S. Harbicht, L. Johnston, S. Parker, and K. Reimer. 1994. **Historical Ocean Disposal in the Canadian Arctic: Survey of Materials Disposed in Cambridge Bay and the State of the Marine Environment.** Ottawa: Environment Canada and Department of National Defence.

Bright, D., S. Harbicht, L. Johnston, S. Parker, K. Reimer, and S. Solomon. 1995. **Baffin Region Ocean Disposal Investigation: Seabed Debris and Contaminant Inputs Near Iqaluit, Resolution Island, Cape Dyer and Kivitoo.** Ottawa: Department of National Defence.

Dobrocky Seatech Ltd. 1985. **1982-83 Beaufort Sea Shorebase Monitoring Programme, Statistical Analysis and Recommendations for Future Programmes.** Yellowknife: Indian and Northern Affairs Canada.

Finley, K.J., C.R. Greene, and R.A. Davis (LGL Limited). 1983. **A Study of Ambient Noise, Ship Noise, and the Reactions of Narwhals and Belugas to the MV Arctic Breaking Ice in Admiralty Inlet, N.W.T. 1982.** (2). Ontario.

Hardy, E.P., and BBT Ltd. 1988. **Geophysical Assessment of Waste Drilling Fluid Containment Sites in the Mackenzie Valley Region, N.W.T.** Ottawa: Indian and Northern Affairs Canada.

Jensen J., K. Adare and R. Shearer, eds. 1997. **Canadian Arctic Contaminants Assessment Report (CACAR).** Ottawa: Indian and Northern Affairs Canada.

Nilsson, A. 1997. **Arctic Pollution Issues: A State of the Arctic Environment Report.** Oslo: Arctic Monitoring and Assessment Programme.

UMA Engineering Ltd. 1993. **Municipal Wastewater Treatment Technologies Capable of Achieving Compliance with the Fisheries Act in the Northwest Territories.** Yellowknife: Government of the Northwest Territories.

Wells, P.G., and S.J. Rolston, eds. 1991. **Health of Our Oceans. A Status Report on Canadian Marine Environmental Quality.** Ottawa: Environment Canada.

CHAPTER 6. SOUTHERN QUEBEC/ST. LAWRENCE REGION

INTRODUCTION

The National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA) in the Southern Quebec Region[3] covers the marine area of the Saguenay fjord, the St. Lawrence estuary and the northwest part of the Gulf of St. Lawrence (along the north shore, Anticosti Island, the Gaspé Peninsula and the Magdalen Islands). Land-based activities are relatively limited and are spread out over approximately 8000 km of shoreline. Fewer than 400 000 people live along the shores of this vast area and there are no urban centres with populations over 40 000.

The riparian population density averages three inhabitants per square kilometre. Agriculture is significant only along the south shore of the estuary and along Chaleur Bay. Heavy industry, consisting of 10 pulp and paper mills, three aluminum smelters and two ore pelletization facilities, is concentrated in a few urban centres (La Malbaie, Rivière-du-Loup, La Baie, Matane, Baie-Comeau, Port-Cartier, Sept-Îles, Chandler and New-Richmond). The impacts of these activities on the marine environment are often confined to the immediate vicinity of the local industries.

The area in question is downstream from highly urbanized, industrialized and agricultural regions. The first, the upper St. Lawrence basin (Great Lakes and southern Quebec), has approximately 40 million people (United States and Canada combined) and is one of the largest industrial and agricultural areas in the world (metallurgy, petrochemical, pulp and paper). The second region, the upper Saguenay River basin, has three aluminum smelters and six pulp and paper mills. Adding to these two remote sources of persistent toxic substances are long-range transport of atmospheric pollutants from the entire northern hemisphere. The impact of remote sources of persistent pollutants is felt throughout the entire marine ecosystem of the St. Lawrence basin. The extent of the impact depends largely on how these substances can become magnified in the food chain.

The coastal habitats of this area include a large variety of ecosystems. For example, the middle estuary, located upstream from Tadoussac, represents the mixing zone where freshwater from the river and seawater meet. This area is known for its high tides, relatively warm, turbid waters and inter-tidal marshes. The Saguenay fjord, on the other hand, is known for its rocky and very steep shores and for a layer of brackish water over deep basins of seawater. The Saguenay is home to marine wildlife with boreal and Arctic features, as well as a few relic populations of Arctic species, remnants of the last glacial stage. The lower estuary, located downstream from Tadoussac, and the Gulf have rocky coasts intersected by large sandy deltas at the mouth of the main rivers. In these areas, the inter-tidal marshes are confined to environments sheltered from the waves, such as estuaries and the Gaspé sandbars. The Gulf region has the most diversified habitats and fishery resources. Many marine mammals come to this region to find food, the many lagoons are quite productive, and large colonies of seabirds nest on islands. Finally, in the Magdalen Islands two large sets of sandbars, surrounding lagoons, connect the largest islands. These sandbars comprise a vast expanse of dunes that are partly held in place by vegetation.

[3] Northern Quebec — the areas east of James Bay, east of Hudson's Bay and Ungava Bay — will be covered in a later version.

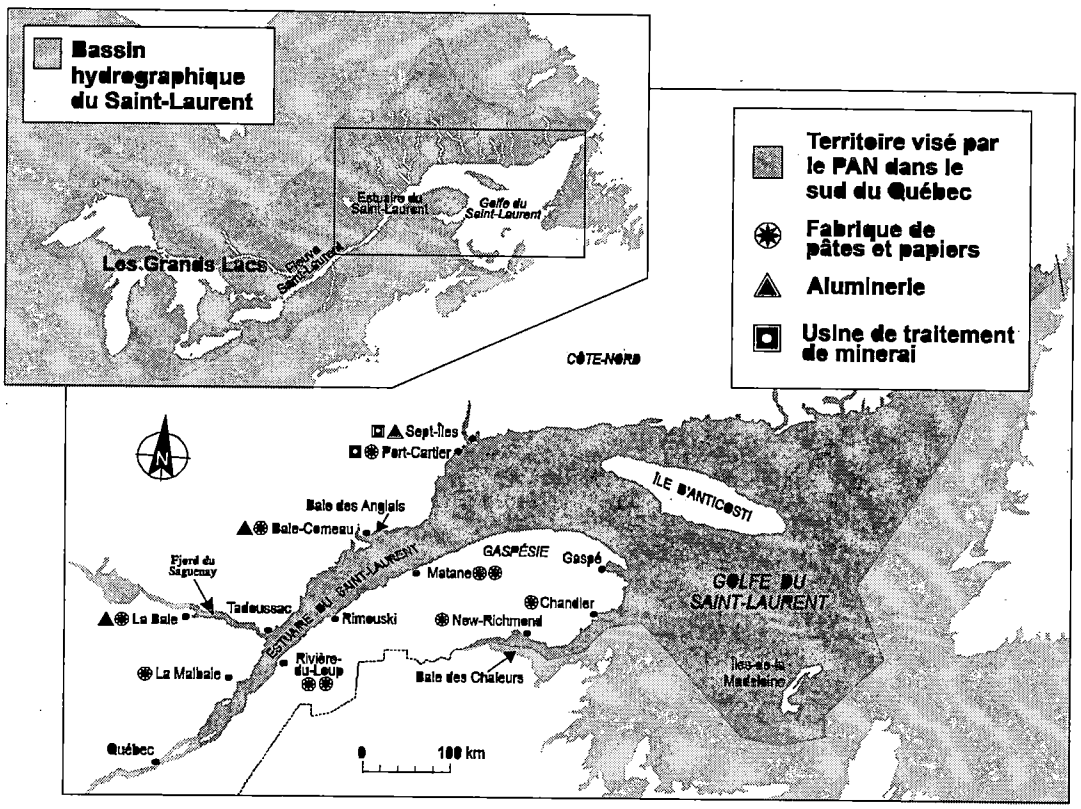

Figure 6-1. St. Lawrence River Drainage Basin, Area Covered by this Chapter and Key Industrial Facilities in the Area

6.1. Identification and Assessment of Problems

6.1A. Contaminants

Sewage

The contamination of the coastal zone by sewage was a major problem during the early 1990s. Contamination was mostly caused by untreated municipal sewage and overflows during heavy rains of combined sewer systems linked to treatment plants (point sources) and individual septic tank systems (non-point sources).

In a few areas, runoff from inadequately installed storage facilities for livestock wastes also adds to contamination. The percentage of the riparian population in the region that is served by treatment plants has gone from less than 19% during the early 1990s to almost 50% in 1996, and will reach 70% at the end of 1998.

The main problem associated with domestic sewage in the Quebec Region is the contamination of coastal environments with pathogenic micro-organisms. This type of contamination poses human health risks (consumption of bivalve mollusks), contributes to the overall degradation of the quality of coastal environments and limits their use (e.g., swimming). Shellfish water quality in approximately 200 areas has been monitored for several years. The harvesting of mollusks is permanently or temporarily prohibited because of bacterial contamination in nearly half of all shellfish areas in the region. The problem is particularly acute along the south of the estuary and in the Gaspé Peninsula.

New treatment plants currently undergoing testing should help improve most trouble spots and allow them to be used for recreational/tourism activities. They will also pave the way for the harvesting of mollusks in some shellfish areas currently closed by bacterial contamination. However, the shellfish waters in many other areas will remain unfit for harvesting because of combined sewer system overflows during heavy rains, inadequate septic tank systems and agricultural activities along the shores.

Persistent Organic Pollutants

Organochlorines that contaminate marine organisms in the region are largely transported by water from the upper St. Lawrence basin and by long-range atmospheric transport. Depending on the kinds of substances in question, the relative importance of local and remote sources varies, along with the importance of atmospheric and upstream sources.

For example, it has been estimated that 65% of the polychlorinated biphenyls (PCBs) found in the estuary and the Gulf of St. Lawrence at the end of the 1980s came from the St. Lawrence River and 35% from direct atmospheric pollution. The only major local land-based source of PCBs was an aluminum smelter located in Baie-Comeau, and its releases were virtually eliminated at the end of the 1980s. Moreover, the only known sources of mirex are located in the Great Lakes Region. However, heavy DDT spraying of coastal forests in the estuary and the Gulf until the beginning of the 1970s was a major local source of toxic substances. The effects of the spraying can still be found in the marine food chain to this day. Dioxins and furans enter the region's waters by fluvial transport and atmospheric pollution in proportions similar to those estimated for PCBs. Chlorine bleaching processes, an important source of organochlorines, are no longer used by pulp and paper mills located in the Quebec marine region. In general, the St. Lawrence estuary has been more contaminated by organochlorines than the Gulf of St. Lawrence. The only hot spot from these types of substances is situated in Baie des Anglais, which was contaminated with PCBs released from an aluminum smelter.

Contrary to organochlorine sources, local sources of polycyclic aromatic hydrocarbons (PAHs) are relatively important. The main ones are aluminum smelters located along the river shores and in harbours. PAH contamination is particularly severe in the Saguenay fjord and Baie des Anglais near Baie-Comeau. Contaminated sediments can also be found near wharves treated with creosote.

Since the 1970s, major industrial cleanup efforts have been made throughout the St. Lawrence basin and have had a beneficial impact on the marine environment. Concentrations of PCBs, DDT, PAHs and other substances have decreased in water, suspended matter, surface sediments and marine organisms. Most of the persistent organic pollutants (POPs) introduced into the marine environment since the start of the industrial era are currently buried under less contaminated sediments in the main sedimentation zones of the ecosystem (Saguenay fjord and the lower estuary of the St. Lawrence).

Current levels of organochlorine contamination for most fishery resources in the region (mollusks, crustaceans and fish) do not pose a significant risk to human health. However, American eels migrating from Lake Ontario and the upper St. Lawrence are highly contaminated with PCBs, mirex and dieldrine. Species from the Baie des Anglais region (mussels, whelk, crab, herring, cod) are subject to consumption restrictions because of local sediment contamination with PCBs (Duchesne et al., 1996). Moreover, PAH levels are high in mollusks found in zones

located close to local sources of these contaminants (i.e., in the Baie des Anglais and Saguenay fjord regions).

The level of organochlorine contamination in the region's fish-eating birds has decreased considerably since the 1970s and is currently halfway between that found on the Atlantic coast and that of the Great Lakes Region. This level does not appear to have a significant impact on the health of these birds.

Because of biomagnification, organochlorines reach relatively high concentrations in marine mammals, particularly in year-round species such as belugas and harbour seals. Organochlorine levels in the adipose tissue of beluga whales are 100 times higher than in Arctic populations. It is believed that the deaths of many of these whales may be linked to high levels of exposure to organochlorines through their diet.

Radionuclides

Radionuclides, resulting from human activity and found in the region's sediments, originate primarily from long-range atmospheric transport, as no major local source has been identified. Levels in the marine environment are not a concern.

Heavy Metals

In general, heavy metals from human activity, found in the waters of the St. Lawrence, come primarily from chlor-alkali plants located along the shores of the St. Lawrence and Saguenay rivers and the south shore of Chaleur Bay. These sources have been reduced considerably since the 1970s, and have been almost totally eliminated. Currently, mercury inputs in the St. Lawrence marine waters, particularly in the Gulf, are thought to come from atmospheric pollution. As for lead, the amount of atmospheric pollution in the St. Lawrence watershed has decreased considerably since 1970, with the introduction of unleaded gasoline.

The main problem associated with heavy metals and organometallics in the region is the mercury contamination of the Saguenay fjord. This contamination comes from a chlor-alkali plant that operated from 1947 to 1976 in the upper Saguenay basin. Since this plant was closed, the level of contamination in the water, surface sediments and in marine wildlife in the fjord has decreased considerably. The St. Lawrence estuary, particularly the marine estuary, is another area that has been heavily contaminated with mercury and lead. Once again, the level of contamination has decreased considerably since the 1970s.

Heavy metal concentrations in fishery resources in the region (mollusks, crustaceans and fish) are usually low, and do not pose significant human health risks. The exception is in the Saguenay fjord, where mercury concentration levels in crab and shrimp are near the maximum acceptable levels set by Health Canada (SEBSC, 1985, in Duchesne et al; 1996). The same is also true of migratory eels from the upper St. Lawrence basin. Heavy metal concentrations in marine birds are low and do not appear to affect bird health. However, in beluga whales concentrations of mercury, lead and selenium are higher than those reported in Arctic populations.

Oils/Hydrocarbons

Since 1970, six major oil spills (100-500 tonnes) off the coast and in the ports have directly affected the area. There are also approximately 60 minor spills every year in ports along the St. Lawrence.

During the 1970s, most hydrocarbons found in the marine environment came from accidental or deliberate discharges by ships on the high seas. The situation has been

greatly improved by measures to prohibit the discharges of petroleum in the Gulf and to reduce discharges in the Atlantic. However, large volumes of petroleum products are handled and stored in ports, thus creating a significant risk.

Following recommendations in the 1990 Brander-Smith report, there have been considerable improvements in the regional ability to prevent petroleum- and chemical-product spills in the marine environment, and to respond when spills occur or when habitats are contaminated by petroleum. The region has a new strategy to deal with emergency situations in the marine environment. It includes:

- high pollution alert systems, personnel and supply depots of intervention materials in many harbours (Québec-Lévis, Chicoutimi-La Baie, Rimouski, Baie-Comeau, Sept-Îles, Havre Saint-Pierre and Gaspé); and
- bird-cleaning centres (Cap-Tourmente, Saint-Fulgence, Mont-Joli, Baie-Comeau, Gaspé [Forillon] and Cap-aux-Meules).

Research projects into the development of biotechnological restoration techniques for petroleum-contaminated coasts are under way.

Nutrients

Nutrients from sewage, aquaculture and other land-based activities such as agriculture are not considered a threat to the Quebec marine ecosystem. Although it has been scientifically established that this type of pollution may promote algal blooms in plankton that are toxic to vertebrates, no such correlation has been found for the Estuary and Gulf of St. Lawrence. This type of contamination is not considered a priority in the region.

Contaminated Sediments

About 40 contaminated sediment sites have been inventoried in the Quebec portion of the St. Lawrence (river, estuary, northwest of the Gulf and Saguenay fjord) containing persistent and bioaccumulative toxic substances (PCBs, PAHs, hexachlorobenzene, mercury and lead). In the majority of cases, the land-based contamination sources have been eliminated or considerably reduced. As well, dredging and disposal of these sediments is subject to strict regulations that forbid any disposal of contaminated sediments in the marine environment. However, the contaminants found at these sites can be reintroduced into the food chain by physical, chemical, biochemical and biological means that are difficult to control, and whose effects are not known.

Litter

At the end of the 1980s, contamination by persistent solid waste of the St. Lawrence estuary shores was much less significant than on the beaches of the eastern U.S. coast. Close to 85% of the waste consisted of plastic originating from household sewage, storm sewers, snow disposal, illegal dumps and recreational/tourism activities along the shoreline. The primary impact of solid waste on the environment is that it is an eyesore. However, fish and marine mammals have been known to ingest litter or to get tangled up in it, with sometimes fatal consequences.

The situation is probably better now as many municipal sewage treatment plants have come on line and there has been a gradual closing of illegal dumps located close to the shore. In addition, as of 1999, municipalities that continue to dump their snow in the water will have to pay compensatory duties. Recently, numerous cleanup projects have assisted in the clearing away of litter along the shores.

6.1B. *Physical Alteration and Destruction of Habitat*

Shoreline Construction/Alteration

For the most part, the shorelines have retained their natural features, particularly along the north shore and to a lesser extent along the south shore of the St. Lawrence and Chaleur Bay. Between 1945-1988, about 2063 ha (excluding marshes, estuaries, sandbars and lagoons) were affected by the development of harbour facilities, roads and residences. The artificial shores are mostly located in important harbours (La Baie, Matane, Baie-Comeau, Port-Cartier and Sept-Îles), in urban centres and on stretches of roads built along the coastline. This is particularly true along the north shore of the Gaspé Peninsula and along the Manicouagan Peninsula, where several kilometres of shoreline have been reinforced to control erosion. Depending on the case, these alterations have modified natural environments, changed the heterogeneity of the coastal environment, or created or modified erosion/permanent deposition zones and thereby caused habitat modification. However, there are now several provincial and federal laws and regulations aimed at protecting the shoreline.

Inter-tidal and Sub-tidal Habitat Alteration

Very little seaweed harvesting is carried out in the region, and aquaculture is not highly developed. In contrast, the use of all-terrain vehicles in marshes, dunes and on beaches has become a major concern, especially in the Magdalen Islands. The misuse of these vehicles contributes to the destruction of dune and marsh vegetation, which can cause or aggravate erosion. In 1997, Quebec established a regulation on the use of motorized vehicles in certain fragile environments in order to reduce the impact of this kind of alteration.

Mineral and Sediment Extraction/Alteration

From 1983 to 1991, an average volume of 400 000 m^3 of sediments was dredged every year in regional ports, fishing harbours and marinas. The main potential physical impacts of these activities are habitat destruction and temporary increases in water turbidity. However, dredging is done only when the environment is least likely to be harmed. The dredged areas are usually fairly unproductive, artificial habitats, and there are few disposal areas. Ongoing studies should shed more light on the rate of benthic organism recovery. Limited dredging takes place along the region's coasts and therefore the impact on the marine environment is negligible. These activities are governed by a number of federal and provincial laws, regulations and policies, most notably the Quebec Environment Quality Act concerning the issue of authorization certificates and the Environmental Impact Assessment and Review Procedure; the Fisheries Act and the Policy for the Management of Fish Habitat; and the provisions of Part VI of the Canadian Environmental Protection Act concerning ocean dumping.

Wetland and Saltmarsh Alteration

Salt marshes and brackish marshes in the region have been significantly altered because of agriculture, residential construction and the development of roads and harbour facilities. The problem is particularly serious along the south shore of the St. Lawrence estuary, which has the highest concentration of marshes. Over 1000 ha of marshland have been altered over the course of the 20th century, primarily through the drainage of their upper portion with dikes for agriculture. These changes have reduced the productive capacity of the marine environment and eliminated critical habitats for aquatic wildlife and birds. The changes made to the natural environments of this area have had a major impact on many

species associated with the upper marsh zones. Waterfowl and some endangered birds, such as the Nelson bunting and the yellow rail, nest in these habitats.

From 1988 to 1996, close to 6500 ha of coastal environment located in the area covered by the NPA have received protection status. Despite all the important work that has protected thousands of hectares of habitat, including critical habitats for endangered species, there is still a great need for further protection.

Marine Waters and Coastal Watershed Alteration

Flows on the St. Lawrence River and several other major rivers (Saguenay, Betsiamites, aux Outardes, Manicouagan and, since 1998, Sainte-Marguerite) are controlled by hydroelectric dams. Their cumulative impact has reduced seasonal variations in freshwater inflows into the estuary over the last 20 years by 50%. Less recognized is the reduction of surface nutrient salt caused by lower water levels. The harnessing of rivers also alters the sediment regime and can cause delta erosion. Dams can also create obstacles to the migration of anadromous and catadromous species of fish, and may have contributed to declines observed in several populations since the 1950s. The dredging of the St. Lawrence ship channel between Montreal and Quebec City during the 1950s may have also had a negative impact on fish populations such as the striped bass, the Atlantic sturgeon, and the rainbow smelt.

Road and railway construction in coastal areas has reduced exchanges with the sea in several estuaries and lagoons in the region. This problem is particularly serious in the Gaspé Peninsula and in the Magdalen Islands, where saltmarshes and eelgrass flats are found. This type of alteration has reduced the biological productivity and biodiversity of environments that provide critical habitats for fishery resources and migratory birds. In the territory covered by the NPA, two disrupted areas, the Bonaventure and the Paspébiac sandbars, have recently been restored. Many other areas are currently being studied for eventual restoration.

Biological Alteration

There have been no documented cases of the introduction of exotic species that have had a significant impact on the habitats and resources in the marine region of Quebec. However in 1993, about 6.1 million tonnes of ballast water from foreign ships were discharged into the harbours of the estuary and the Gulf of St. Lawrence. Many planktonic algae and invertebrates known to have been introduced in coastal environments similar to those of the Gulf may have been introduced through ship deballasting in harbours. Voluntary guidelines now encourage foreign ships that enter the Gulf to exchange their ballast water offshore. But it is not known whether the guidelines are followed by ships headed to harbours in the St. Lawrence estuary, the Gulf of St. Lawrence or the Saguenay River. Because of aquaculture development, transfers are on the rise of mollusks from zones harbouring distinct populations of the same species. These transfers from other zones can bring about the inadvertent introduction of toxic algae or diseases. This can alter the phenotypic composition of local populations and reduce their ability to adapt to the environment.

6.2. Establishment of Priorities

The priorities for action were established using the following criteria:

1. The severity of risk or the actual impact on human health, or the health of the marine ecosystem.
2. The nature of the activities at the source of the problem and the effectiveness of the existing control

measures. The contaminant and habitat-alteration categories that have been given high priority entail a significant amount of risk, or currently have major negative consequences on human health or on productivity and biodiversity of the marine environment.

3. With risk and impact being equal, a higher priority has been given to categories requiring additional or more effective measures.

Based on these criteria, each contaminant and habitat-alteration category was ranked as **high**, **medium** or **low priority**.

6.2A. Contaminants

Sewage

The control measures implemented since the early 1990s (municipal sewage treatment plants) will not completely restore the quality of the coastal area or be sufficient for the restoration of many potential shellfish harvesting areas. Additional measures are required to restore shellfish areas that have been contaminated by inadequate septic tank systems and livestock waste storage facilities, as well as by the overflows of sewer systems during heavy rains. A **high priority** is given to this category.

Persistent Organic Pollutants

Despite the major drop in POPs in the marine environment since the 1970s, these substances can still represent a major local threat to human health and the ecosystem. The elimination of land-based sources of POPs throughout the St. Lawrence watershed must continue. A **high priority** is given to this contaminant category.

Radionuclides

There are no significant local sources of radionuclides in Quebec. A **low priority** is given to this contaminant category.

Heavy Metals

The main industrial sources of heavy metals in the St. Lawrence watershed have been eliminated or considerably reduced. The main inputs now come from atmospheric transport. A **medium priority** is given to this contaminant category.

Oils/Hydrocarbons

Measures aimed at preventing and dealing with oil spills in harbours have improved considerably during the 1990s and are considered adequate. A **low priority** is given to this contaminant category.

Nutrients

The main potential problems linked to nutrients in the marine environment are not a major concern and are taken into consideration by the measures that target the sewage point sources. Inputs from non-point sources attributable mainly to agricultural activities are a cause of some concern and will be taken into consideration in the near future. A **low priority** is given to this contaminant category.

Contaminated Sediments

Inventoried contaminated sediment sites in the Gulf, river and the estuary harbours, as well as in the sediment basins of the St. Lawrence estuary and of the Saguenay fjord, are reservoirs of persistent bioaccumulative toxins (PCBs, PAHs, mercury). The risk that these areas pose to the marine environment and the implementation of management plans aimed at reducing the impact are priorities. However, owing to the contaminant loads and the size of the areas involved, this category is given **medium priority**.

Litter

The measures aimed at reducing the quantity of land-based solid waste inputs in the marine environment are considered adequate. A **low priority** is given to this contaminant category.

6.2B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

Current legislation ensures an adequate level of shoreline protection. This issue is nevertheless considered a **high priority** because of the threat of erosion and the continuing development in numerous sectors. There is a lack of data on the habitat loss sustained during the past few decades.

Inter-tidal and Sub-tidal Alteration

The activities which disrupt these habitats rarely take place in the region, and a **low priority** is accorded to this category.

Mineral and Sediment Extraction/Alteration

Many measures control dredging and sediment disposal activities. However, several questions remain unanswered regarding the impact of these activities on resources (regeneration of benthos, recirculation of contaminants). Since dredging is often conducted in areas where sediments are likely to be contaminated (e.g., in some harbours), this issue is considered a **medium priority**.

Wetland and Saltmarsh Alteration

The protection of wetlands and coastal seabeds remains a **high priority** even though the total area of protected environments has increased during the past few decades. The law does not yet protect most of these habitats, which are essential to the survival of many species.

Marine Waters and Coastal Watershed Alteration

The protection, conservation and, when possible, the restoration of lagoons and sandbars is a **high priority**. Many protection, enhancement and restoration projects have been or will be initiated shortly by local groups. This shows there is a general interest in protecting riparian populations in these highly productive environments. Hydroelectric development projects are likely to have the greatest impact on the hydrodynamics of the coastal watersheds. The current regulatory framework should adequately control these projects. This issue is considered a **medium priority**.

Biological Alteration

There is a risk of introducing exotic species into the marine environment through ship ballast water. The measures now in place to deal with this problem are considered inadequate. Since a large part of the problem stems from offshore activities, this kind of alteration is considered a **medium priority**.

6.3. Setting Goals and Management Objectives

Under the NPA, Canada's goals are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

The following are specific management objectives for each source category.

6.3A. Contaminants

Generally, for most of the contaminants the management objective is to reduce contamination of the marine environment, primarily through pollution prevention. Where contaminants are released to or occur in the marine environment, the management objective is to apply life-cycle management or remediation to address the problems.

The management objectives for all categories of contaminants in Quebec are to:

- reduce, control or eliminate persistent, bioaccumulative toxic substances in liquid effluent in the entire St. Lawrence River drainage basin and in atmospheric emissions that can affect the marine environment; and
- reduce, control or eliminate all categories of pollution from local, land-based sources.

Specific management objectives for each of the contaminants, consistent with the national plan, are as follows:

Sewage — reduce contamination due to sewage; maintain and improve estuaries, coastal water and marine ecosystem quality for all users; maintain and restore shellfish growing areas.

Persistent Organic Pollutants — reduce/virtually eliminate anthropogenic inputs; apply life-cycle management to remaining inputs.

Radionuclides — reduce inputs where they are likely to cause pollution; apply radiological protection.

Heavy Metals — reduce inputs where they are likely to cause pollution; apply life-cycle management.

Oils/ Hydrocarbons — prevent spills and establish contingency plans; apply life-cycle management.

Nutrients — reduce inputs where they are likely to cause pollution.

Contaminated Sediments — reduce sediment contamination at source.

Litter — reduce the incidence of litter/debris found in the marine environment.

6.3B. Physical Alteration and Destruction of Habitats

The primary management objectives are to mitigate or avoid harmful alteration and destruction of habitats and to restore those already affected. For some categories of harmful alteration (e.g., mineral and sediment extraction or disposal; alteration of marine waters and coastal watersheds), it is also necessary to identify critical habitats so that such activities take place in areas of lesser environmental sensitivity or significance. Finally, there are some specific management objectives that apply to unique problems such as the accidental or deliberate introduction of undesirable or non-native (exotic) species to the marine environment from land-based activities, and where the objective is to eliminate such introductions.

The management objectives for all categories of physical alteration and destruction of habitat aimed at maintaining the productivity and biodiversity of the marine environment, are to:

- prevent the destruction or alteration of the critical habitats of fish and species at risk;
- reduce the impact of land-based activities on habitat;
- increase the area of habitat that is given legal protection status; and
- restore the productivity and biodiversity of altered habitats, where possible.

Moreover, specific management objectives which apply to each of the habitat categories, consistent with the NPA, are as follows:

Shoreline Construction/Alteration — minimize habitat loss and balance losses by restoring or creating equivalent replacement habitat.

Inter-tidal and Sub-tidal Alteration — identify critical habitats and prevent loss or degradation of such areas while restoring those already degraded.

Mineral and Sediment Extraction/Alteration — identify and protect sensitive habitats and marine resources.

Wetland/Saltmarsh Alteration — prevent any further loss or destruction of critical habitats and, where feasible, restore valuable areas previously drained or altered.

Marine Waters and Coastal Watershed Alteration — protect key habitats for all life stages of marine resources.

Biological Alteration — reduce the risks of inadvertent or inappropriate introductions of undesirable (exotic) species and pathogens, and monitor sensitive coastal ecosystems.

6.4. Strategies and Actions

6.4A. Contaminants

Many laws, regulations, policies and programmes are already in place at both the provincial and federal levels, to meet NPA goals and the objectives of management to reduce or eliminate land-based sources of contamination. The existing international and federal strategies and measures are discussed in Chapter 3 of this document. The Government of Quebec's measures deal, in particular, with municipal, industrial and agricultural sewage, atmospheric emissions, pesticide use and the disposal of solid waste, snow and hazardous waste.

- The Programme d'assainissement des eaux du Québec (PAEQ) [Quebec water treatment programme] is of particular importance. The aim of this programme, implemented in 1978, is to clean waters so as to use them to their full capacity, and to preserve the ecological balance of ecosystems. The urban component of this programme was replaced by the Programme d'assainissement des eaux municipales (PADEM) [municipal water treatment programme] in 1995. In May 1998, another programme was added to existing measures for the treatment of municipal waste water. Entitled "Les eaux vives du Québec" [Quebec's flowing water], the programme targets municipalities that do not have a waste-water treatment plant. In the agricultural sector, Quebec promulgated in June 1997 the Regulations on the Reduction of Pollution from Agricultural Sources, the goal of which is to improve the storage of livestock waste and the spreading of fertilizers to minimize inputs into water. It is backed up by the Programme d'aide à l'investissement en agroenvironnement (PAIA) [agri-environment investment support programme] to improve the management of livestock wastes.
- The Programme de réduction des rejets industriels (PRRI) [industrial discharges reduction programme] was established in 1988, to protect air, water and land by setting discharge standards determined by the characteristics of the receiving environment. As a result the standards may be more stringent than those required by regulation.
- The Programme de gestion et de réhabilitation des lieux d'élimination des déchets dangereux (GERLED) [hazardous waste disposal site

management and rehabilitation programme] is designed to define hazardous waste disposal sites and, if necessary, to restore them according to the intervention priorities based on potential health and environmental risks.

- The Plan d'action pour l'évaluation et la réhabilitation des lieux d'enfouissement sanitaire (PAERLES) [sanitary landfill site evaluation and rehabilitation action plan] was introduced in 1991 to, among other goals, reduce the impact of sanitary landfill sites on the receiving environment.

The St. Lawrence Action Plan (SLAP), launched in 1988 and whose third five-year phase started in June 1998, is a joint programme between the Government of Quebec and the federal government. The St. Lawrence Action Plan — Vision 2000 (Phase III) contains many measures aimed at reducing the incidence of contaminants in Quebec. It has several components, including those focused on reducing industrial discharges, restoring disturbed environments and ensuring the involvement of the coastal communities. This last component comprises a programme geared specifically toward promoting public participation and action at the local level. Called the Priority Intervention Zone (ZIP) programme, it has already spearheaded the creation of many local committees whose mandate is to consult the public in order to define priorities for action in their sector, and to develop joint ecological rehabilitation action plans (PARE) on the basis of identified priorities.

The Government of Quebec is working with the other provinces, as well as the federal government, to find solutions to specific problems regarding atmospheric emissions. For example, the Strategic Options Process (SOP) is aimed at reducing the quantity of certain kinds of contaminants such as fine particles that contain toxic substances (some metals: lead, arsenic, mercury; some organic substances: PAH, benzene). Also a working group was created within the framework of the Conference of New England Governors and Eastern Canadian Premiers in order to develop a mercury reduction strategy with a component on atmospheric emissions.

To recap, strategies and actions include:

- existing measures that are deemed adequate, and that it is proposed to maintain and to improve where required (monitor);
- existing measures deemed inadequate, and that it is proposed to strengthen (existing measures should be strengthened); and
- new actions deemed necessary that merit further consideration in the future (proposed).

When contaminants are discharged into the environment, an approach based on the management of substances during their life cycle and on the prevention of pollution at source is favoured. In addition, an approach based on integrated watershed and coastal area management is also favoured to promote joint action by local, regional, provincial and federal stakeholders to optimize the protection of the marine environment and human health.

The following strategies and actions apply to all contaminant categories:

- Promote compliance with the laws and regulations in force (monitor).
- Maintain and improve the regulations and programmes related to the discharge of contaminants (pulp and paper, oil refineries, snow, air quality, hazardous waste, pesticides, agricultural pollution, SLAP, PRRI) (monitor).
- Develop and encourage the use of economic instruments as an incentive to

improve the existing infrastructures and to reduce the discharge of toxic substances in the environment (proposed).
- Pursue and promote research and acquisition of knowledge on toxic substances, their behaviour and long-term impacts on the environment (monitor).

The following strategies and actions apply specifically to each contaminant category:

Sewage

- Maintain current PADEM objectives, which forecast that 70% of coastal residents will be served by a sewage treatment plant in 1998 (monitor).
- Expand PADEM in order to increase the number of municipalities that treat sewage and to authorize the improvement and maintenance of existing sewage treatment systems (proposed).
- Maintain the programme entitled "Les eaux vives du Québec" [Quebec's flowing water] launched in May 1998 by the Government of Quebec and which targets municipalities that do not yet have sewage treatment plants (monitor).
- Maintain the PAIA launched in June 1997 by the Government of Quebec (monitor).
- Promote the installation and the maintenance of functional, individual septic tanks and systems for storing livestock wastes (existing measures should be strengthened).
- Give priority to the restoration of shellfish harvesting areas currently closed (existing measures should be strengthened).
- Promote public participation in the restoration of shellfish areas (proposed).
- Increase public awareness regarding the impact of sewage mismanagement on human health (proposed).
- Promote the use of economic instruments to improve the existing infrastructures (proposed).

Persistent Organic Pollutants

- Identify land-based sources of chlorinated furans, dioxins and PAHs (and other POPS where appropriate) which are not currently regulated, and implement legislation and programmes that will eliminate, reduce or control them (proposed).
- Implement the PRRI programme for industrial sectors other than pulp and paper (existing measures should be strengthened).
- Reduce and control PAH contamination from wharves made with creosote-treated wood (proposed).
- Remediate contaminated sites that pollute the marine (existing measures should be strengthened).
- Promote the use of substitutes for chemical products causing the production and discharge of POPs and the use of better environmental management practices in industry (existing measures should be strengthened).
- Promote the use of better environmental management practices for pesticides that are POPs and in use, including lindane and creosote (existing measures should be strengthened).
- Promote the use of appropriate environmental indicators (proposed).

Radionuclides

- Promote the use of safe production, storage, handling, transportation and disposal practices regarding radionuclides (monitor).
- Maintain contingency procedures in case of an accidental release (monitor).

Heavy Metals

- Implement the PRRI programme for industrial sectors other than pulp and

paper (existing measures should be strengthened).
- Identify the mercury and alkyl lead land-based sources that are not currently under regulation and promote the implementation of legislation and programmes that will eliminate, reduce or control them (proposed).
- Identify problematic heavy metal land-based sources that are not currently under regulation and promote the implementation of legislation and programmes that will eliminate, reduce or control them (proposed).
- Promote the use of clean technologies for specific industrial sectors (e.g., metal mines) (existing measures should be strengthened).
- Reduce losses of metal ore during loading and unloading through good operating procedures (existing measures should be strengthened).
- Promote the use of better environmental management practices (existing measures should be strengthened).
- Promote the use of appropriate environmental indicators (proposed).

Oils/Hydrocarbons

- Promote the use of sound waste oil management practices throughout the Province of Quebec (existing measures should be strengthened).
- Maintain an effective accidental spill reporting system (monitor).
- Maintain effective planning and contingency intervention measures in case of an accidental spill — contingency intervention plans (monitor).
- Develop intervention and rehabilitation technologies to deal with oiled shorelines (existing measures should be strengthened).
- Promote better environmental management practices (existing measures should be strengthened).
- Encourage public education and awareness (existing measures should be strengthened).

Nutrients

- Maintain the PAIA launched in June 1997 by the Government of Quebec (monitor).
- Maintain the measures currently in place for municipal sewage and agricultural practices (monitor).

Contaminated Sediments

- Characterize contaminated sediment sites for which there is insufficient data (proposed).
- Develop and implement plans for the management of contaminated sediments for each site at risk (proposed).
- Promote the development of rehabilitation technologies for contaminated sediment sites (existing measures should be strengthened).
- Develop and implement an integrated contaminated sediment management approach for the entire St. Lawrence basin (proposed).
- Promote the use of better environmental management practices in harbours and ports (existing measures should be strengthened).
- Promote the use of appropriate environmental indicators (existing measures should be strengthened).

Litter

- Promote sound solid waste management practices (monitor).
- Encourage public education and awareness of the problems caused by persistent solid waste (plastic) in the aquatic environment (proposed).

6.4B. Physical Alteration and Destruction of Habitat

Many laws, regulations, policies and programmes are already in place, at both

the provincial and federal levels, to meet the general NPA objectives for the physical alteration and destruction of habitats. The existing international and federal strategies and measures are discussed in Chapter 3 of this document. The Government of Quebec measures deal, in particular, with the shores and coastal environments, the protection of endangered species (and their habitats) and the protection of unique and representative sensitive habitats (wildlife habitats, ecological reserves, conservation reserves, parks).

The St. Lawrence Action Plan (SLAP) includes many programmes geared toward the preservation, protection and rehabilitation of sensitive habitats, endangered species, and the restoration of altered habitats. The Priority Intervention Zone (ZIP) programme, mentioned in section 4A, is specifically geared toward public participation in the development of local rehabilitation measures.

Furthermore, an approach based on the integrated management of watersheds and/or coastal zones is recommended to encourage communication among local, regional, provincial and federal stakeholders. This would optimize the measures in place to protect the marine environment and human health.

The strategies and actions that were identified to meet the goals and management objectives mentioned in the previous section on contaminants are presented below. This list includes:

- existing measures that are deemed adequate, and that it is proposed to maintain or improve as needed (monitor);
- existing measures deemed inadequate, and that it is proposed to strengthen (existing measures should be strengthened); and
- new actions deemed necessary that merit further consideration in the future (proposed).

The following strategies and actions apply to all the physical alteration and destruction of habitats categories:

- Promote the purchase and protection of habitats (monitor).
- Create protected marine and coastal areas as stipulated in the Oceans Act (existing measures should be strengthened).
- Promote compliance with the laws and regulations in force (existing measures should be strengthened).
- Promote the updating of regulations regarding habitat protection (existing measures should be strengthened).
- Promote the restoration of altered habitats, and develop and improve restoration technologies (existing measures should be strengthened).
- Identify critical and sensitive habitats whose protection is a priority and ensure no further alterations or destruction occurs (existing measures should be strengthened).
- Identify under-represented habitats which should have legal protection (existing measures should be strengthened).
- Maintain and increase the channels of communication and partnerships with non-government organizations by means of SLAP (existing measures should be strengthened).
- Harmonize the various approaches for the conservation of land and marine habitats by means of SLAP and other programmes (existing measures should be strengthened).
- Educate the people living in shoreline areas about habitat protection with the help of non-government organizations and ZIP committees (existing measures should be strengthened).

- Promote the use of an integrated management approach for the watersheds and coastal zones (proposed).
- Promote the acquisition and exchange of knowledge to help make better management decisions, and to pool the various databanks to get the maximum amount of information (existing measures should be strengthened).

The following strategies and measures apply specifically to each category regarding the physical alteration and destruction of habitats.

Shoreline Construction/Alteration

- Prevent erosion with environmentally benign technology (planting vegetation) and in accordance with regional plans (existing measures should be strengthened).

Inter-tidal and Sub-tidal Alteration

- Gather more information about these habitats and the impacts of human activity (existing measures should be strengthened).

Mineral and Sediment Extraction/Alteration

- Promote the updating of policies and regulations regarding this kind of activity (existing measures should be strengthened).
- Create a consultation committee on integrated management for dredging activities in the St. Lawrence by means of SLAP (proposed).
- Gather more information on habitats that need protection and on the impact of dredging and stockpiling (existing measures should be strengthened).
- Develop environmentally and economically viable and effective management approaches (proposed).

Wetland and Saltmarsh Alteration

- Maintain and increase investments in wetland restoration (existing measures should be strengthened).
- Gather more information and pool various databanks (monitor).
- Develop and improve the restoration techniques for wetlands; put the now-available grass wetland restoration guide to the test (existing measures should be strengthened).

Marine Waters and Coastal Watershed Alteration

- Promote measures that ensure that new project planning takes into consideration fish passage so as not to obstruct their movement (existing measures should be strengthened).
- Follow the evolution of restored habitats, using successes to promote potential restoration projects (existing measures should be strengthened).

Biological Alteration

In order to prevent the introduction of exotic species:

- Promote the updating of regulations regarding the introduction of exotic species (proposed).
- Maintain, improve and apply mechanisms currently in place regarding ship ballast water (existing measures should be strengthened).
- Improve knowledge of exotic species that could be established in the marine waters of the St. Lawrence (existing measures should be strengthened).

With regard to the conservation of endangered species, the strategy calls for:

- the promotion of the protection of all the different habitats in order to meet the needs of as many species as possible as a preventive measure (existing measures should be strengthened);

- the identification of endangered species and those that may become endangered (existing measures should be strengthened); and
- the development and implementation of recovery plans for the endangered species as well as those considered a priority (existing measures should be strengthened).

6.5. Next Steps

The following steps will be taken to complete the preparation of the Southern Quebec/St. Lawrence Region component of the NPA and to guide its implementation:

- Workshops are planned with interested government and non-government stakeholders to consult on management objectives, goals and priorities presented here, and to develop and plan strategies and actions that may be implemented.
- Necessary steps will be taken to integrate the NPA with existing programmes and initiatives for the protection of Quebec's marine environment, such as the St. Lawrence Action Plan — Vision 2000 and its Priority Intervention Zone (ZIP) programme, as well as programmes under the Oceans Act.

  Also, it is anticipated that the NPA will be completed with the addition of northern Quebec elements. To this end, the following actions should be undertaken.

- Consultations and workshops are planned with the Cree, the Inuit and other government and non-government stakeholders in northern Quebec in order to take stock of pollution sources, identify priorities, establish goals and management objectives, develop intervention strategies and plan possible actions.
- To complete the NPA, the results of the above-mentioned activities will be integrated with the NPA.
- At the same time, steps will be taken to link the NPA to existing programmes and initiatives to protect the northern marine environment such as the federal government's Northern Ecosystems Initiative (NEI) and programmes under the Oceans Act.

Parallel to these consultation and harmonization efforts, it is the intention of the NPA to promote and support:

- the implementation of the Ecological Remedial Action Plans (ERAP) developed under the ZIP programme;
- the development and implementation of integrated coastal management plans (Oceans Act);
- the establishment and management of marine protected areas (Oceans Act); and
- the implementation of the NEI.

Literature Cited

Comité d'examen public des systèmes de sécurité des navires-citernes et de la capacité d'intervention en cas de déversements en milieu marin (Commission Brander-Smith). 1990. **Protégeons nos eaux, Rapport final.** Ottawa : Approvisionnements et Services Canada.

Duchesne, J.-F., J. Chartrand et D. Gauvin. 1996. **Synthèse des connaissances sur les risques à la santé reliés aux divers usages du fleuve Saint-Laurent dans le secteur d'étude Estuaire Maritime. Rapport technique Zone d'intervention prioritaire 18.** Centre de santé publique du Québec, Direction de santé publique du Bas-Saint-Laurent, Direction de santé publique de la Côte-Nord, ministère de la Santé et des Services sociaux du Québec et Santé Canada.

Santé et Bien-être social Canada (SEBSC). 1985. **Lignes directrices sur les contaminants chimiques du poisson et des produits de poisson au Canada.** Loi et règlements des aliments et drogues, Canada.

Additional References

Bureau d'audiences publiques sur l'environnement (BAPE). 1997. **Déchets d'hier, ressources de demain**. Rapport de la Commission sur la gestion des matières résiduelles au Québec.

Centre Saint-Laurent (CSL). 1996. **Rapport synthèse sur l'état du Saint-Laurent, Volumes 1 et 2.** Environnement Canada, région du Québec. Conservation de l'environnement et Éditions MultiMonde. Montréal: Coll. «BILAN Saint-Laurent».

Gagnon, M. 1998a. **Bilan régional, rive nord de l'Estuaire moyen.** Environnement Canada, région du Québec, Conservation de l'Environnement, Centre Saint-Laurent.

Gagnon, M. 1998b. **Bilan régional, rive sud de l'Estuaire moyen**. Environnement Canada, région du Québec, Conservation de l'Environnement, Centre Saint-Laurent.

Gagnon, M. 1998c. **Bilan régional, Gaspésie-nord**. Environnement Canada, région du Québec, Conservation de l'environnement, Centre Saint-Laurent.

Gagnon, M. 1998d. **Bilan régional, Îles-de-la-Madeleine**. Environnement Canada, région du Québec, Conservation de l'environnement, Centre Saint-Laurent.

Gagnon, M. 1997a. **Bilan régional, Côte-Nord - Anticosti**. Environnement Canada, région du Québec, Conservation de l'environnement, Centre Saint-Laurent.

Gagnon, M. 1997b. **Bilan régional, Gaspésie-sud - Baie des Chaleurs.** Environnement Canada, région du Québec, Conservation de l'environnement, Centre Saint-Laurent.

Gagnon, M. 1996. **Bilan régional, estuaire maritime du Saint-Laurent.** Environnement Canada, région du Québec, Conservation de l'environnement, Centre Saint-Laurent.

Gagnon, M. 1995. **Bilan régional, secteur du Saguenay**. Environnement Canada, région du Québec, Conservation de l'environnement, Centre Saint-Laurent.

Gagnon, M. et P. Bergeron. 1997. **Identification et description des sites aquatiques contenant des contaminants préoccupants pour le béluga du Saint-Laurent**. Rapport de Biorex inc. au Comité multipartite sur les sites contaminés pouvant affecter le béluga.

Gauthier, D. et D.A. Steel. 1996. **A Synopsis of the Situation Regarding the Introduction of Non Indigenous Species by Ship-Transported Ballast Water in Canada and Selected Countries**. Rapport manuscrit canadien des sciences halieutiques et aquatiques. 2380.

Gouvernement du Canada et Gouvernement du Québec. 1997. **Saint-Laurent Vision 2000, rapport annuel 1995-1996.**

Gouvernement du Canada et Gouvernement du Québec. 1996. **Saint-Laurent Vision 2000, rapport bisannuel 1993-1995.**

Gouvernement du Canada et Gouvernement du Québec. 1993. **Plan d'action Saint-Laurent, bilan 1988-1993.**

Harding, G.C. 1992. **A Review of the Major Marine Environmental Concerns Off the Canadian East Coast in the 1980s.** Rapport technique canadien des sciences halieutiques aquatiques. 1885.

Marquis, H., J. Therrien, P. Bérubé, G. Shooner et Y. Vigneault. 1991. **Modifications physiques de l'habitat du poisson en amont de Montréal et en aval de Trois-Pistoles de 1945 à 1988 et effets sur les pêches commerciales.** Rapport technique canadien des sciences halieutiques aquatiques. 1830.

White, L. et F. Johns. 1997. **Évaluation du milieu marin de l'estuaire et du golfe du Saint-Laurent.** Pêches et Océans Canada, Dartmouth, Nouvelle-Écosse et Mont-Joli, Québec.

CHAPTER 7. ATLANTIC REGION

INTRODUCTION

The Atlantic Region of Canada includes Nova Scotia, Prince Edward Island, New Brunswick, and Newfoundland and Labrador (Figure 7-1). It is a diverse area with a wide range of physical, climatic and human settlement characteristics. The region includes three major ecosystems: the Gulf of St. Lawrence, the Atlantic coast and the Bay of Fundy/Gulf of Maine. The terrain ranges from the rolling fields of Prince Edward Island to the craggy peaks of the Torngat Mountains in Labrador. The 40 000 km of coastline has such varied geomorphologic types as deep fjords carved from granite in Newfoundland, high-energy rocky shores along southern Nova Scotia, red sandy beaches in Prince Edward Island and vast mud flats in the Bay of Fundy. The 1.7 million km^2 of continental shelf is equally diverse with sandy shallows in the Gulf, and an outer continental shelf with basins, gullies and channels.

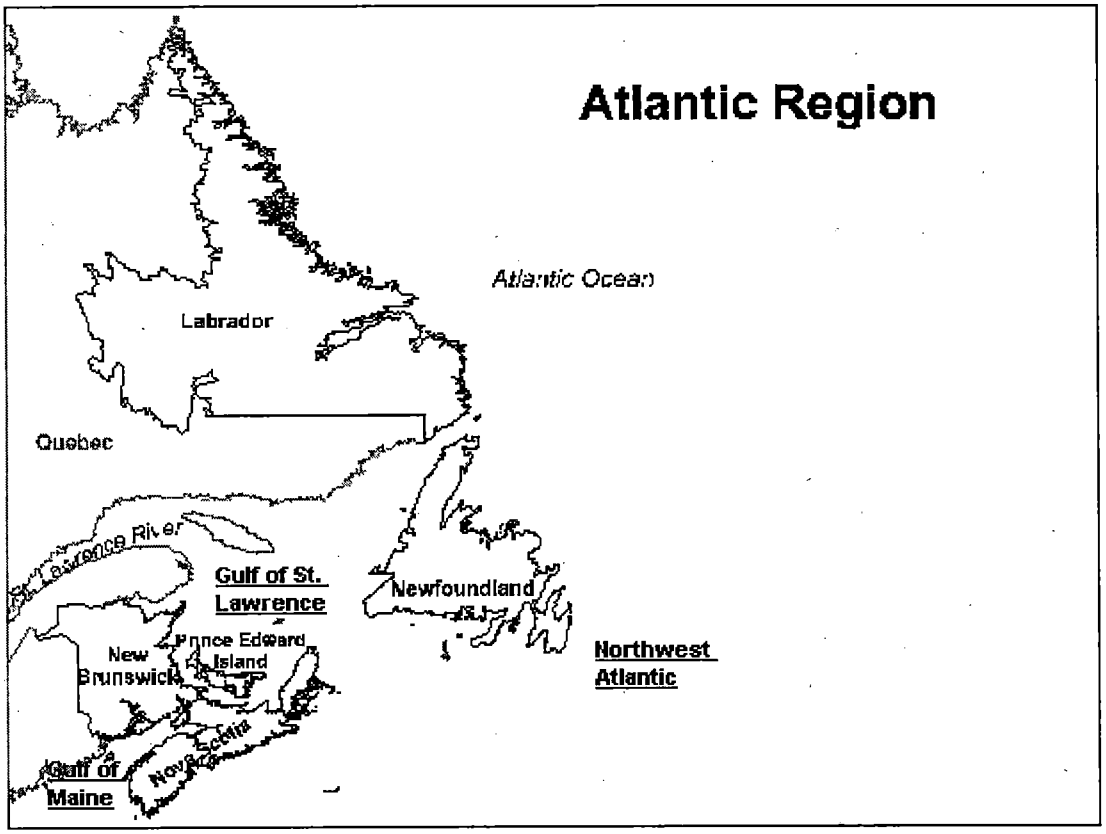

Figure 7-1. Map of Atlantic Canada

This geomorphologic diversity creates a variety of habitats that support some of the most productive marine ecosystems in the world. The merging of the warm Gulf Stream and cold Labrador currents powers this high productivity. The Gulf of St. Lawrence is also the southern limit of many cold climate species, and the northern limit of warm climate species, creating a unique and highly productive ecosystem with a wide variety of conditions, populations and pollution issues. Drainage

waters enter the Gulf of St. Lawrence from the most urbanized and industrialized areas of North America, such as the Great Lakes and St. Lawrence River watersheds. At the same time, the percentage of people living in rural areas in the Atlantic provinces is double that of the rest of Canada (Table 7-1).

The total dimensions of the Gulf of St. Lawrence watershed area are 1.6 million km^2, with a surface area of 226 000 km^2, and a volume of 34 500 km^3. The mean depth is 152 m, and 25% of the Gulf of St. Lawrence is shallower than 75 m.

Table 7-1. Atlantic Region Rural-Urban Population Distribution, 1991 (Statistics Canada, 1994)

Region	Total population	Rural population (%)	Urban population (%)
Newfoundland	568 474	46	54
New Brunswick	723 900	52	48
Nova Scotia	899 942	46	54
Prince Edward Island	129 765	60	40
Atlantic Region Total	2 322 081	51	49
Canada Total	27 296 859	23	77

The Northwest Atlantic marine ecosystem includes approximately 28 000 km of coastline. The area is characterized by a wide, shallow and highly productive continental shelf with strong currents and a large riverine input. There are also large areas of seasonal ice cover with strong storm-driven wave action.

The Bay of Fundy, a highly dynamic and diverse ecosystem, has very productive fisheries. Part of the Gulf of Maine ecosystem, the Bay of Fundy twice daily receives a tidal ebb and flow 2 000 times the volume of the St. Lawrence River. It is funnel-shaped, 150 km in length, 100 km wide at its mouth and 45 km wide at the head. The average depth is 75 m. The tidal heights range from 4 m at the mouth of the Bay, to 14 m to 16 m at the head.

The Gulf of Maine/Bay of Fundy ecosystem is the site of one of two pilot projects supported by the Commission for Environmental Co-operation (CEC) for the implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) in North America. The GPA is being implemented through a broadly based multistakeholder coalition named the Global Programme of Action Coalition (GPAC) for the Gulf of Maine. Members of the GPAC include the provinces and states that border the Gulf of Maine, federal agencies from both countries, First Nations, industry, environmental non-government organizations and community action groups. The implementation of the GPA in the Gulf of Maine is following the steps of the GPA, much as National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA) is in Canada. The two initiatives mesh through the common role played in both by Nova Scotia and New Brunswick. There is further integration through the involvement by Canadian federal agencies.

7.1. Identification and Assessment of Problems

7.1A. Contaminants

Sewage

Sewage, principally untreated municipal waste water, is one of the most prevalent problems facing nearshore coastal waters in Atlantic Canada. Point sources include municipal waste water, industrial effluents, and combined sewer overflows, while non-point sources consist of agricultural and urban runoff.

In the Atlantic Region, only a small portion of the population (approximately 25%) is served by waste water treatment, with over 980 000 m^3 of waste-water discharged daily (Eaton et al., 1994). Many smaller point sources of sewage in the Atlantic Region now receive some form of treatment; however, there are still a number of large point sources that discharge raw sewage, namely Halifax, Saint John, St. John's and Sydney.

Prince Edward Island is fortunate in that 100% of its point source industrial and municipal waste water is collected and treated in one way or another. With the exception of Charlottetown and Summerside, which have only primary municipal treatment plants, all other industrial and municipal facilities (except fish plants) treat at least to the secondary level. Approximately one-half the population of New Brunswick is serviced by municipal sewage treatment facilities. All municipal systems have secondary treatment except Moncton, where treatment is primary and chemically assisted. Nova Scotia's 250 sewage treatment facilities serve approximately 24% of the population, while an additional 45% of the population is served by on-site disposal systems. As a result, some 31% of the population (almost 300 000 people) still have sewage collection systems without treatment. Nova Scotia's two major cities, Halifax and Sydney, still discharge raw sewage into their harbours (Grant, 1998). In Newfoundland, the total discharge of waste water has been estimated to be 100 000 m^3/day, of which 90% is discharged into coastal waters without any treatment.

Non-point sources of pollution have received only limited attention in the region. Most Atlantic provinces still use combined sanitary and storm sewer systems. These combined systems occasionally cause flooding and subsequent bypassing of treatment plant processing. In terms of the shellfish closures and beach closures, the non-point sources and some of the smaller urban discharges are the most significant concern in this region.

Municipal waste water is implicated as a contributing pollution source in over half of the closed shellfish areas in the Atlantic Region. In 1996, 35% of the classified shellfish growing area in the Atlantic Region was closed to harvesting of shellfish because of fecal bacteria pollution (Table 7-2) (Menon, 1998). The Department of Fisheries and Oceans estimates that income of over $8 million is lost every year due to closures of the soft shell clam fishery in southwest New Brunswick.

Table 7-2. Summary of Closures in Atlantic Region of Classified Shellfish Growing Areas, 1996 (Menon, Personal Communication, 1998)

Region	Closures	Closed (km^2)	Shoreline (km)
New Brunswick	127	571	1 699
Newfoundland	81	425	1 019
Nova Scotia	278	939	3 314
P.E.I.	83	110	783
Atlantic Region Total	569	2 044	6 815

The problem of sewage is more acute in protected harbours and inlets where tidal flushing or ocean currents are less effective at dispersing effluents (e.g., St. John's Harbour and Corner Brook in Newfoundland). In areas where sewage and industrial outfalls are in close proximity, such as in Pictou, Nova Scotia, and Bathurst, New Brunswick, this condition may become more problematic at times (Fairchild and St.-Hilaire,1998). Approximately half of all industrial discharges in the Atlantic Region are into estuaries (Eaton et al., 1994). A combination of microtidal amplitude and relatively low river flows also creates low flushing conditions in estuaries of eastern New Brunswick, Prince Edward Island and northeastern Nova Scotia.

Persistent Organic Pollutants

Persistent organic pollutants (POPs) in Atlantic Canada originate locally from incinerators, smelters, power generating stations, abandoned military bases, industrial and sanitary effluents, municipal waste water, urban runoff, snow removal, pulp and paper mills, landfills, residues from current and past applications of pesticides to agricultural and forest lands, and antifouling paint used in marine industries.

POPs affecting Atlantic Canada also originate from distant sources. The atmosphere is a principal pathway for the transport of volatile chemicals. This is particularly important for Atlantic Canada, as it is in the downwind path of most weather systems that first pass through industrialized regions of North America (White and Johns, 1997). Atmospheric transport from distant sources is a major contributor of POPs as well as lead, mercury and cadmium.

Polychlorinated biphenyl (PCB) levels in plankton have dropped substantially from the early 1970s to the 1980s, but the decline has levelled off. A preliminary PCB budget for the Gulf of St. Lawrence demonstrates that most of the contamination in the pelagic ecosystem was present in the water column. Preliminary fluxes of PCBs in the Gulf of St. Lawrence indicate atmospheric, riverine and oceanic inputs are approximately equivalent (Harding et al., 1997).

Agriculture is a major sector of the economy, and it includes the wide use of pesticides. The chemicals enter the aquatic and marine environment through runoff from treated locations. An example: in 1986, 850 000 kg of pesticides were sprayed on 200 000 ha of farmland in

Atlantic Canada (4.25 kg/ha) (Environment Canada, 1991). The estimate does not include the intensive household use of pesticides where, on average, greater quantities are applied per acre than on agricultural land. Much of this application is meant to support artifically green pest- and weed-free lawns.

The Atlantic Region's most heavily used pesticides are bactericides: the region's water and sewage authorities use 1.2 million kg of chlorine gas and chlorine-based compounds each year to disinfect water supplies and to treat waste water. Over-chlorination is common as plant operators strive for clean treated water, and is especially prevalent at treatment plants that are not functioning properly, either because of age or mechanical breakdown (Garron, 1992).

Forestry use of pesticides is extensive as well, both for insect and vegetation control. New Brunswick's forest spray programme, the longest running and most extensive in the world, distributed more than five million kg of DDT over 10 million ha of forest between 1952 and 1968, mainly in its battle against the spruce budworm (Environment Canada, 1991). Wide-scale use of DDT was banned in 1972, but residues of DDT and its breakdown products (such as DDE) persist in the environment today. Forest insect infestations are cyclic and are currently at a low point. Consequently, biological pesticides (primarily *B.t., Bacillus thuringiensis*) that pose minimal risk to marine systems are the primary control agents. However, when insect infestations are reported, all methods of control are considered.

The use of pesticides in finfish aquaculture has increased dramatically both in extent and intensity. Pesticides are used primarily to control sealice, although they are also used as disinfectants and fungicides. The sealice pesticides used so far (pyrethrin, dichlorvos, sodium hypochlorite, azamethiphos and cypermethrin) have varying toxicity to marine organisms, particularly crustaceans, and their release to the marine environment is suspected to present a definite risk to pelagic and benthic organisms.

Concentrations of DDE, PCBs and several other POPs declined rapidly in seabirds after their use was banned in Canada during the 1970s and early 1980s. However, since 1988, POP levels in seabirds in the Atlantic Region have remained fairly stable. Differences in POP levels between seabird species suggest that river inputs from land-based sources have declined the most since 1968, while atmospheric inputs have remained constant since the early 1980s. While POP levels were high enough in the late 1960s and early 1970s to impair reproduction in some seabirds, present levels appear to have no obvious impacts on seabird population numbers.

The sources of concern for POPs have changed over the past years because of increased regulation and control of local sources. Point sources in the region are diminishing, while non-point sources continue to increase. In addition, the use of pesticides in agricultural operations in some portions of the region is of increasing public concern.

Radionuclides

Sources of radionuclides are quite limited in the Atlantic Region. There is one nuclear power generating station, Point Lepreau, located in southern New Brunswick along the Bay of Fundy. Radionuclides are also discharged in effluent from the fertilizer plant at Belledune, New Brunswick (Eaton et al., 1994). Radiation therapy, radiology facilities and military bases are other potential sources, although monitoring of visiting nuclear powered vessels in Halifax Harbour has shown no releases. There are

no identified problems in the marine environment in the Atlantic Region related to radionuclides.

Heavy Metals

Heavy metals in coastal areas originate locally from mining operations (all Atlantic provinces except Prince Edward Island), stockpiles and storage of minerals at various harbours, metal plating, leachate from landfills, ash disposal from fossil fuel generating plants, industrial and municipal effluents, and land application of sewage sludge. Input from dredging and ocean disposal is well regulated. Local sources of metals have been identified in areas such as Belledune, Halifax and St. John's Harbour. Metals are known to contaminate the sediments of these harbours and may be related to impacts on fish and shellfish. In addition, metals enter the region from external sources via long-range transboundary air pollution (LRTAP). Mercury is suspected of entering the region this way, since elevated levels are found in some freshwater ecosystems. Not enough data is yet available to quantify this issue in the marine environment.

The point source discharges of metals from mines, and industrial discharges, have decreased and are covered under Fisheries Act regulations. Point sources continue to pose a problem for a number of large harbours in the region (such as Halifax, Saint John, and St. John's). However, long-range transport is suspected of contributing a larger proportion of the metals found in the marine environment, as local point sources are better controlled. There are a number of gaps in studies related to metals for the Atlantic Region. There is no available information on the long-range transport of metals in Newfoundland. Elevated cadmium concentrations were identified in lobsters captured in Belledune Harbour, New Brunswick, in 1980. This is one example where chemical contaminant concentrations have been considered elevated enough to be a human health problem and a fisheries closure has been declared (White and Johns, 1997).

In recent years, interest has been expressed in marine mining for base metals in the Baie Verte Peninsula area in Newfoundland, and the Bay of Fundy in New Brunswick. Potential impacts on fish habitat of such activity have not yet been quantified.

The use of tributyltin (TBT) as antifouling paint has been limited to boats more than 25 m in length and aluminum hull boats in Canada since 1989. This step was taken after TBT was proven to be toxic for marine organisms and found to be an endocrine disrupter. Following a two-year monitoring programme in the Gulf of St. Lawrence (St.-Jean et al., 1998), it appears that regulatory controls have brought decreases of TBT in sediments. However, in the Atlantic region, concentrations of TBT in sediments from large vessel harbours have increased since 1989 (Savard and Gray, 1998). Major input of TBT is related to the commercial fleet, and is most apparent along marinas, dockyards and in large ports. Input of TBT to the marine environment results from two main sources: leaching from treated surfaces; and from applying, removing or cleaning antifouling coatings. In the Atlantic Region, there are no provincial or federal regulations in place to address the containment and/or disposal of TBT residues, either in contaminated sandblasting grit or hydroblasting waste water.

TBT levels in biota (wild blue mussels, *Mytilus edulis*) for the southern Gulf of St. Lawrence seem to persist, and may be increasing, in ranges that are of environmental concern (St.-Jean et al., 1998). The highest levels found in blue mussels (between 100-500 ng/g) are comparable to moderately contaminated sites in other areas of the world. This is in a

range that is considered to be chronically toxic to most susceptible marine organisms, confirming that regulations restricting the use of TBT have been only partially effective and that further controls are required (St.-Jean et al., 1997).

Oils/Hydrocarbons

Land-based releases of hydrocarbons into the marine environment are linked to urban waste water, storm water and industrial discharges. These are primarily point sources. Some limited non-point sources are associated with storage, handling and transport of hydrocarbons in the region.

Generally, individual releases of oil are limited. However, there is concern over cumulative impacts, particularly on coastal waterfowl and seabird populations, fish larvae and fish eggs. Heavier crude can smother fish habitats and have significant impacts on bird and marine mammal populations through both direct toxicity and sub-lethal effects. The bulk of oil contamination in sediments comes from chronic release sources such as storm water runoff. There is a constant release of these oil contributors into the environment that, over time, dwarfs the contribution from spills (M.B. Davis, personal communication). All oil spills represent a risk to the aquaculture and fishing industry. The possibility for a large unpredictable oil spill is always present, as a number of important oil handling facilities are located throughout the Atlantic Region.

An emerging issue in the region is related to the use of Orimulsion ® in coastal power plants. Twenty thousand tonnes of Orimulsion ® are shipped each year from Venezuela to the thermal power plant in Dalhousie, New Brunswick. This oil-in-water emulsion, in addition to having a high polycyclic aromatic hydrocarbon (PAH) content, may pose a high risk to benthic organisms, particularly filter-feeders. There is little information on the toxicity of Orimulsion ® to marine biota, especially at cold temperatures. In addition, available spill control and recovery methodology is not effective with this type of product. Benthic communities and commercial scallop beds in the Baie des Chaleurs would be particularly at risk in the event of a dockside spill (Alexander and Lee, 1998). Further research on the potential impact of this product in marine ecosystems is required.

Nutrients

Sources of excess nutrients (principally nitrogen and phosphorus) in the Atlantic Region include food processing, municipal and industrial waste water, agricultural fertilizer runoff, nutrient-enriched groundwater, aquaculture operations, and soil erosion from agricultural and forestry practices.

Nutrients are released into the marine environment through point sources such as municipal and industrial discharges, and through non-point sources associated with agriculture. In the Southern Gulf of St. Lawrence, nutrients from agricultural sources present a significant problem, particularly where the flow pattern in estuaries has been disrupted by the construction of causeways. In a few local areas, effluent from pulp and paper mills has introduced a significant amount of organic matter to the local area. However, the pulp and paper sector is specifically regulated under the Fisheries Act, and most mills now comply with these regulations.

Another potential source for nutrient loading in the Atlantic Region is food processing plants. Table 7-3 identifies the federally registered plants in Atlantic Canada.

Table 7-3. Number of Federally Registered Food Processing Plants in Atlantic Canada (Bourque, Personal Communication, 1998)

Region	Fish plants	Meat packing and processing plants	Dairy processing plants	Fruit and vegetable processing plants
Newfoundland	182	2	3	1
New Brunswick	157	4	2	3
Nova Scotia	289	7	6	5
Prince Edward Island	47	4	5	3
Total Atlantic	675	17	16	12

The potential exists for eutrophication of coastal waters in all of the Atlantic Region. It is a particularly critical problem in coastal waters around Prince Edward Island, where the addition of agricultural fertilizers has led to enriched groundwater and eutrophication of upper estuarine waters. In New Brunswick, concern is focused on excess nutrients associated with soil erosion from agricultural and forestry practices.

Data shows that nitrate levels in three Prince Edward Island river systems have increased several-fold over the past 30 years (Figure 7-2). Water quality in these systems is not influenced by point sources. The principle sources would be agricultural fertilizers and livestock manure. The report *Cultivating Island Solutions* expressed concern about the deterioration of the province's water resources from agricultural activities (Prince Edward Island Round Table on Resource Land Use and Stewardship, 1997).

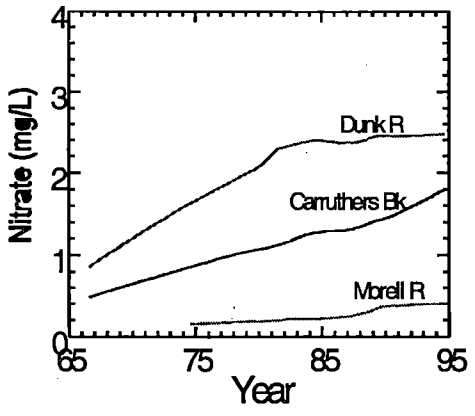

Figure 7-2. Nutrient loading over time in three Prince Edward Island estuaries

Prince Edward Island estuaries are known to be among the most productive shellfish growing areas in the world. However, excessive phytoplankton and macroalgal growth is causing serious water and aquatic habitat problems in many Prince Edward Island estuaries, promoted by the high availability of essential nutrients such as nitrogen and phosphorus.

The decay of the massive quantities of plant material, particularly sea lettuce (*Ulva lactuca),* results in oxygen depletion and the production of toxic gases such as hydrogen sulphide and ammonia. In a report prepared for the Canada-P.E.I. Water Annex Agreement, Thompson (1988) listed nine major estuaries on the Island where eutrophic conditions were prevalent during the summer months. In all cases, land-use-related non-point sources were considered to be the main factor. Whitford and Lane (1990) determined that upper estuary systems on Prince Edward Island were very productive and had no residual capacity to assimilate additional nutrients and associated plant production. It was also concluded that nutrient additions from agricultural systems have reached unacceptable limits. In related work, Brylinsky (1988) evaluated the trophic status of two Prince Edward Island estuaries according to criteria established by the U.S. National Oceanic and Atmospheric Administration. It was determined that the Wheatley River was highly eutrophic while the Hunter River was in the high mesotrophic range. Anoxic conditions have been known to occur in the Hunter River in more recent years. Application of this criterion to other Prince Edward Island estuaries could establish whether or not they are eutrophic and susceptible to anoxic events. The high nutrient levels in surface waters may be a major contributing factor in harmful algal blooms (HABs).

Worldwide, HABs are increasing in frequency, severity, duration and geographic distribution, beyond that which can be attributed to improved monitoring and awareness. Causes for this include increased use of coastal resources and eutrophication. Toxic algal blooms cause shellfish to become contaminated, resulting in illnesses, and in the worst case scenario, human deaths. These incidents of contamination are cyclic in nature and occur, with varying levels of toxin production, throughout the coast of eastern Canada each year (see Figure 7-3). Periods of higher toxicity appear to coincide with an 18.6-year lunar tidal cycle (Bates, 1997).

Domoic acid contamination in Prince Edward Island during 1987, and an initial ban on fish and shellfish products, resulted in a drop in seafood demand by as much as 80% (Wessels et al., 1995). Total losses in eastern Canada were estimated at $8.4 million, including employment losses, hospitalization costs, costs of monitoring and testing, costs of public relations, losses to Canadian mussel growers for 1987-1988 and losses to other Canadian shellfish harvesters, wholesalers and retailers. (Wessels et al., 1995). Not all the economic losses were directly attributable to contamination, but rather to the perception that seafood was unsafe to eat. Without shellfish monitoring programmes, the human and economic cost attributed to HAB would be much higher.

Another example is the millions of dollars in damage to the fishing industry in the mid-Atlantic states from a recently discovered toxic alga, the fish-killing dinoflagellate, *Pfiesteria piscicida.* A tentative link has been made between both the distribution and severity of *Pfiesteria* blooms and eutrophication caused by effluents from pig and poultry farms. There is concern that this organism could be transported into

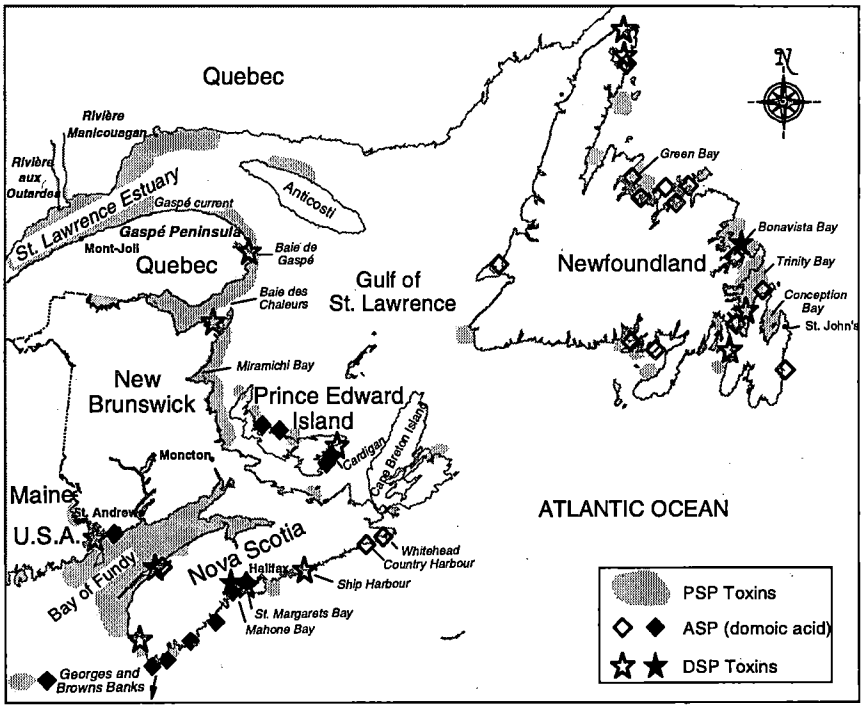

Figure 7-3. Distribution of HAB in Atlantic Canada (adapted with permission from Bates, 1997)

the Gulf of St. Lawrence, causing adverse economic and environmental consequences. No such event has occurred in Atlantic Canada, but there is a need to closely follow the situation in the United States and to determine whether the dinoflagellate can survive in the colder waters of Atlantic Canada.

Contaminated Sediments

The Sydney Tar Ponds and the Coke Ovens Site in Cape Breton, Nova Scotia, are among the worst contaminated sites in Canada. After approximately 100 years of steelmaking, the contaminated sites are extensive and complex. The Sydney Tar Ponds contain approximately 700 000 tonnes of sediments contaminated with a complex mixture of chemical compounds. The Coke Ovens, closed in 1988, were the primary source of PAH contamination in Sydney Harbour. The Province of Nova Scotia, area citizens and environmental groups have joined the federal government to implement an effective solution to this environmental issue.

St. John's Harbour in Newfoundland contains sediments contaminated with an array of domestic and industrial pollutants including heavy metals, PCB oils, hydrocarbons and other organic compounds. St. John's Harbour ACAP (Atlantic Coastal Action Programme) took sediment samples from the harbour bottom at six locations on August 2, 1994. It was determined that the samples were highly contaminated.

Litter

Litter, or marine debris, is a common problem throughout the Atlantic Region. Litter is released from both point and non-point sources. Common sources are random littering events, sewage outfalls, shore-side food kiosks, construction and repair sites and wharves.

Tourism, particularly ecotourism, depends on unspoiled beaches, so the concerns over aesthetic impacts have led to communities bearing hidden costs for maintaining clean coastal areas. In certain areas, groups have been formed in response to the issue of litter in the marine environment. In Newfoundland, one such volunteer association, Ocean Net, is dedicated to the conservation of the marine environment, and sponsors regular shoreline and nearshore cleanups by scuba divers at selected sites. The Clean Nova Scotia Foundation has co-ordinated the Moosehead Beach Sweep throughout three Maritime provinces for several years. There is growing interest in this type of initiative in the region.

7.1B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

Shoreline construction and alteration activities include coastal flood protection works, bridges, marinas, wharves, breakwaters and infilling associated with road construction, sewer works and other infrastructure. Impacts include loss of primary productivity and a long-term impact on local food production; harmful alteration, disruption or destruction of fish and wildlife habitat; changes in sedimentation regimes; and loss of economic opportunity. Both large-scale and small-scale projects have site-specific problems; however, they are addressed by current regulatory regimes. The need to better assess the cumulative impact of these projects at an ecosystem scale has been recognized and warrants further research.

In Newfoundland and Labrador, the Small Craft Harbours Branch of the Department of Fisheries and Oceans (DFO) currently administers 457 fishing harbours. This represents approximately 900 facilities including wharves, breakwaters and slipways. New Brunswick has 150 small vessel harbours, Nova Scotia has 150 and Prince Edward Island has 76. Each one of these facilities undergoes a number of maintenance activities each year, such as dredging and refitting. In addition, the region has a number of larger port facilities, such as Belledune, St. John's and Halifax, where this type of impact is larger.

Inter-tidal and Sub-tidal Alteration

Inter-tidal and sub-tidal alterations of fish habitat in the Atlantic Region are mainly linked to shoreline construction activities, the use of certain fish harvesting gears, marine plant harvesting, and intensive finfish aquaculture. These activities can result in loss or degradation of shellfish and finfish habitats, including particularly sensitive spawning and nursery habitats.

Rockweed harvesting (*Fucus* sp. and *Ascophyllum nodosum*), an emerging industry on the south coast of Newfoundland, is an activity whose impact on the coastal ecosystem is poorly understood. It is also a traditional industry in New Brunswick and Nova Scotia, especially in the southwestern section. This industry is regulated by the provinces and operates on the principle of sustainable harvest. Rockweed provides an important microhabitat for many species. Its harvesting potentially affects many species dependent on that habitat. Products are being assessed for various commercial uses including as a food source for sea urchins prior to export. Other common macroalgae being harvested include Irish Moss (*Chondrus crispus*), dulse (*Rhodymenia palmata*), kelp (*Laminaria* sp.) and Nori (see biological alteration, Section 7.1B).

The use of recreational vehicles in coastal areas is a concern at sensitive sites in the Atlantic Region. These sites include sand dunes in the Gulf of St. Lawrence and the south and southwest coast of

Newfoundland, which are nesting sites for the endangered Piping Plover. The activity can also disturb seal populations in their summering habitats. Use of all-terrain vehicles (ATVs) on sand dunes can destabilize these fragile ecosystems and result in altered hydrodynamics. Regulations on the operation of ATVs vary by province and are difficult to enforce.

Mineral and Sediment Extraction/Alteration

Mineral extraction on beaches can have substantial impact on habitat. Public outcry over past practices has resulted in extensive controls. It is not currently a major problem in any jurisdiction in the Atlantic Region.

Harbour and channel dredging are major activities in the Atlantic Region. The dredging and disposal of sediment can have a substantial impact on habitat and is particularly critical for species that use substrate for spawning. It can also result in the resuspension of sediment in the water column, resulting in diminished phytoplankton production, feeding and respiration of fish (White and Johns, 1997).

Because the glacial till and sandstone coastline of Prince Edward Island erodes so easily, shoreline erosion is a very significant issue in most areas of the province, especially along the north and west coasts. As these vast quantities of sediment are introduced to the shoreline sediment transport system, accumulation in the proximity of protruding coastal structures and sandbars' barrier channels becomes a significant navigational issue. In many cases navigation by commercial fishers is seriously impeded, and human safety becomes an important consideration. Consequently, dredging and beach extraction, mostly of sand material around wharves, is an ongoing activity.

In Newfoundland and Labrador, dredging in marine waters is conducted annually to facilitate vessel passage and access to port facilities. In 1998, there were as many as 50 small-scale dredging operations. Such operations are of short duration and typically involve removing a small volume of substrate infilled along existing navigation routes. Larger-scale operations occur in cases of critical need, perhaps one or two a year. These operations remove substantial amounts of material that have infilled navigation channels. Where possible, longer-term solutions such as breakwaters and groynes are used for both minor and major activities. All proposed dredging activities are screened under the Canadian Environmental Assessment Act (CEAA), and must meet Canadian Environmental Protection Act (CEPA) ocean disposal provisions.

Wetland and Saltmarsh Alteration

Activities include infilling, draining, dyking, and alteration of estuaries, wetlands and coastal areas for land expansion purposes. Additional activities are associated with cranberry bog creation and peat harvesting. The Atlantic Region has a long history of these activities, but in the present day, increasing real estate value of coastal areas has resulted in more landfilling of wetlands and saltmarshes. Impacts include the cumulative loss of significant habitats and reduced primary productivity.

The expansion of the peat industry in the Atlantic Region during the last 20 years has raised major concerns regarding its impact on the quality of coastal and estuarine ecosystems. High levels of peat fibres are released and transported from commercial peat bogs to fresh and marine waters. In modern peat operations, bogs are drained; water collects in deep ditches and eventually flows toward the sea via a network of streams and rivers. Current legislation requires the installation of settling basins to reduce excessive peat runoff. A recent study examined the effects of peat on the biodiversity and health of

aquatic habitats following the release of excessive peat in an estuary. It showed a negative modification of habitat in the vicinity of peat sediments (Ouellette et al., 1997). As the depth of peat sediments increases, the density of certain fish and shellfish species diminishes. Laboratory experiments demonstrated a definite avoidance of peat substrate when organisms are provided with a choice. This preliminary indication of habitat impact points to the need to study the long-term impacts of peat on aquatic biota. There is further evidence that peat bogs, through various natural enzymatic and microbial reactions known as biochlorination, synthesize dioxins and furans (Silk et al., 1998). All unique isomers of dioxins and furans typically found in bogs have been identified in crustacean hepatopancreas (tomalley) tissue in coastal areas.

Marine Waters and Coastal Watershed Alteration

Siltation is an issue in the Atlantic Region. Many land use practices result in increased erosion and silt loads to the coastal environment. Silt is a major carrier of pesticides, heavy metals and nutrients from watersheds to coastal waters, where it settles into the sediment. Any disturbance of sediments can potentially release these toxic substances into the ecosystem.

The suspended sediment released in runoff and urban discharges causes further physical problems, such as clogging of fish gills, and adverse effects on water quality, light penetration and temperature. Water quality is also affected by damming, construction of causeways and tidal power plants, reduction of freshets, thermal change in habitat, stratification and increased biological oxygen demand (BOD). Such activities can also exacerbate nutrient enrichment of coastal waters by altering the flushing capacity of coastal waters. Barriers to water flow obstruct the migration of anadromous fish to their breeding habitats, and have consequent impacts on population levels.

Sediment is derived from a number of sources. Along the southern Gulf of St. Lawrence, the sources are primarily non-point in nature. In areas where agriculture is extensive and where row cropping is used, very high erosion levels occur. In other parts of the region, urban waste water is the major contributor of sediments, particularly in harbours associated with large urban areas. These harbours also have elevated sediment contaminant levels associated with sediments.

Sedimentation is currently the single most significant threat to water and habitat quality in Prince Edward Island surface water systems. (Prince Edward Island Round Table on Resource Land Use and Stewardship, 1997). Recent work on the Wilmot River, conducted under the National Soil Conservation Erosion Monitoring Programme, found that a sub-watershed with 47% potato crop cover produced high suspended solids in the receiving water. The annual average suspended solids concentration was 977 mg/l, with a maximum peak concentration of 20 146 mg/l (Dehaan,1994).

In the 1940s and 1950s, it was common practice on Prince Edward Island to replace span bridges with less expensive earthen causeways. In many cases these causeways were constructed across major estuary systems and were equipped with very narrow openings. Often, water level control structures were added to stabilize water levels in the impounded areas. The natural tidal exchange was seriously impeded, causing significant water quality and ecosystem health problems. In these very productive environments, the high level of nutrient input has led to severely eutrophic situations. The province has made progress in its efforts to replace these causeways with free-flowing bridges.

In northern Nova Scotia and around the Bay of Fundy, erosion is common in areas with fine-grained soils that erode easily. These soils contribute to heavy sediment loading of the rivers leading to the Bay of Fundy and Northumberland Strait. Along the Atlantic Coast of Nova Scotia, fine-grained sediments from drumlin structures are susceptible to erosion from forestry and urban development. In New Brunswick, land-based activities involving sloped terrain and soils that erode easily provide sources of sediment to marine waters. In Newfoundland the scale of sedimentation is relatively small when compared to other areas of Canada, but there is evidence of significant localized changes in sediment loading from activities along such urban rivers as the Waterford, emptying into St. John's Harbour.

Dams have been built on most of the significant rivers in Nova Scotia to provide head ponds for hydropower and public water supply and, to a lesser extent, to provide flood control. There are 25 water licences for hydropower generation in the province, along with 56 public surface water supplies. As many as 150 additional sites exist for private, community and agricultural water systems. Damming of rivers has impacts upstream and downstream because of interference with the transport of both water and waterborne sediments. Dams have also been major impediments to fish passage, while hydrology regimes have been affected by the construction of transportation corridors across rivers, estuaries and even the Canso Strait. Hundreds of individual culverts exist in coastal areas of the Atlantic provinces, restricting marine flow.

In Newfoundland and Labrador, hydroelectric development began in the early 1900s, when dams were constructed in the northeastern, eastern and southern portions of the province. Dams on larger rivers (the Humber and Exploits) were built to provide hydroelectric power for pulp and paper mills. In the 1960s and 1970s, there were large hydroelectric developments at Bay d'Espoir in Newfoundland and Upper Churchill Falls in Labrador, including the flooding of large areas. There is now the possibility of hydroelectric development on the Lower Churchill River. Currently there are 42 hydroelectric systems of all sizes in the province, some of which have multiple dams and diversions.

Biological Alteration

The introduction of non-native aquatic species and human pathogens (e.g., viruses, bacteria, parasites) can modify ecosystem dynamics. Rainbow trout (*Salmo gairdneri*) have escaped from finfish aquaculture operations in the Bay d'Espoir area on the south coast of Newfoundland and there may be an impact (as yet unquantified) on the local ecosystem and indigenous fish species. Both rainbow trout (*Salmo gairdneri*) and brown trout (*Salmo trutta*) were introduced as game fish in eastern Newfoundland, New Brunswick, Prince Edward Island and Nova Scotia in the late 1800s and 1900s. Since their introduction, brown trout have spread into waters beyond those to which they were first introduced. Successful sea-run or anadromous populations of brown trout occur in all of these provinces, except in Prince Edward Island (Scott and Scott, 1988). Other examples of documented introductions include goldfish (*Cyprinus auratus*), small mouth bass *(Micropterus dolomieui*), and chain pickerel (*Esox niger*) in Nova Scotia and New Brunswick.

There have been documented reports of Coho salmon (*Oncorhynchus kisutch*) and of Chinook salmon (*Oncorhynchus tshawytsha*) being caught in rivers in New Brunswick and Nova Scotia as a result of introduction in New England state rivers, including the St. Croix river between New Brunswick and Maine (Scott and Scott, 1988). There have been undocumented reports of exotic pet species released in

coastal areas by their owners. Even the introduction of native species, such as Atlantic salmon, outside their natural range may have adverse impacts on wild populations by affecting gene pools or introducing parasites.

Regional/provincial introductions and transfer committees review all planned movements of invertebrates in Atlantic Canada, with the exception of lobsters (*Homarus americanus*). These reviews apply to species destined for openwater live-holding, release, hatchery use or remote setting, and involve screening for parasites, pests and diseases. Canada currently has no federal regulations to prohibit or control the movements of marine plants.

Specific introductions of biopollutants in Atlantic ecosystems include the following examples.

Marine Plants

- Since 1995, there have been numerous reports of *Codium fragile* in Atlantic Canada's waters. It was first noticed in southern Nova Scotia and has been confirmed in the Gulf of St. Lawrence. There are indications that Malpeque Bay in Prince Edward Island is now colonized throughout, and that the plant is severely affecting, in equal measure, shellfish growing areas (substrate) and suspended culture gears. This alga quickly spreads to coastal areas, and is not killed by air drying. One oyster lease, where the seaweed was first discovered in 1996 in Prince Edward Island, has become heavily colonized with a mat 0.2 m to 0.6 m thick covering much of the lease bottom. In the summer of 1997, more than 45 000 kg of this alga was removed from one oyster lease, without making a noticeable reduction in plant volume. The presence of this alga has the potential to cause a significant economic burden on the shellfish industry (Campbell, 1998).
- The culture of the seaweed Nori *(Porphyra yezoensis)* from monospores (obtained from Maine hatcheries) has been approved in the Bay of Fundy, where the cold water conditions allow growth but prevent reproduction. With growing interest in the culture of this seaweed, there is concern that it could be moved to other areas in the Atlantic Region where it could successfully reproduce and compete detrimentally with other algae.

Viruses

- Since 1996, a severe disease condition has affected farmed Atlantic salmon in the Bay of Fundy. In the fall of 1997, the disease was confirmed to be infectious salmon anemia (ISA), first identified in Norway in 1984. The presence of the infectious salmon anemia virus (ISAV) in New Brunswick represents the first instance that the virus has been isolated outside Norway and in May 1998 the virus was also found in Scotland. There have been severe economic losses in New Brunswick salmon farms. More than 1.25 million salmon (1997 year-class) in three affected bays were destroyed in 1997-98, adding to losses in the 1996 year-class. It is estimated that the loss to the salmon aquaculture industry in 1997-98 could reach $30 million (N. Alward, personal communication, 1998). Scientists are looking at a number of hypotheses to explain the outbreak of this disease in New Brunswick. One is that ISAV was always present in wild fish populations and that some unknown conditions have changed, allowing the disease to spread in cultured Atlantic salmon. Another theory involves introduction through the aquaculture industry, with potential infection of wild stocks.

7.2. Establishment of Priorities for Action

7.2A. Contaminants

Sewage

Sewage is the one of the most prevalent problems facing the Atlantic Region with the exception of Prince Edward Island, and it is therefore a **high priority**.

The impact of sewage on the emerging aquaculture industry, shellfish harvesting, commercial fish processing and marine recreation represents a significant regional concern. Restrictions on the use of the fisheries resource in these coastal ecosystems has had a direct impact on local residents and their means to access food and income.

The Atlantic Region is increasingly dependent on the tourism industry, and expansion in this sector may be seriously limited by bacterial contamination, eutrophication and associated loss of aesthetic and recreational value.

Sewage is also a public health issue where treatment is not available or the technology not adequate. There are two dimensions to this problem: first, the major point sources for sewage in this region are the large municipalities where harbours suffer from contaminated sediments, bacterial closures and aesthetics problems; second, non-point sources play a large role in the contamination of shellfish growing areas, particularly in the Gulf of St. Lawrence.

Persistent Organic Pollutants

Persistent organic pollutants have been assessed to have a **medium priority**. Local sources continue to diminish as controls come into place. However, atmospheric transport from other parts of North America increasingly contributes to ecosystem-wide impacts. There is more concern over the role of POPs as endocrine disrupters, and unregulated application of pesticides for non-commercial purposes is seen as one area where substantial improvements could be made.

Radionuclides

Radionuclides were given a **low priority**. Current regulatory mechanisms are effective, and should continue to be enforced.

Heavy Metals

Heavy metals constitute a **medium to high priority** in the Atlantic Region. There are a number of individual contaminated sites in the region, primarily associated with metal mining activities. These point sources are coming under increasing control. However, the discharges associated with urban waste water continue to cause contamination in Atlantic harbours. There is rising concern about the level of mercury in certain areas. Further research on metals in the Atlantic Region is required.

Oils/Hydrocarbons

Oils and hydrocarbons were given a **medium priority**. When no major spill occurs, the sources of these contaminants are usually small spills, leaks or accidents. The cumulative effect and public perception generates the priority concern, along with the expansion of the offshore petroleum oil and gas production, and associated land-based facilities.

Nutrients

Nutrients are given a **medium priority**, with the qualifier that nutrients are a major concern in Prince Edward Island and may become a concern in certain areas of Nova Scotia and New Brunswick. Studies on the link between coastal eutrophication and HABs merit further research and continued monitoring.

Contaminated Sediments

Contaminated sediments are assigned a **medium priority** in the Atlantic Region. There are a number of contaminated sites, particularly several harbours in the region where sediments have been the recipient of municipal waste water and industrial effluents.

Litter

Litter is given a **high priority**. It is a highly visible public issue throughout the region. Ecotourism, a growing industry in Atlantic Canada, relies on the perception of pristine beaches and coastal waters to attract its customers, making this an important environmental and economic issue.

7.2B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

Although shoreline construction and alteration practices are well regulated by the provincial and federal governments, this sector of activity can have a large-scale impact on habitat. It is therefore assessed at a **medium priority**, particularly to address the need for further research on the cumulative impact of shoreline construction and alteration on coastal ecosystems. Further research on the adequacy of habitat compensation/mitigation measures is required.

Inter-tidal and Sub-tidal Alteration

The growing inter-tidal and sub-tidal alteration activities, linked to the growth in the marine plant harvesting and aquaculture industry in the region, require continued monitoring. The existing provincial and federal legislation is adequate, explaining the **low priority** rating. This rating may need to be reviewed if the region continues to experience further expansion in this sector. More research is required on productivity associated with rockweed ecosystems and lobster nursery habitats before more expansion.

Mineral and Sediment Extraction/Alteration

Mineral extraction on beaches can have substantial impact on habitat. Public outcry over past practices has resulted in extensive controls on this activity. It is not currently a problem in any jurisdiction in the Atlantic Region, thus it is given a **low priority**. Renewed interest in abandoned gold and copper mines, as well as potential interest in mineral and aggregate extraction in offshore waters, could affect this rating in the future.

Wetland and Saltmarsh Alteration

There is a long history of wetland and saltmarsh alteration in the region. Increasing real estate demand and value of coastal areas may bring more landfilling of wetlands and saltmarshes. The cumulative loss of these significant habitats, and resulting effect on primary productivity, call for improvement in the application of existing provincial and federal regulations. Further public education is also required. Expansion of peat mining activities in coastal bogs requires further assessment. This is given a **medium priority**.

Marine Waters and Coastal Watershed Alteration

The main Atlantic issue of marine water and coastal watershed alteration is siltation. Many land-use practices, although limited by existing provincial and federal legislation, result in increased erosion and silt loads to the coastal environment. This issue is given a **medium priority** to recognize the need to improve existing project review mechanisms, and to address the need to develop habitat quality standards in coastal environments.

Biological Alteration

The Atlantic Region has been somewhat protected from the introduction of biopollutants, given its relatively cold and

saline waters. The expansion of aquaculture, tourism and transport activities increases the likelihood of exotic species introduction. This raises the potential for serious social, economic and health consequences and therefore requires a **medium-high priority**.

7.3. Setting Goals and Management Objectives

Under the NPA, Canada's goals are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;
- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

The following are specific management objectives for each source category.

7.3A. Contaminants

For most of the contaminants, the management objective is to reduce the contribution of contaminant sources to the marine environment, primarily through pollution prevention. Where contaminants are released to, or occur in, the marine environment, the management objective is to apply life-cycle management or remediation to address the problems.

Specific management objectives for each of the contaminants of concern at the national level are:

Sewage — reduce contamination; maintain and improve estuaries, coastal water and marine ecosystem quality for all users; maintain and restore shellfish growing areas.

Persistent Organic Pollutants — reduce/ virtually eliminate anthropogenic inputs and apply life-cycle management to remaining inputs.

Radionuclides — reduce inputs where they are likely to cause pollution, and apply radiological protection.

Heavy Metals — reduce inputs where they are likely to cause pollution, and apply life-cycle management.

Oils/ Hydrocarbons — prevent spills, establish contingency plans and apply life-cycle management.

Nutrients — reduce inputs where they are likely to cause pollution.

Contaminated Sediments — reduce sediment contamination at source.

Litter — reduce the incidence of litter/debris found in the marine environment.

7.3B. Physical Alteration and Destruction of Habitat

The primary management objectives are to mitigate or avoid harmful alteration and destruction of habitats and to restore those habitats already degraded. For some categories of harmful alteration (e.g., mineral and sediment extraction or disposal; alteration of marine waters and coastal watersheds), it is also necessary to identify critical habitats to ensure such activities take place in areas of lesser environmental sensitivity or significance. There are also some specific management objectives that apply to unique problems such as the accidental or deliberate introduction of exotic species to the marine environment from land-based activities, where the objective is to eliminate such introductions.

Specific management objectives for each of the habitat categories of concern at the national level are:

Shoreline Construction/Alteration — minimize habitat loss and balance losses by restoring or creating equivalent replacement habitat.

Inter-tidal and Sub-tidal Alteration — identify critical habitats and prevent loss or degradation of these areas while restoring areas already degraded.

Mineral and Sediment Extraction/Alteration — identify and protect sensitive habitats and marine resources.

Wetland and Saltmarsh Alteration — prevent any further loss or destruction of critical habitats and restore valuable areas previously drained or altered where feasible.

Marine Waters and Coastal Watershed Alteration — protect key habitats for all life stages of marine resources.

Biological Alteration — prevent all inadvertent or inappropriate introductions of alien species and pathogens and protect sensitive coastal ecosystems.

7.4. Strategies and Actions

7.4A. Contaminants

Sewage

- Expand incentive programmes encouraging the installation or upgrade of municipal waste water treatment systems.
- Facilitate the installation of waste management solutions adapted to small communities for collection and treatment of sewage.
- Promote a community-based approach to address point and non-point sources from agriculture and urban areas and develop ownership and empowerment mechanisms for coastal communities.
- Promote the installation and better maintenance of septic systems by individual households, and involve the septic maintenance industry in this process.
- Enforce existing regulations in cases of non-compliance.

Persistent Organic Pollutants

- Monitor indicator species to assess the long-term impacts of POPs on populations.
- Encourage efforts by industry to switch to better management practices and life-cycle management of their products, and to lower the input and ecological cost associated with the use of POPs.
- Develop domestic pesticide and integrated pest management awareness for homeowners, explaining alternative and practical measures to reduce household reliance on chemical pesticides.
- Produce a household pollution prevention audit and resource guide that will include information on the safe storage and handling of household hazardous wastes and propose substitutes for toxic household chemicals.
- Improve testing and control of chlorination and bromination to disinfect water supplies and treat waste water.
- Study the scale and severity of the endocrine-disruptor effects attributed to POPs.
- Encourage better management practices in agricultural and aquaculture production.

Radionuclides

- Continue monitoring the Point Lepreau generating station.
- Continue monitoring Belledune effluents.

Heavy Metals

- Continue monitoring of known sources and efforts to clean up known sources of heavy metals.
- Continue efforts to solicit interest in the development of pollution prevention processes from U.S. and Canadian large industry.
- Study the endocrine-disruptor effects and other health effects of heavy metals.
- Develop codes of practice and certification programmes that meet pollution prevention guidelines for heavy metals.

Oils/Hydrocarbons

- Maintain centralized emergency spill reporting facilities.
- Update and maintain spill contingency plans and training.
- Encourage efforts of industry to switch to better management practices and lower the ecological cost associated with improper waste oil disposal.
- Conduct research on Orimulsion ®.
- Promote research and development of alternative non-hydrocarbon-based energy sources.

Nutrients

- Encourage industries to switch to better management practices and lower the input and ecological cost associated with eutrophication.
- Monitor the effects of intensive finfish aquaculture operations.
- Promote a community-based approach to address point and non-point sources of nutrients and adopt watershed management.
- Prepare public education programmes to help communities reduce nutrient loads.
- Monitor indicator species.
- Promote research on the impact of nutrient application in agriculture on water quality.

Contaminated Sediments

- Continue monitoring of known sources of sediment contaminants.
- Encourage proper disposal of known or suspected contaminated sediments.
- Continue efforts to clean up contaminated sites such as the Sydney Tar Ponds.
- Minimize disturbance of known contaminated sites.

Litter

- Promote community-based approach to reduce litter in coastal areas.
- Conduct awareness campaigns directed toward waste reduction and litter prevention.
- Promote the adoption by the fishing community of biodegradable gear.
- Continue efforts to equip marinas, wharves and ports with waste disposal facilities.

7.4B. Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

- Promote community-based approach to reduce shoreline construction and alteration in Atlantic communities.
- Build on existing government and community-based programmes to protect fish habitat.
- Monitor indicator species and key habitats.
- Prepare public education programmes.

Inter-tidal and Sub-tidal Alteration

- Promote community-based approach to prevent damaging inter-tidal and sub-tidal habitats.
- Monitor aquaculture operations.
- Introduce ownership mechanisms where none exist (e.g., leases).
- Monitor indicator species and key habitats.

- Encourage shoreline rehabilitation by local groups.

Mineral and Sediment Extraction/Alteration

- Protect critical habitats.
- Monitor potential expansion in this sector of industry.
- Ensure development of adequate codes of practice for the industry.

Wetland and Saltmarsh Alteration

- Protect critical habitats through adequate impact assessment of projects.
- Promote community-based approach to protect these critical habitats.
- Harmonize federal-provincial policies on activities related to wetland and saltmarsh alteration.
- Encourage efforts by the peat and cranberry industries to adopt better management practices.

Marine Waters and Coastal Watershed Alteration

- Encourage efforts by industry to adopt better management practices and lower the input and ecological cost associated with sedimentation.
- Adopt community-based approach to increase public awareness of the effects of sedimentation.
- Build on existing government and community-based programmes to protect fish habitat.
- Promote integrated coastal zone management and land use resource planning to protect critical habitats.
- Encourage co-operation in the assessment and approval of activities that may cause sedimentation.

Biological Alteration

- Encourage efforts by the aquaculture industry to prevent the introduction of biological pollutants.
- Promote community-based approach to protect critical habitats.
- Promote public education on the consequences of species transfers.
- Continue to identify and monitor the distribution of non-native aquatic species.

7.5. Next Steps

The steps represent the type of initial actions in the Atlantic Region.

Promote the Adoption of Integrated Coastal Zone Management:

- Global Programme of Action Coalition (GPAC) for the Gulf of Maine: GPAC has identified priority issues and developed 16 strategies to address those issues.
- Southern Gulf of St. Lawrence Coalition: A framework has been proposed for the formation of a multistakeholder coalition for the southern Gulf that would address the issues related to land-based impacts on the marine environment.
- Nova Scotia continues to implement its overall approach to coastal zone management as developed in the Coastal 2000 concept.
- New Brunswick is actively developing its coastal zone management policy framework as proposed under the Commission on Land Use and Rural Environment (CLURE).
- The Government of Prince Edward Island is actively developing and implementing soil and land management and watercourse protection legislation in the province.

Promote Research and Monitoring Activities

- Gulf of Maine Council on the Marine Environment: The Council operates a monitoring programme in the Gulf of Maine/Bay of Fundy called Mussel Watch, which utilizes mussels as bioaccumulators in the environment to

monitor for toxic chemical levels. This is an ongoing project.

- A number of large projects in the Atlantic Region have taken into consideration habitat compensation and mitigation measures. Studies are under way to examine the cumulative impact of habitat-impacting projects and the adequacy and effectiveness of mitigation measures.
- Bay of Fundy Ecosystem project: A co-ordinated effort to identify science priorities around the Bay of Fundy and to develop linkages within the science community to address key issues.

Promote Education Programmes and Community Involvement:

- Remediation and Protection of Shellfish Growing Areas — A Demonstration Project: This project is to be implemented in 1998 and 1999 in selected watersheds in Prince Edward Island.
- Twelve of the 13 ACAP sites supported in the Atlantic Region have developed comprehensive environmental management plans for estuary and coastal areas in the Atlantic Region in all four provinces. These sites continue to involve local communities in the implementation of those plans.
- Sustainable development projects in New Brunswick will continue to address and remediate issues related to land-based impacts such as bacterial contamination of shellfish areas.

Literature Cited

Alexander, Ross (Department of Fisheries and Oceans, Moncton, N.B.) and Ken Lee (Department Fisheries and Oceans, Halifax, N.S.). 1998. Personal Communication.

Alward, Nelson (N.B. Salmon Growers Association, St. Andrews, NB). 1998. Personal Communication.

Bates, S.S. 1997. **Toxic Phytoplankton on the Canadian East Coast: Implications for Aquaculture.** Bulletin of the Aquaculture Association of Canada, 97 (2): 81-83.

Bourque, Clarence (Canadian Food Inspection Agency, Moncton, N.B.). 1998. Personal Communication.

Brylinski, M. 1988. **Assessment of Potential Water Quality Impacts Resulting from Removal of Rustico Island Causeway, Prince Edward Island.** Report for Parks Canada, Publication No. 48 of the Acadia Centre for Estuarine Research.

Campbell, Malcolm. 1998. **ICES Working Group on Introductions and Transfers of Marine Organisms.** National Report for Canada, March 25-27, 1998. The Hague, The Netherlands.

Davis, M.B. (Department of Fisheries and Oceans, St. John's, Newfoundland). 1998. Personal Communication.

Dehaan, R. 1994. **NSCP Erosion Monitoring Project, Final Report**, P.E.I. Department of Agriculture, Fisheries & Forestry (Resources, Research & Labs) and Agriculture Canada.

Eaton, P.B., A.G. Gray, P.W. Johnson and E. Hundert. 1994. **State of the Environment in the Atlantic Region.** Environment Canada, Atlantic Region.

Environment Canada. 1991. **Waiting for the Fiddler: Pesticides and the Environment in Atlantic Canada.** Dartmouth, N.S.

Fairchild, Wayne (Department of Fisheries and Oceans, Moncton, N.B.) and André St-Hilaire (Department of Fisheries and Oceans, Moncton, N.B.). 1998. Personal communication.

Garron, C.A. 1992. **Disinfectant Chemical Use in Domestic Water and Wastewater Treatment in the Atlantic Region in 1990.** Dartmouth, N.S.: Environment Canada.

Gilbert, Michel (Department of Fisheries and Oceans, Mont-Joli, Q.C.). 1998. Personal communication.

Grant, M.T. (Nova Scotia Department of the Environment, Halifax, N.S.). 1998. Personal Communication.

Harding, G. et al. 1997. "Organochlorine Levels in the Marine Food Web of the Southern Gulf of St. Lawrence." In: R.C. Pierce and D. Williams, **Book of Abstracts: Department of Fisheries and Oceans Green Plan Toxic Chemicals Program Wrap-up Conference, Government Conference Centre, Ottawa, January 28-31, 1997.** Ottawa: Canadian Technical Report of Fisheries and Aquatic Sciences, 2163.

Menon, Amar (Environment Canada, Dartmouth, N.S.). 1998. Personal communication.

Ouellette, C., A.D. Boghen, S.C. Courtenay and A. St-Hilaire. 1997. **Potential Environmental Impact of Peat Moss Harvesting on the Richibucto River in New Brunswick.** Bulletin of the Aquaculture Association of Canada, 97 (2): 81-83.

Prince Edward Island Round Table on Resource Land Use and Stewardship. 1997. **Cultivating Island Solutions.** Prepared for the Province of Prince Edward Island. Charlottetown, P.E.I.

Savard, M., and M. Gray. 1998. **Assessment of the Use, Handling and Disposal of Antifouling Paints at Ship Repair Facilities in the Atlantic Region.** Dartmouth, N.S.

Scott, W. B., and M.G. Scott. 1988. **Atlantic Fishes of Canada.** Canadian Bulletin of Fisheries and Aquatic Sciences 219.

Silk, P., G.C. Lonergan, T.L. Arsenault and C.D. Boyle. 1998. **Evidence of Natural Organochlorine Formation in Peat Bogs.** Chemosphere (35): 2865-2880.

Statistics Canada. 1994. **Human Activity and the Environment 1994.** Ottawa: Statistics Canada and Ministry of Industry, Science and Technology.

St-Jean, S.D., S.C. Courtenay and E. Pelletier. 1997. "Organotin Monitoring in the Southern Gulf of St. Lawrence". In: R.C. Pierce and D. Williams, eds. **Book of Abstracts: Department of Fisheries and Oceans Green Plan Toxic Chemicals Program Wrap-up Conference, Government Conference Centre, Ottawa, January 28-31, 1997.** Ottawa: Canadian Technical Report of Fisheries and Aquatic Sciences.

St-Jean, S.D., S.C. Courtenay, E. Pelletier and R. St. Louis. 1998. **Butyltin Concentrations in Sediments and Blue Mussels (*Mytilus edulis*) of the Southern Gulf of St. Lawrence, Canada.** Marine Pollution Bulletin.

Thompson, G.R. 1988. **The Role of Vegetated Buffers in Reducing Agricultural Impacts on Prince Edward Island Surface Waters, A Review, 1998.** Prepared for Canada-Prince Edward Island Water Annex Agreement Technical Report of Environmental Science No. 6.

Wessels, C.R., C.J. Miller and P.M. Brook. 1995. **Toxic Algae Contamination and Demand for Shellfish: A Case Study of Demand for Mussels in Montreal.** Marine Resource Economics. (10): 143-159.

Whitford J., and Associates Limited in Association with P. Lane Associates Limited. 1990. **Water Supply and Wastewater Treatment for Industrial Development in Prince Edward Island, 1990.** Project No. 5520, Report to the P.E.I. Department of Industry, Atlantic Canada Opportunities Agency and Public Works Canada.

White L., and F. Johns. 1997. **Marine Environmental Assessment of the Estuary and Gulf of St. Lawrence.** Dartmouth and Mont-Joli: Fisheries and Oceans Canada: Bedford Institute of Oceanography and Fisheries and Oceans Canada: Maurice Lamontagne Institute.

Additional References

Burkholder, J.M. 1998. **Implications of Harmful Microalgae and Heterotrophic Dinoflagellates in Management of Sustainable Marine Fisheries.** Ecological Applications. 8(1) Supplement. pp. s37-s62.

Colbourn, T., D. Dumanoski and J. Peterson Myers. 1996. **Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival: A Scientific Detective Story**. Penguin Books Ltd. England.

APPENDIX 1. TERMINOLOGY

Contaminants

Sewage

The largest point source of sewage is the discharge of municipal waste water from either waste water treatment plants, storm water sewers or combined sewers. In some areas of Canada, industrial waste water is co-discharged with municipal waste water. Effluents from municipal areas can be complex mixtures, their composition depending upon inputs. Inputs can include metals, oil and grease, persistent organic pollutants, nutrients, viral and bacterial pathogens, plastics, floatables, solids, and suspended and dissolved substances that exert a biological oxygen demand. Non-point sources of sewage include animal wastes (manure) from agricultural lands and leakage from septic systems along the coast or entering freshwater systems discharging to marine waters. Non-point sources generally carry nutrients and viral and bacterial pathogens.

Pathogens from either point or non-point sources result in human health problems through exposure via bathing waters or through ingestion of contaminated shellfish. The closure or restricted use of shellfish growing areas has likewise cost millions of dollars in lost fisheries and has contributed to unemployment, declines in tourism, restriction of aquaculture activity, lost amenities and higher prices to consumers (Government of Canada, 1996).

Possible disruption of the reproductive characteristics of fish and shellfish through endocrine disruption is also a recent concern around sewage outfalls. These impacts are generally local in nature with some transboundary implications.

Persistent Organic Pollutants

Persistent Organic Pollutants (POPs) are characterized as toxic, persistent in the environment (slow to be metabolized by organisms into inert or innocuous substances). They also bioaccumulate. They are generally synthetic organochlorine compounds and other organic compounds which are manufactured for use as pesticides or other uses (e.g., HCH, HCB, DDT). They are formed as unintended by-products (e.g., dioxins and furans), or derived from incomplete combustion either naturally or by human activities (e.g., PAHs). Other POPs are toxic metabolites of a parent compound (e.g., DDE and DDD from DDT).

POPs are characterized by low water solubility, high fat solubility and frequently by high volatility. They are generally transported in water by being attached to organic particles (sediments) or in the fat of organisms. In the atmosphere, they can be transported long distances as volatile gases or bound to dust particles. Anthropogenic emissions, both point and diffuse, are associated with industrial processes, pesticide or product use and applications, waste disposal, leaks and spills, and combustion of fuels and waste materials. The primary transport routes into the marine and coastal environment include long-range transportation via the atmosphere or oceans, surface runoff, and point source discharges.

Radionuclides

This category refers to radioactive substances (i.e., materials containing radionuclides) which enter the marine or coastal environment directly or indirectly, as a result of human activities. These activities include production of energy, reprocessing of spent fuel, military operations, nuclear testing, medical applications and other operations associated with the management and disposal of radioactive wastes and the

processing of natural materials by industrial processes. Other activities, such as the transport of radioactive material, pose risks of such releases.

Heavy Metals

Many metals are essential to life (e.g., copper, zinc, iron, chromium) but are toxic in excess amounts. Other metals, such as cadmium or mercury, are biologically non-essential and are toxic at relatively low concentrations. Organic metals such as organotin also are toxic in small amounts. Metals and their compounds, both inorganic and organic, are released to the environment as a result of a variety of human activities. However, metals also enter the environment through the natural weathering of rock. The main anthropogenic sources of metals are various industrial point sources, including present and former mining activities, foundries, smelters and incinerators; and diffuse sources such as erosion of piping, constituents of products, and combustion by-products, etc. Relatively volatile metals and those that become attached to airborne particles can be widely dispersed. Metals conveyed in aqueous and sedimentary transport (e.g., river runoff) enter the normal coastal biogeochemical cycle and are largely retained in the sediments of nearshore and shelf regions.

Oils/Hydrocarbons

Most oils from land-based sources are refined petroleum products or their derivatives. They enter the environment through operational and accidental discharges and emissions from oil exploration, exploitation, refining and storage facilities; urban and industrial runoff; vehicular use; and the inappropriate disposal of used lubricating oils. The main pathways to the marine environment include atmospheric dispersion of volatile fractions; storm sewers and sewage treatment works; and rivers.

Some oils are volatile or easily degraded and disappear rapidly from aquatic systems, but others may persist in the water column or in sediments.

Nutrients

Nutrients are chemical elements, or simple compounds formed from these elements (e.g., nitrogen or phosphorus compounds which are needed by plants for growth and reproduction). Nutrients are available to plants from the air, soil and water, and are both naturally present and added by human activity. In general, eutrophication, caused by the presence of excessive nutrients, is usually confined to the vicinity of coastal discharges. Sources of excessive nutrients may be sewage, surface runoff from agricultural lands, and various industrial processes, especially waste products from food manufacturing plants or aquaculture operations.

Contaminated Sediments

Metals and POPs of toxic concern can be found in dissolved form or attached to particulate matter. Chemicals with low water solubility are primarily found absorbed to particles. Whether chemicals enter the marine environment in dissolved or particulate form, they eventually become part of the bottom sediments or incorporated into biological organisms. Sediments are commonly viewed as sinks for contaminants where they accumulate over time. Once chemicals are in sediments they are generally less available to organisms or for transport to other areas unless disturbed and resuspended. However, benthic organisms can be subject to contamination and can be a major pathway for contaminants in sediments to enter food chains.

Sources for contaminated sediments are those activities outlined for sewage, POPs and heavy metals. Dredging may cause resuspension of contaminated sediments and improper disposal of contaminated dredge spoils will increase contaminant

exposure. Effects are generally local in nature, but transboundary impacts may occur in some areas where littoral currents carry sediments across international boundaries. The impacts of contaminated sediments are similar to those described for POPs, heavy metals and oil.

Litter

Litter or marine debris is any persistent manufactured or processed solid material which is discarded, disposed of, or abandoned in the marine and coastal environment. Sources include poorly managed or illegal waste dumps adjacent to rivers and coastal areas, windblown litter from coastal communities, resin pellets used as industrial feedstocks, and litter that is channelled to the marine and coastal environment through municipal storm water systems and rivers. Marine litter is also caused by dumping of garbage into the marine and coastal environment by coastal communities as well as by recreational and commercial vessels.

Litter threatens marine life through entanglement, suffocation and ingestion and degrades the visual amenities of marine and coastal areas with negative effects on tourism and general aesthetics. Litter in the marine environment can also damage coastal habitats, foul fishing and aquaculture gear, and create navigational hazards.

Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

This includes urban development, ports, harbour works, erosion control, wharves, breakwaters, etc. In general, this category is meant to capture those alterations which stabilize coastal features largely for the purpose of human development. Protective measures intended to harden shorelines against natural erosive forces are included, since they are often required to protect human amenities which were placed in vulnerable locations.

Loss and/or degradation of shoreline habitat generally results from a widespread and cumulative process involving many small-scale activities which, considered in isolation, do not appear to have a significant impact on the marine environment. The net consequence of these activities taken over many years, however, has been a growing and irreversible loss of fish and wildlife habitat, loss of primary productivity, alteration of sedimentation regimes, and loss of potential economic opportunities. Large-scale alterations of shoreline habitat, while infrequent, have massive impacts when they occur.

Inter-tidal and Sub-tidal Alteration

This includes some aquaculture/fisheries structures and habitat-altering activities such as ice breaking, log holding, etc. Only onshore structures or those attached to the shore and used in fisheries or aquaculture activities are included in this category. Other forms of devices used offshore in fisheries and aquaculture are not included.

Siting of, and physical effects related to, fixed fishing gear and certain types of land-fast aquaculture devices and facilities may cause loss or degradation of critical habitats, including areas required for migration, spawning and nurseries for some native fish and shellfish species. Breakup of land-fast ice to permit marine transportation in the Arctic can impact on subsistence hunting, on the safety of human transportation over sea ice and on migratory, particularly breeding, populations of marine mammal species. Harvesting of marine plants from the inter-tidal and sub-tidal zone can be considered a habitat-altering activity if loss of this vegetation constitutes significant alteration of habitat for other species, or threatens biodiversity, or survival of the marine plants themselves. Log holding and transport on the West Coast causes loss of habitat in the

holding areas but also results in degradation of benthic habitat due to the accumulation of bark.

Mineral and Sediment Extraction/Alteration

This category includes harbour and channel dredging within nearshore waters, sediment disposal, sand and gravel extraction, coastal mining, etc. It is similar to shoreline construction and alteration in that the activity can be habitat-altering with similar impacts. Sea disposal of dredge spoils taken from shoreline facilities is not considered a land-based activity, though the dredging activity itself is included.

Dredging can affect the stability of the seabed and cause siltation problems, particularly in shallow areas. Once disturbed, bottom sediments may be resuspended into the water column by waves and currents. Short-term effects include a decrease in phytoplankton production, increased egg and larval mortality, impaired feeding and respiration of adult fish, and the smothering of benthic organisms. Dredging and sediment extraction may also result in long-term negative effects including increased erosion and permanent alteration of seabed topography, which may permanently destroy critical habitat areas such as spawning grounds.

Wetland and Saltmarsh Alteration

This includes dyking, drainage, some forms of waterfowl habitat development, vegetation removal/harvesting, etc. Substantial alteration of coastal wetlands and marshes, mainly for agricultural or industrial development purposes, has resulted in significant and irreversible losses of these highly productive marine habitats. Wetlands provide vital habitat and play an essential role in the life cycle of many species because of the water cover and associated vegetation they provide. They serve as spawning grounds and nurseries for fish and as nesting grounds, staging areas and migration stop-overs for birds. Many populations that are normally widely dispersed concentrate in these areas during critical stages of their life cycle. Some forms of habitat alteration are also undertaken for beneficial reasons (e.g., creation of migratory waterfowl habitats); however, these activities may not always result in benefits to all marine habitats and ecosystems.

Marine Waters and Coastal Watershed Alteration

This includes damming, water intakes (marine and freshwater), thermal pollution, diversion, extraction, etc. The category also includes extractive use of water for industrial purposes, which may occasionally harm free-swimming species through entrapment or entrainment. Barriers to migration (physical, thermal, salinity) may also be included in this category.

Damming and alteration of marine waters and coastal watersheds can alter the salinity, temperature and, in some instances, the nutrient and sediment loads of marine waters and coastal watersheds. These changes can directly affect native species and alter habitat conditions.

Natural sedimentation and siltation are important in the development and maintenance of numerous coastal habitats. Habitats requiring sediment input include coastal wetlands, lagoons and estuaries. Reduction in natural rates of sedimentation can compromise the integrity of these habitats, as can excessive sediment loads, which may bury benthic communities and threaten sensitive habitats such as nursery areas, seagrass beds and rocky substrates through either direct impact or reduced light levels.

Biological Alteration

This category includes accidental or deliberate introduction of genetic materials and/or alien species, including pathogens, parasites and toxic algae, etc. (see Sewage, above). A potential source of alteration of

both genetic and species diversity in coastal ecosystems and of disease for both marine species and humans who consume them, this category takes a number of forms. There is a close association with the aquaculture industry, though for the purposes of the NPA, one must distinguish between aquaculture facilities that fit the description of a land-based activity (e.g., hatcheries, cages adjacent or fixed to shore) as opposed to those that are really marine facilities (e.g., salmon "ranching" net pens, offshore cages). Another problem relates to transfer of species in ballast water. This is generally excluded here because it does not, for the most part, fall within the definition of land-based activity, the exception being incidents where ballast water exchange occurs in a port or harbour facility.

The introduction of more tolerant and competitive exotic species has directly affected native species, thereby reducing biodiversity and the functioning of marine and coastal ecosystems. Similarly, reductions in genetic diversity, whether through the use of genetic engineering or the introduction of non-native species, has resulted in increased species vulnerability to environmental change, both natural and anthropogenic. These biological changes together have tended to reduce the overall resilience, complexity, and diversity of marine ecosystems, placing them at greater risk.

Literature Cited

Government of Canada. 1996. **The State of Canada's Environment 1996.** Ottawa: Public Works and Government Services.

Arctic Council. September 1998. **Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities.**

APPENDIX 2. LIST OF ACRONYMS

ACAP — Atlantic Coastal Action Programme

AEPS — Arctic Environmental Protection Strategy

AMAP — Arctic Monitoring and Assessment Programme

APEC — Asia-Pacific Economic Co-operation

AREET — Arctic Regional Environmental Emergencies Team

ARET — Accelerated Reduction and Elimination of Toxics

ATV — All-Terrain Vehicles

BOD — Biological Oxygen Demand

CAFF — Conservation of Arctic Flora and Fauna

CEAA — Canadian Environmental Assessment Agency

CEAA — Canadian Environmental Assessment Act

CEC — Commission on Environmental Co-operation

CEPA — Canadian Environmental Protection Act

CSD — Commission on Sustainable Development

DDE — p,p'- 2, 2-Bis (4-chlorophenyl) - 1, 1-dichloroethylene

DDT — p,p'- 1, 1-Bis (4-chlorophenyl) - 2, 2, 2- trichloroethylene

DEW — Distant Early Warning

DFO — Department of Fisheries and Oceans

DIAND — Department of Indian Affairs and Northern Development

DNA — Deoxyribonucleic Acid

DND — Department of National Defence

EEM — Environmental Effects Monitoring (Programme)

EIA — Environmental Impact Assessment

EMAN — Ecological Monitoring and Assessment Network

EPPR — (Arctic Council Working Group on) Emergency Prevention, Preparedness and Reponse

GBEI — Georgia Basin Ecosystem Initiative

GERLED — Programme de Gestion et de Réhabilitation des Lieux d'Élimination des Déchets dangereux [hazardous waste disposal site management and rehabilitation program]

GNWT — Government of the Northwest Territories

GPA — Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities

GPAC — Global Programme of Action Coalition

HAB — Harmful Algal Blooms

ICZM — Integrated Coastal Zone Management

IMO — International Maritime Organization

LRTAP — Long-Range Transboundary Air Pollution

MACA — Municipal and Community Affairs

MPA — Marine Protected Area

NAAEC — North American Agreement on Environmental Co-operation

NAFTA — North American Free Trade Agreement

NARAP — North American Regional Action Plans

NCP — Northern Contaminants Program

NEI — Northern Ecosystems Initiative

NGO — Non-Government Organization

NPA — National Programme of Action

ODA — Official Development Assistance

PADEM — Programme d'assainissement des eaux municipales [municipal water treatment program]

PAIA — Programme d'aide à l'investissement en agroenvironnement [agri-environment investment support programme]

PAERLES — Plan d'action pour l'évaluation et la réhabilitation des lieux d'enfouissement sanitaire [sanitary landfill site evaluation and rehabilitation action plan]

PAEQ — Programme d'assainissement des eaux du Québec [Quebec water treatment program]

PAH — Polycyclic Aromatic Hydrocarbon

PAME — Protection of the Arctic Marine Environment

PARE — Plans d'action et de réhabilitation écologique [ecological rehabilitation action plans]

PCB — Polychlorinated Biphenyl

POP — Persistent Organic Pollutant

PRRI — Programme de réduction des rejets industriels [industrial discharges reduction program]

RPA —Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities

SLAP — St. Lawrence Action Plan

SDS — Sustainable Development Strategy

SDU — Sustainable Development and Utilization

SOP — Strategic Options Process

TBT — Tributyltin

UN — United Nations

UN-ECE LRTAP Convention — United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution

UNEP — United Nations Environment Programme

YTG — Yukon Territorial Government

ZIP — Zone d'intervention prioritaire [Priority Intervention Zone programme]

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