TECHNICAL GUIDE FOR
GREAT LAKES - ST. LAWRENCE RIVER SHORELINES

PART 8

ENVIRONMENTALLY SOUND HAZARD MANAGEMENT

WITHIN THE HAZARDOUS LANDS

ENVIRONMENTALLY SOUND HAZARD MANAGEMENT WITHIN THE HAZARDOUS LANDS

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8.1 INTRODUCTION

Increasing pressure to develop along shorelines susceptible to *flooding, erosion and dynamic beach hazards* has resulted in detrimental impacts to the shore and aquatic ecosystem. Effective shoreline management requires that implementing agencies manage not only the *natural hazards* (i.e., *flooding, erosion and dynamic beach hazards*) but that there also be a recognition and understanding of the potential impacts of any such actions on the shoreline environment or ecosystem and the mandates and objectives of other resource management programs (e.g., fisheries, wetlands, wildlife).

The purpose of **Part 8: Environmentally Sound Hazard Management Within the Hazardous Lands** is to provide direction in considering the shoreline environment. Through understanding the function and susceptibility of various shoreline ecosystems to disturbance, the potential impacts that may occur as a result of proposed development or remedial works can be identified, and methods of reducing these impacts through design changes or mitigation measures can be implemented.

Environmentally sound refers to those principles, methods and procedures involved in addressing the protection, management and enhancement of the shoreline ecosystem which are used in disciplines such as geology, geomorphology, botany and zoology. These methods and procedures are applied in the study of shoreline processes, vegetation, wildlife, and aquatic habitat resource management.

Within Part 8, the shoreline manager will be introduced to the various methods associated with undertaking hazard management in an environmentally sound manner when considering development proposals within the *hazardous lands.* Specifically:

- **Section 8.2** provides the policy direction related to the **recognition of environmental impacts** and the need to **ensure that developments are undertaken in an environmentally sound manner.**
- **Section 8.3** outlines the **importance of habitat and interdependencies within the shoreline ecosystem**; describes the **physical and biological components of the shoreline** relative to their ecosystem function, **significance and susceptibility to disturbance from protection works**; focuses on terrestrial habitats, wetlands, and aquatic habitats.
- **Section 8.4** outlines the **potential biological impacts that may be expected from shoreline protection works** in terms of their **spatial impacts and temporal impacts**, as well as other contributing factors such as an area's ability to recover from disturbance.
- **Section 8.5** outlines provincial and federal **legislation** in Ontario/Canada, and U.S. federal and state legislation, governing the management of terrestrial habitat, wetlands, and aquatic habitat as well as some of the primary programs and policies on both sides of the *Great Lakes and St. Lawrence River System* which may affect works in the shoreline area.
- **Section 8.6** provides a listing of **references** and/or source materials.
- **Section 8.7** provides a **glossary of terms** to be used for the purposes of this Technical Guide.
- **Appendix A8.1** provides a list of the habitat of endangered species.

8.2 PROVINCIAL POLICY AND PROVINCIAL NATURAL HAZARDS MANAGEMENT PROGRAM

The direction and intent of Policy 3.1: Public Health and Safety: Natural Hazards *(Provincial Policy Statement*, 1996) for the *Great Lakes - St. Lawrence River System* is to ensure that shoreline environments and related resource management values and programs are given due regard in any decision-making process.

Where *development* and *site alteration* may be considered within the least hazardous portions of the “area of provincial interest”, as defined by the *hazardous lands*, Policy 3.1.3 confirms the standards and requirements which must all be fulfilled. One of the five standards and requirements is that:

"no adverse environmental effects will result" (Policy 3.1.3(c))

To assist in clarifying and ensuring that “no adverse environmental effects will result”, specifically that due regard and recognition is given to environmental concerns and impacts in any decision-making process dealing with the shorelines of the *Great Lakes - St. Lawrence River System*, **Part 8: Environmentally Sound Hazard Management within the Hazardous Lands** provides the information and direction necessary to assist shoreline managers in achieving this goal.

The management principles to be followed are:

- recognition of the connection between all life within the natural world, including humans;
- preservation of biodiversity;
- integrated resource management;
- prevention of negative environmental impacts in new resource situations; and
- "precautionary principles" in resource use, due to incomplete understanding of ecosystem function.

The objective is to ensure the long-term health of ecosystems by protecting and conserving soil, aquatic, forest and wildlife resources as well as their biological foundations.

8.3 ENVIRONMENTAL RECEPTORS AND SENSITIVITIES

8.3.1 The Shoreline Ecosystem

The environmentally sound management of shorelines requires an understanding not only of the changes to physical processes that result from protection works, as described in **Part 7: Addressing the Hazards** of this Technical Guide, but also of the effects of these physical processes on the shoreline ecosystem. The significance and susceptibility of the relationships in this ecosystem to changes resulting from protection works are the focus of this section.

For the purpose of this Technical Guide, an **effect** is a change to the existing environment, and may be positive or negative. An **impact** describes a detrimental change to the environment.

The biological environment is best described in the context of the **shoreline ecosystem**. **An ecosystem is a dynamic network of living organisms interacting with each other and with their environments**. The shoreline ecosystem can be described as the ecological unit comprised of terrestrial and aquatic organisms and their physical environment which are inseparably inter-related and interact with each other because of the land/water interface (illustrated in Figure 8.1). This land/water interface is in a state of constant change through the movement, removal and deposition of materials by the action of water. The complexity of the physical characteristics of the shorelines provides a diversity of habitat types for plant and animal species.

For practical reasons, in this document, ecosystems are considered as areas with relative homogeneity which may be described and characterized efficiently. The environmentally sound management of the shoreline ecosystem requires both the recognition of these ecosystem units as well as their functions and interactions including condition, shape, diversity, size, configuration and connectivity in the landscape.

The environmentally sound management of shorelines also needs to ensure adequate provision of habitat for viable populations of a diversity of species in areas which are large enough to accommodate natural disturbances.

Habitat is the combination of **living and non-living things** which provide a particular species with the resources it needs to complete its life cycle. These may include soil, water, air, rocks, rain, heat and the other plants and animals which provide the food needed for survival. The existence of a diversity of habitats is essential to accommodate the needs of many species and to ensure the continued diversity of wildlife.

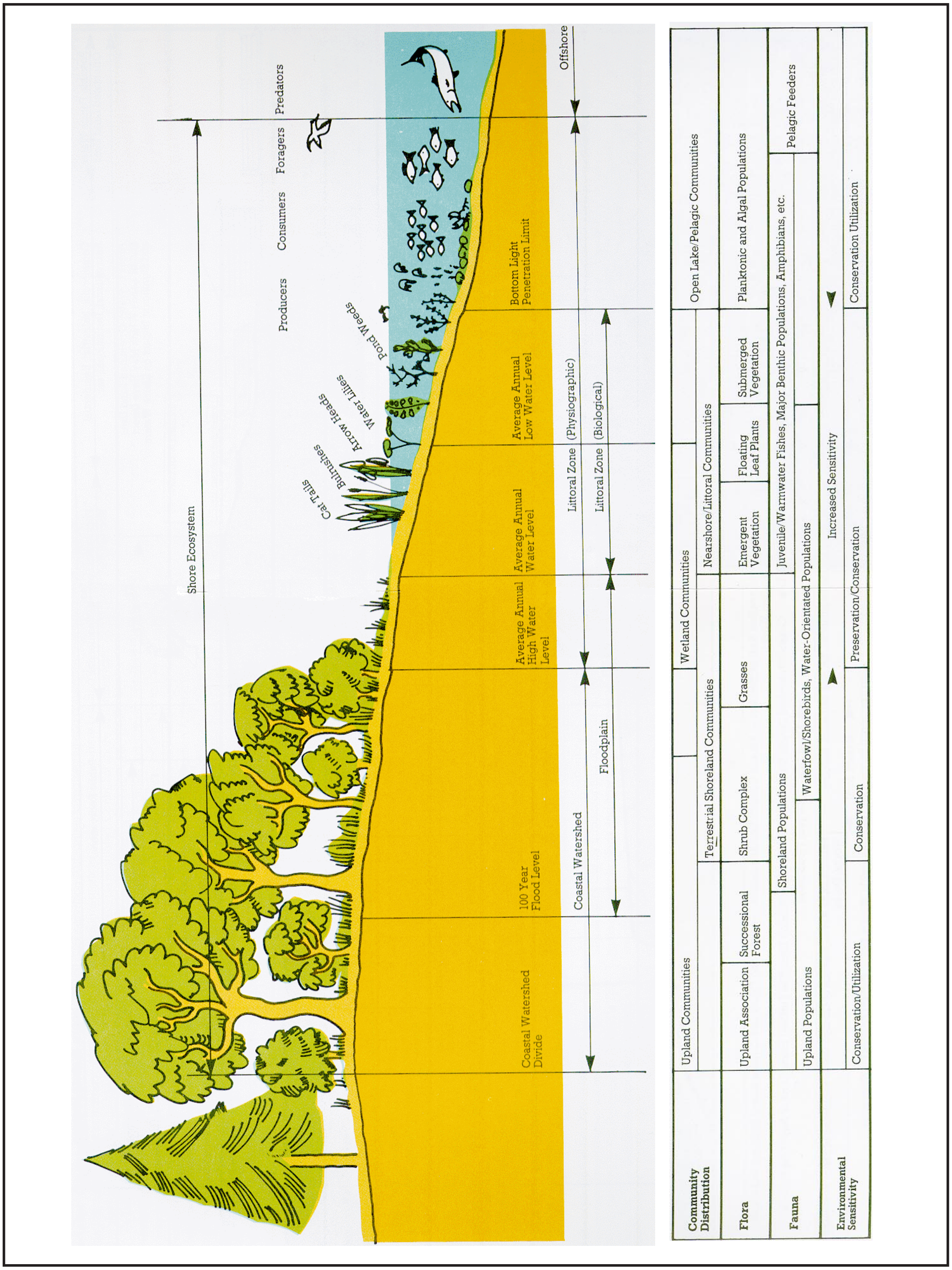
The area of provincial interest for shorelines of the *Great Lakes - St. Lawrence River System* extends lakeward from the furthest landward limit of the *hazardous lands*. The lakeward extent of the shoreline ecosystem is considered to be the limit of significant effect of physical processes, generally to a **water depth of 5 to 8 m**. In some cases, the shoreline ecosystem that may be impacted by protection works extending beyond these boundaries. The range of effects of physical processes and the resultant biological impacts which extend further offshore must be taken into consideration.

The shoreline ecosystem can be considered in terms of the terrestrial, aquatic and wetland ecological units and the communities they support.

As shown in Figure 8.1, the spatial distribution of these communities overlap. For example, the area between the average low water and the high water level may support terrestrial shoreline, wetland or littoral (aquatic) communities. For the purposes of this Technical Guide, **three general classifications** will be used:

- **Terrestrial Habitat** includes the plant and animal habitat of predominantly terrestrial species in the upland or backshore areas of the shoreline. Terrestrial communities range from shoreland communities such as herpetofauna found in beach/dune areas to the upland communities which use the shoreline as a migration corridor.

Figure 8.1: Selected Characteristics of a Shore Ecosystem



- **Wetlands** — as defined in the Policy 2.1 governing wetlands (i.e., *Provincial Policy Statement*, 1996), wetlands are defined as those "lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or near the surface. In either case, the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plants".

- **Aquatic Habitat** — the *Federal Fisheries Act* (Sec. 34.C1) defines fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes". This includes communities in the nearshore or littoral zones which are the shallow areas close to shore, river mouths, and embayments as well as communities in the open lake.

These three general classifications are described in more detail below. For each group, the function and significance are discussed and its susceptibility to disturbance is described. The function and significance of a ecological unit includes the interrelationships between it and other components of the ecosystem, its general importance, in terms of its economic or social value, or its intrinsic value such as providing habitat to endangered species.

The susceptibility of a ecological unit describes the response of that particular area to stress or changes being placed upon it. Areas that can withstand this stress, or can adapt or recover quickly have a low susceptibility to disturbance. Stress or change to the shoreline ecosystem can be caused by natural processes (i.e., large storm) or by human actions such as protection works. The focus of this section is on susceptibility to disturbance resulting from protection works.

As described in **Part 7: Addressing the Hazards**, **protection works can be categorized into three groups**, each having a different potential to impact on the shoreline ecosystem. These are:

- **prevention**
- **protection (non-structural)**, and
- **protection (structural).**

Prevention techniques, such as the siting of buildings landward of the shoreline *natural hazard* limits (i.e., *flooding, erosion* and *dynamic beach hazards)*, property acquisition, and **non-structural protection works**, such as relocation and floodproofing, do not require alteration to the nearshore and backshore environments. The environmental impacts and potential for long- term disturbance to sensitive habitats from these measures are considered to be negligible.

Other non-structural protection works, such as bluff measures and dune enhancement, require some alteration of the onshore and backshore. These measures may add new stressors to susceptible habitats but often provide an opportunity to enhance environmental conditions if done properly (e.g., stabilization of dune vegetation).

Structural protection works may occupy the onshore (e.g., filling and dyking), backshore (e.g., revetments and seawalls) and nearshore (e.g., beach nourishment, groynes, headlands and detached breakwaters). Structured protection works have the potential to cause environmental impacts depending on the susceptibility of the biological communities and their associated habitats to disturbance.

8.3.2 Characteristics of the Shoreline Ecosystem: Function, Significance and Susceptibility to Disturbance

a) Terrestrial Habitats

Terrestrial habitat includes the plant and animal habitat of predominantly terrestrial species. These include communities that are not necessarily water-oriented but may inhabit the upland or backshore area.

i) Function and Significance

Terrestrial habitats play an important role in the shoreline ecosystem. Key roles of shoreline vegetation include:

- providing shelter and protection for a variety of wildlife species;
- providing linkages along the shoreline for the movement of wildlife;
- stabilizing slopes as shallow rooted grasses hold soil particles in place while deeper roots of woody vegetation prevent slippage of soil layers;
- slowing wind velocity and trapping wind blown sediments; and
- helping to prevent erosion by removing water from bluff areas through uptake and transpiration and absorbing the energy of falling rain.

Wildlife that use shoreline areas are a renewable resource that provide many benefits and socio-economic advantages to Canadians. For example, visitors who are drawn to Point Pelee every spring to observe migrating songbirds contribute an estimated 10 million dollars to the local economy. Other activities such as hunting also provide economic benefits. It is vitally important to treat habitats on which various wildlife depend as a precious resource and to manage those habitats in such a way that future generations will receive the full benefits in perpetuity.

Intensive agriculture, urban development and extensive shoreline development have resulted in the elimination and fragmentation of wildlife habitats. This often results in a replacement of the former habitat with less complex and less stable ecosystems, characterized by reduced biodiversity. Pre-disturbance species are replaced by the opportunistic species which adapt to the altered environment. Fragmentation also results in the disruption to movement corridors or linkages along the shoreline.

The *Great Lakes - St. Lawrence River System* shoreline supports many different types of terrestrial habitats. For example, wooded bluffs provide shelter and corridors for wildlife movement but on unprotected beaches, the conditions may be hostile to many wildlife species. The beach/dune environment provides habitat for a variety of plants and wildlife. They often contain plant species such as marram grass and sea rocket which are not found in other locations in the province. Birds such as semipalmated piper and whimbrel use beach systems during migration. They are also used for breeding by kingfisher, bank swallow, piping plover, killdeer, and spotted sandpiper. Turtles, snakes and other herpetofauna use sandy beaches and dunes for laying eggs.

The beach dune is also a feeding area for birds, mammals, and herpetofauna. Many shorebirds and gulls use the beach zone for feeding, utilizing material carried on shore by waves as well as invertebrates. Nests of birds and herptiles provide food for other birds and mammals.

ii) Susceptibility to Disturbance

Terrestrial habitats are most susceptible to disturbance from protection works (i.e., structures) which change the topography of the backshore or which result in the removal of vegetation.

An important characteristic of the shoreline for mammals such as raccoons, deer, and skunk is the availability of drinking water. Therefore these areas are sensitive to any changes that may affect the safe access of animals to the water's edge. This may include changes to the topography or slope that restricts access, or the clearing of vegetation which removes the protective vegetative cover. The clearing of vegetation may also increase the susceptibility of the backshore to erosion and may disrupt wildlife movement corridors along the shoreline.

Beach dunes are susceptible to a number of stresses. The beach wave zone receives nutrient and energy inputs from the body of water. The presence of washed up vegetation, fish and other organisms results in significant local nutrient inputs to the beach zone for plant growth and for many scavengers. Beach cleaning and sweeping results in the removal of this material.

Turtles, snakes and other herpetofauna utilize the shallow water, beach and backshore areas of the shoreline. These creatures serve an important role in providing food for both higher and lower levels of the food chain. Tadpoles, turtle hatchlings, frogs and toads are a very important food source for many species of marsh birds, fish and riverine animals. Many herpetofauna begin the decomposition phase by feeding on carrion and plants that other animals have left. Herpetofauna habitat includes driftwood, debris, quiet backshore lagoons, vegetation and rock crevices which provide necessary cover and protection. The removal of this material, particularly the removal of shoreline vegetation and dredging of soil, reduces not only the food sources available to herpetofauna but also places stress on other organisms.

b) Wetlands

Wetlands, which interface between aquatic and terrestrial environments, are defined as areas where the water table is at, near or above the land surface long enough each year to support the formation of hydric soils and the growth of hydrophytes, as long as other environmental variables are favourable.

Shoreline wetlands provide an important source of Great Lakes fish and wildlife habitats and are the most productive and diverse component of the *Great Lakes - St. Lawrence River System* shoreline ecosystem. *Great Lakes - St. Lawrence River System* shoreline wetlands are highly productive and are often more significant, in terms of ecological functions performed and resources produced, than inland wetlands. Shoreline wetlands types include:

- **Open Shoreline Wetlands** usually exist as a hydrophytic vegetation fringe adjacent to the shore. The fringe generally tends to expand inland or lakeward in response to lake effects such as wave action. The dominant vegetation is usually emergent, however submergent vegetation may also be present, although not necessarily bordering on the shoreline.
- **Unrestricted Bays** are characterized by a marshy fringe along a bay shoreline, having natural protection from such lake effects as wave action. Depending on its size and depth, the whole bay could be vegetated. Submergents can be a part of those vegetative communities. This wetland type also includes typical open shoreline areas that are sheltered by an island or peninsula.
- **Shallow Sloping Beach Wetlands** are typically areas with very gentle to almost flat slopes on sand substrates. Very small variations in lake levels have widespread effects on vegetation zones. Sand bars, if present, provide some wave protection.

i) Function and Significance

Wetlands serve many important **functions** within the ecosystem. These functions, which may be described as the biological, physical and socio-economic interactions that occur in an environment as a direct result of the properties of the wetland, include:

- **groundwater recharge and discharge;**
- **flood and/or erosion damage reduction;**
- **shoreline stabilization;**
- **sediment trapping;**
- **nutrient retention and removal;**
- **food chain support;**

- **habitat for fish and wildlife;**
- **corridors for wildlife movement**; and
- **social and economic benefits.**

Along the shorelines of the *Great Lakes - St. Lawrence River System*, wetlands can act as a buffer between open water and uplands. The dense root systems and stems of wetland vegetation break up wave energy and stabilize the shoreline as well as trap silt and organic materials carried in overland runoff.

Wetlands help to purify water by converting nitrates and phosphates into protein and other nutrients and putting oxygen back into the water. Recent research indicates that plants growing in wetlands may act as a sink for heavy metal contaminants such as mercury, lead, zinc and copper by trapping them in their roots and removing them from certain foodchains, but not from the foodchains of herbivores (i.e., some waterfowl and fish).

Wetlands are important to the productivity of the entire ecosystem. They provide essential habitat for a wide variety of plants and animals. Many forms of wildlife depend on wetland habitats for resting, breeding and feeding. For example, one of the most important habitat requirements for waterfowl is access to shallow waters that contain extensive beds of submerged aquatic vegetation and that produce high numbers of small aquatic invertebrates. This provides a high-quality diet for egg-laying females and actively growing young. Wetlands with a high proportion of edge between emergent vegetation and water (such as found in the shoreline in quiet bays and inundated backshore areas) provide particularly good waterfowl habitat. These areas are highly sensitive to disturbance from the removal of aquatic vegetation, prolonged fluctuations in water level and shifts in substrate material that may cover benthic invertebrates.

Waterfowl also depend on wetlands for feeding and resting areas during their spring and fall migration. Some of the best staging locations for waterfowl in eastern Canada are located in marshes adjacent to the southern Great Lakes. In particular, the marshes of Long Point, Lake St. Clair and the Detroit River are the most used by waterfowl during spring and fall migrations and contain valuable habitat. The marshes of Prince Edward County, the Grand River, Rondeau Bay and Point Pelee vicinity are of secondary importance but are valuable habitat areas (Dennis et al. 1984).

Reptiles and amphibians return to wetland areas to breed. The invertebrates that form the food of birds and fish also rely on water for most if not all phases of their existence and are most numerous in wetland areas. Many other plants and animals live in areas adjacent to wetlands and are directly dependent on them for survival.

Wetlands serve **three major kinds of functions for fish communities**. They provide:

- **breeding grounds,**
- **nursery grounds,** and
- **act as a source of food and provide cover from predators**, especially for young fish.

Most species of freshwater fish are dependent on wetlands for one or more of these functions.

Wetlands provide essential habitat for a wide variety of endangered species. Some of the threatened and endangered species, nest in marshy areas of lakes and feed on small wetland-dependent fish species.

Wetlands provide valuable renewable resources of fur, wild rice, fish, bait, cranberries and game. They are rich in plant and animal life and are ideal for scientific studies and educational purposes.

Great Lakes, St. Lawrence River and Connecting Channels Wetland Communities

Lake Superior

The Ontario shoreline consists predominantly of low, resistant rock outcrops. Wetlands are located in large sheltered embayments on the northwest and southwest shores.

Lake Huron

Small wetland areas are scattered along the shoreline, particularly in Georgian Bay and in connecting channels such as the St. Mary's River and the St. Clair River. Embayment of shoreline wetlands occur in Sturgeon, Matchedoch and Black Bass Bays.

St. Clair River/Lake St. Clair

Emergent aquatic vegetation frequently occurs along the St. Clair River, with broad marshes on the islands of the St. Clair River delta and the north and east shores of Lake St. Clair.

Detroit River

Wetlands along the Detroit River and extreme western Lake Erie and adjacent open water areas provide fall and spring staging areas for thousands of migrating waterfowl.

Lake Erie

Extensive wetlands exist at creek mouths and behind sand spits. Large wetlands occur around Point Pelee, Rondeau Bay, Long Point and Dunnville.

Niagara River

Wetlands are not common, but where they occur, they provide important habitat for fish and wildlife.

Lake Ontario

Wetlands are scattered along most of the shoreline, particularly in the eastern part of the lake.

St. Lawrence River

Wetlands are scattered along the shore, with larger wetland areas found in shallow or sheltered embayments.

iii) Susceptibility to Disturbance

Human impacts on wetlands vary depending on the scope, intensity and duration of the impact. The most serious type of impact results in the total displacement or removal of the wetland (e.g., infilling or draining). This results in the loss of the wetland functions in that area and may have indirect effects, such as increased flooding on adjacent areas.

The destruction of large wetland areas creates isolated patches of wetlands. The greater the distance between these patches, the fewer number of bird species that are attracted to each wetland area.

Wetlands are also sensitive to fluctuations in water levels. In most shoreline wetlands, cyclic changes or fluctuations in water levels are required to stimulate plant regeneration, promote diversity of plant growth, and encourage the release of nutrient material from organic debris through oxidation. When water levels are controlled for an extended period of time (about seven years), the productivity of the wetland declines.

Some species utilizing wetlands are highly sensitive to disturbance. For example, many birds require undisturbed habitat during the nesting season (May to June).

c) Aquatic Habitats

The topography and physical processes in the *Great Lakes - St. Lawrence River System* give rise to a variety of nearshore and offshore substrates which in turn provide habitats for small aquatic organisms, fish and wildlife. For example, erosion over time on a bedrock cliff may cause chunks of rock to break off and fall into the shallow nearshore area. The flood prone beach low plain, on the other hand, frequently provides conditions suitable for growth of submerged and emergent aquatic vegetation. Sediments that have accumulated over time in shallow protected embayments often provide excellent conditions for wetlands which in turn provide significant habitats for fish and wildlife.

Fish have evolved to carry out their life processes (i.e., reproduction, feeding, rearing of young) in specific habitats. Smallmouth bass, for example, lay their eggs in exposed rock/cobble areas and guard them until they hatch. Pike, however, leave their eggs among vegetation in sheltered areas where they remain hidden until they hatch.

Many fish species found in the *Great Lakes - St. Lawrence River System* are near the northern limit of their range and as a result have very specific habitat requirements. Therefore, knowledge of the aquatic habitat or bottom substrate type along a piece of shoreline can be used with some certainty to predict its importance to the fish community of the lake.

Fish habitats adjacent to areas along the shorelines of the *Great Lakes - St. Lawrence River System* which have undergone development (e.g., urban, recreational, resource extraction) have been subject to numerous stresses in the last century. Loss of significant habitat for certain species has resulted in severe declines of those species (e.g., Atlantic Salmon). Of particular note is the destruction of shoreline wetland areas, many of which have been dredged or filled to create hard shorelines to support residential development, marinas and ports and farmland.

The federal *Fisheries Act* provides for the protection of fish habitat from harmful alteration, disruption or destruction. A framework for habitat protection is provided in the Policy for the Management of Fish Habitat (DFO 1986). The long-term policy objective is the achievement of an overall net gain of the productive capacity of fish habitats. This objective can be met through fish habitat conservation, restoration and development. Fundamental to the conservation goal is the guiding principle of "no net loss". When a fishery resource and its supporting habitat are put at risk by a proposed undertaking, a hierarchy of preferences will be used to achieve no net loss. The first preference is the maintenance of habitat without disruption and may be achieved through the redesign or relocation of the project or use of suitable mitigation measures. If this is not possible or practical, compensation measures will be required including like-for-like compensation, or replacement of habitat off-site. The least preferred method of compensation is artificial production to supplement the fishery resource.

In Ontario, MNR is responsible for administering and enforcing the *Fisheries Act* and implementing the Policy for the Management of Fish Habitat (DFO 1986). Approval must be obtained by DFO for any project that may result in the harmful alteration, disruption or destruction of habitat.

i) Function and Significance

The importance of aquatic habitats in the shorelines of lakes and rivers for fish spawning, feeding and rearing activities has long been acknowledged. The littoral zone, that area where light reaches the bottom enabling photosynthesis in algae and aquatic plants to occur, is particularly important. Plants and substrates such as cobble and boulders add structure and diversity to the aquatic habitat by providing attachment surfaces for the small aquatic organisms upon which fish feed (e.g., insect larvae, snails and other aquatic invertebrates). They also provide protective cover for small fish species and young-of-the-year, enabling them to hide from predators.

Aquatic habitats in the nearshore/offshore areas of the *Great Lakes - St. Lawrence River System* can be broadly classified based on the surficial nearshore substrate. The surficial substrate is the material found in the top layer of the lake bottom. In some cases the surficial substrate will be the same as the underlying controlling substrate as discussed in Part 2. In other areas, the surficial substrate has been deposited by shoreline processes acting along the shoreline reach and are not the same as the underlying or controlling substrate. A surficial substrate such as sand overlying a controlling substrate such as a cohesive material is an example.

The five categories of surficial nearshore substrate are as follows:

- **bedrock** This surficial substrate is generally flat and hard and provides habitat for few species.

- **cobble/boulder** This surficial substrate consists of large rocks on a hard surface and provides significant spawning and nursery habitat for many species (e.g., salmonoid species such as lake trout). Larger aquatic invertebrates such as crayfish and dragonfly nymphs favour this habitat and provide a food supply for predators such as rock bass and smallmouth bass.

- **sand/gravel** This surficial substrate consists of small particles which provide good spawning, feeding and nursery habitat for a variety of fish species and bottom-dwelling organisms upon which they feed. Where physical conditions are suitable, aquatic plants may grow in these areas and provide rich and diverse habitats for a wide range of aquatic organisms.

- **fine-grained cohesive** This surficial substrate is a hard packed fine-grained material with a significant proportion of clay and silt material as well as sand and gravel.

- **silt/organic** This surficial substrate is generally found in sheltered or deeper areas where sediments are allowed to settle; where physical conditions are suitable, aquatic plants may become established and increase the productivity and diversity of these areas for aquatic organisms.

Typical characteristics for each of these habitats are shown in Figures 8.2 to 8.7.

Aquatic habitats can also be discussed in terms of exposure to wave action. Open shore areas are unsheltered and are exposed to extensive wave action, resulting in a relatively hostile environment for aquatic organisms. These habitats occur to some degree throughout the *Great Lakes - St. Lawrence River System* and generally provide living space for the same fish species throughout all lakes. There are, however, some differences in the resident fish communities of these lakes which are influenced by the physical characteristics of the lakes themselves (e.g., shoreline configuration, depth, shoreline processes, chemical and temperature regime, etc.). These areas are also susceptible to hypolimnetic upwellings, which result in cold subsurface water introduced to the warmer nearshore area. These upwellings may affect the survival rate of warmwater species inhabiting the nearshore area.

Figure 8.2: Exposed Bedrock (Above Water)

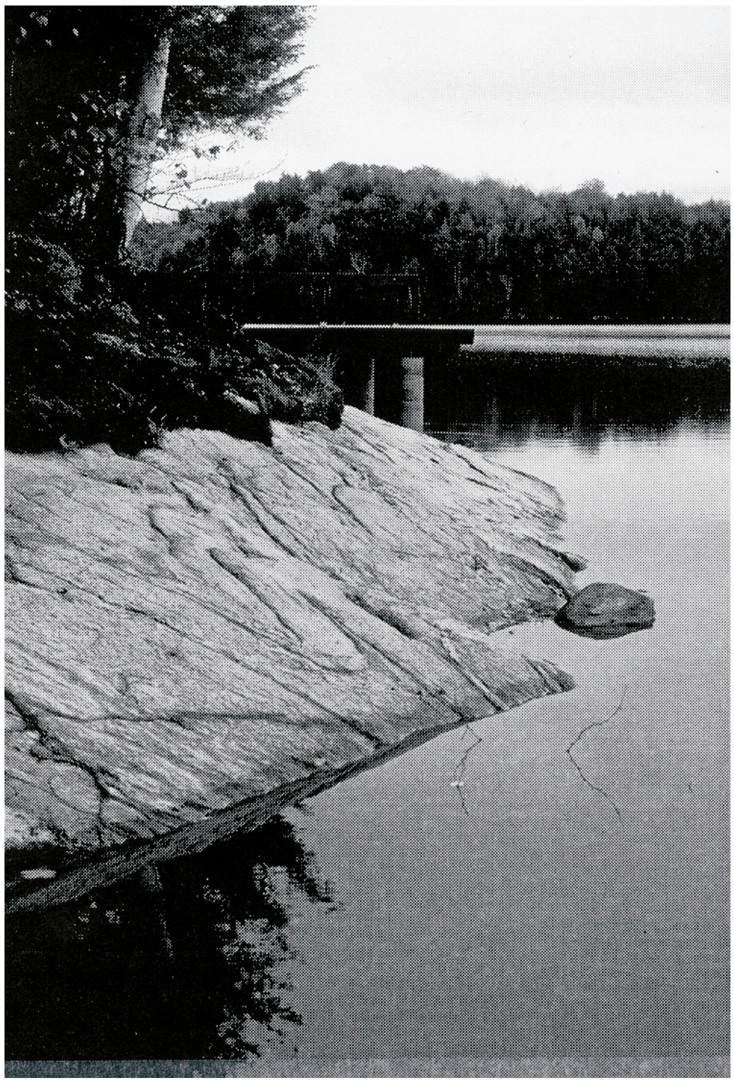


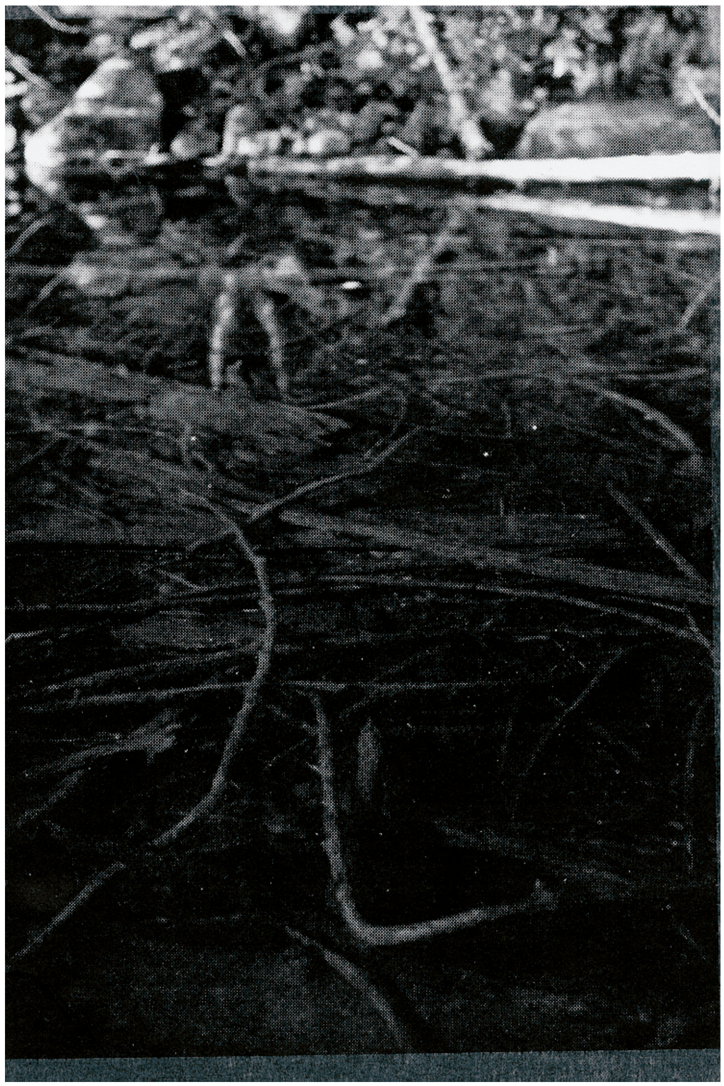
Figure 8.3: Exposed Bedrock (Below Water)

Figure 8.4: Cobble Boulder

Figure 8.5: Sand/Gravel

Figure 8.6: Silt/Organic (Above Water)

Figure 8.7: Silt/Organic (Below Water)



Open shore areas generally support a coolwater and coldwater fish community. Some of these species are migratory and may utilize reefs and shoals for natural reproduction (i.e., lake trout, lake whitefish, lake herring). Prey species, including alewife and smelt, also occupy these areas seasonally, particularly during spawning runs. The action of waves on the shoreline also provides oxygen to the shallow nearshore area.

Other areas of the shoreline such as river mouths, estuaries and embayments are sheltered from the open shore effects. The deposition of fine materials in these areas often allows the establishment of aquatic vegetation. Warmwater fish communities typically utilize these refuse areas. Warmwater fish may also utilize nearshore zones as linkage corridors when migrating between warmwater production areas.

ii) Fish Communities of the Great Lakes - St. Lawrence River System

The indented shorelines and numerous islands and bays throughout the *Great Lakes - St. Lawrence River System* give rise to a variety of habitats that support significant warmwater, coolwater and coldwater fish populations.

Lake Superior

Lake Superior is the deepest of the lakes and generally has the best water quality. It supports organisms typical of cold, oligotrophic lakes in various shoreline habitats, including exposed bedrock, cobble/boulder, sand/gravel and limited amounts of silt/organic.

The coldwater fish community in the first half of this century was dominated by lake herring and lake trout. However, these diminished in number in later years due to increased competition from Coregonids and rainbow smelt, sea lamprey and over exploitation by humans. Efforts to rebuild the original fish community have had some success in recent years due to increases in the herring population and through sea lamprey control programs.

St. Mary's River

The St. Mary's River contains a diversity of habitat types including open-water, wetlands, sand/gravel and rapids. Coldwater species such as rainbow trout, brown trout, brook trout, and lake trout are predominantly found in the rapid areas.

Lake Huron

Lake Huron has the second largest surface area (after Lake Superior) of the Great Lakes. It consists of three basins: the shallow eastern basin of Georgian Bay, the northern main lake basin and the southern basin. Bottom substrates in the nearshore areas contain sand deposits while the offshore areas are largely clay.

The deep water areas of the lake contain coldwater species such as lake trout, whitefish, lake herring and ciscos. Warmwater species such as pike, smallmouth bass, perch and sunfish are common in the shallow water habitats of Georgian Bay and along other parts of the shoreline where the nearshore conditions are suitable.

St. Clair River/Lake St. Clair

Historically, coldwater species such as lake trout, lake herring and lake white fish were major seasonal components of the St. Clair River community. Today, this community is dominated by coolwater fish (e.g., northern pike, muskellunge, walleye) and a variety of warmwater species. Major components of the warmwater fish community include: suckers, catfish, bass, sunfish and members of the drum family. All typically inhabit shallow warmwater habitats and are bottom feeders. Favoured food organisms include insect nymphs and larvae, molluscs, worms and other small invertebrate species.

A number of introduced species have also been recorded in the St. Clair River, the most abundant being alewife, rainbow smelt, coho and chinook salmon, rainbow trout, carp and white perch. Many of these are seasonal inhabitants and spend part of their year in the adjoining Great Lakes.

Detroit River

The Detroit River supports a warmwater fish community including largemouth bass, walleye, as well as migrating salmonids such as rainbow trout, pink and coho salmon and brown trout. The river has sparse riverine marshes and large areas of sand habitat.

Lake Erie

Lake Erie is the shallowest of the lakes and is divided into three basins. The western basin is the shallowest and has bottom substrates consisting of silt and organics with occasional reef areas of rock/cobble. The bottom of the large central portion is mostly clay, while that of the deeper eastern basin is most sand and silty clay.

The fish community of Lake Erie today is largely warmwater and is dominated by yellow perch, rainbow smelt, walleye and white bass. Historically, however, lake trout and lake herring occurred and it appears that recent attempts to renew these species may be successful. Many of the shoreline habitats along the Lake Erie shoreline which are extremely important for warmwater species have been altered over time by erosion, as a result of human activities causing excessive siltation and agricultural drainage problems, and through various land use activities (e.g., urban, industrial, recreational).

Niagara River

The Niagara River supports a diversity of fish species including rainbow trout, chinook salmon, coho salmon, smallmouth bass as well as bait fish such as the emerald shiner. At the mouth of the Niagara River and within the littoral zone of Lake Ontario, there is an abundant warmwater fish community. The Lake Ontario Fisheries Unit also has an active fish stocking program in the area. Chinook, coho and atlantic salmon, lake trout, Washington steelhead and skamannia steelhead were stocked in the lower Niagara River in 1991 (MNR 1991).

Lake Ontario

Lake Ontario is the smallest of the Great Lakes by area. The deeper eastern basin substrates consist of muds and clays although there are a variety of shoreline habitats around the many islands and inundations at the east end of the lake and in the mouth of the St. Lawrence River. The western basin is gently sloping and where natural (i.e., non-urban or agricultural) contains rich habitats and many small wetland areas.

Fish communities have changed dramatically over the years due to stresses such as over-exploitation by humans, sea lamprey predation, pollution and habitat loss. Warmwater species such as bullhead, walleye, white perch, smallmouth and largemouth bass, and pike are common along the shallow shoreline areas while lake trout and various salmon species inhabit the deeper waters.

St. Lawrence River

The St. Lawrence River fish community is similar to that of eastern Lake Ontario. Shallow water habitats in the river are varied, ranging from marshy shoreline areas to rocky shoals and indentations around the numerous islands occurring in the river. Shallow shoreline habitats have been altered in many areas as a result of development by man for cottage, residential, park and urban uses.

Important species include: walleye, white perch, smallmouth and largemouth bass and pike. All use littoral zone habitats during some stage of their life history, especially for spawning activities.

iii) Susceptibility to Disturbance

The susceptibility of each of the surficial substrate categories to disturbance is summarized on Table 8.1.

Open shoreline areas are susceptible to changes which affect the wave zone. The most important open shoreline habitats are usually rocky areas in deeper water that are kept clean of fine sediments by current and wave action. Where this is disturbed, the suitability of the substrate for spawning declines.

TABLE 8.1
Aquatic Habitat in the Great Lakes - St. Lawrence River System:
Susceptibility to Disturbance

Surficial Substrate	Susceptibility to Disturbance
Exposed Bedrock	• not sensitive to disturbance • in exposed, open shoreline areas the nearshore area may be utilized for spawning by alewife and whitefish • low productivity for aquatic organisms (e.g., fish and invertebrates) due to lack of habitat structure
Cobble/Boulder	• moderately susceptible to sedimentation and alteration from removal or disruption of rock/cobble substrate • provides spawning substrate for a variety of warmwater species (e.g., smallmouth bass) in all lakes, and coldwater species (e.g., lake trout) in all lakes except Erie • provides habitat structure and diversity for aquatic organisms
Sand/Gravel	• moderately susceptible due to potential for movement of substrate which can change habitat character and productivity • moderate productivity for aquatic plants and benthic organisms • provides habitat for a variety of warmwater fish species
Fine-Grained Cohesive	• not sensitive to disturbance • hard-packed surface has limited interspatial spaces for invertebrates • often exposed to wave activity • low productivity for aquatic organisms due to lack of habitat structure
Silt/Organic	• highly susceptible to removal of aquatic plants or disruption of currents and/or wave action • high productivity in areas where aquatic plants growth or organic litter occur • provides habitat for a very wide variety of warmwater fish species • wetlands may occur in these substrates if topography and other conditions are suitable • generally found in sheltered embayments and estuaries

8.4 BIOLOGICAL IMPACTS RELATED TO SHORELINE PROTECTION WORKS

The gradual encroachment of human developments has impaired the shoreline ecosystem in many areas. The impacts of expanding urban shoreline areas are cumulative and, as such, may be overlooked until it is too late to recover sufficient habitat for wildlife and nearshore fish and aquatic communities. It is essential that environmental concerns be considered as an integral part of managing the shoreline, and not as an isolated study component at a later stage in a project. If environmental concerns are to be satisfactorily dealt with, they must be considered at all stages of the land use planning process, from formulation of alternative strategies through to plan implementation.

8.4.1 Criteria to Evaluate Impacts on the Shoreline Ecosystem

The **impacts on the shoreline ecosystem** resulting from the installation of protection works can be considered according to a **number of criteria** including:

- **importance;**
- **spatial extent;**
- **duration of impacts;**
- **recovery;**
- **mitigation**; and
- **cumulative effects.**

a) Importance

This criterion addresses the **significance or the value attached to the potentially affected area as a result of such things as its location, uniqueness or importance for wildlife.**

There are many areas along the shorelines of the *Great Lakes - St. Lawrence River System* that are identified as having high value or significance due to the special functions or habitat they provide. Examples include endangered species habitat, spawning areas, Areas of Natural or Scientific Interest (ANSI), Provincially and locally significant wetlands and Environmentally Significant Areas (ESA). Any activity that has the potential to impact on these areas requires attention.

Possible data sources include:

- ESA Reports
- ANSI Reports
- Official Plan Documents
- Wetland Inventories

b) Spatial Extent

The environmental impacts associated with shoreline structures can occur in the **immediate site vicinity** as well as further **updrift and/or downdrift of the activity site**.

Impacts in the immediate vicinity of the work can result from both large-scale activities (e.g., construction of a large breakwater at a harbour entrance) and small scale activities (e.g., clearing of vegetation for a revetment).

Typical **on-site environmental impacts** of protection works include:

- placement of fill material which covers aquatic plants and bottom substrates resulting in disturbance to various aquatic habitate and food supplies;

- change to topography and nearshore substrate upon which fish species may spawn (e.g., cobbles);

- alteration of water levels in periodically flooded areas which may restrict spawning areas and waterfowl habitat;

- removal or clearing of shoreline vegetation which provides shade, bank stabilization, and habitat for wildlife; and

- removal of material from the nearshore such as boulders, cobble, and stumps can affect habitates and feeding grounds by reducing the potential of food organisms.

Typical **effects to updrift and downdrift areas** result from physical processes such as:

- release of sediments into the water column; and

- changes in sediment supply and alongshore sediment transport.

The release of sediments into the water column may cover essential spawning habitat, restrict light penetration, reduce the visibility for fish species, reduce submergent vegetation growth and may result in increased egg mortality. Persistent turbidity may also impair feeding efficiency of filter feeders such as mussels and clams and in the long-term effect the growth and survival of resident fish species.

There are numerous potential impacts on the biological community resulting from changes in sediment transport. For example, existing sand bars and shallow water areas protect the shoreline from significant wave and ice action and provide quiet, protected areas for the establishment of aquatic vegetation, benthic invertebrate habitat and nursery areas for fish. The removal of this protective material may result in the loss of this habitat.

The increased deposition of fine material carried in alongshore transport also influences the downdrift areas. Aquatic macrophytes that provide fish habitat may be covered. Due to the continued addition of material, new aquatic growth may be restricted. The mouths of small streams that serve as fish migration routes may be filled in making passage by fish difficult.

Other effects on updrift and downdrift areas include disruption to the nesting habitat of bird species which may be sensitive to noise and disturbances in the surrounding area.

c) Duration of Impact

This criterion addresses the **length of time associated with the activity and its possible impact**. Impact can be described as being of either short-term or long-term duration. Protection works generally have a defined design life, and as such it is perhaps more useful to discuss temporal aspects of the potential impact on the environment based on the life phase of the structure under consideration.

There are **three key phases**:

- **construction-related activities;**
- **operation and function of the structure during its design life**; and
- **post design life.**

Short-term impacts are generally associated with construction activities and may often be avoided through project design or construction practices. For example, during construction it is often necessary to build access roads to the shoreline. These may require the clearing of vegetation thus increasing the potential for erosion. These areas may be restored/rehabilitated to their original condition after construction so during the design life phase, these impacts no longer occur. The construction phase often involves the highest level of disruption to the site vicinity compared to the other phases. Noise, dust, trampling of vegetation, and increased sedimentation are all examples of short-term construction-related impacts. The disturbances to local wildlife, waterfowl and fish can be avoided or minimized by planning activities around critical nesting and spawning periods.

Long-term impacts are generally related to the project design and occur during/following construction. For example, the direct loss of a fish spawning bed by the placement of a groyne would be considered a long-term impact. During the life of a properly constructed and designed structure which is not situated in a sensitive or critical area, the most prevalent type of impact will be associated with indirect effects in the updrift and downdrift areas, such as changes to alongshore transport. There is potential to incorporate mitigation measures to the design of a structure to significantly reduce impacts.

During the **post-design life phase**, the structure is no longer functioning properly. Impacts during this stage may be more difficult to predict and will likely occur on-site, as well as updrift and downdrift.

d) Recovery

The susceptibility of habitat and its ability to recover following a stress placed on it must be considered. For example, the re-establishment of a small area of shoreline vegetation when a construction access road is no longer required, may be quick and require little input. Other impacts, such as the alteration of drainage patterns to a wetland may be irreversible.

e) Mitigation

Standard practices may be available to **alleviate or reduce impacts** of an activity. Mitigation measures can be employed during the construction phase and in the design of protection works to reduce impacts on the environment. The net environmental impact or residual impact of a structure is therefore lessened.

Mitigation may include changes to the project design, rescheduling of construction activities to avoid critical periods (i.e., nesting, spawning or migration), or the use of well established methods of reducing or controlling impacts. It is important to differentiate those impacts which can be controlled through mitigation and those for which it is not possible. For example, the use of silt curtains during construction may be quite effective to reduce sedimentation in the site vicinity. The loss of spawning substrate by the direct placement of a breakwater may be more difficult, or even impossible to mitigate. Mitigation measures should favour the use of soft-engineering approaches wherever possible. Soft-engineering approaches combine elements of the natural system with structural methods.

When standard mitigation measures will not substantially reduce impacts (i.e., a loss of habitat occurs), compensation for displaced habitat may be required. This may involve the replacement of similar habitat on-site or in a suitable location off-site. Compensation plans for any destruction or alteration of fish habitat must be approved by the Department of Fisheries and Oceans (DFO).

In order to provide a truly integrated, innovative and effective design, one should consider the following design principles, where appropriate:

- enhance, rehabilitate or create aquatic, terrestrial or wetland habitat;
- use a diverse landform (i.e., undulate the landform to provide a variety of slopes, exposures, elevations, orientations and aspects; and
- diversity of substrate types (in combination with varying bathymetry encourages a variety of aquatic vegetation communities).

f) Cumulative Effects

The impact from the proposed activity may be minimal, however, the addition of this new impact on an already stressed ecosystem from a previous activity may cause serious degradation.

8.4.2 Definition of Major and Minor Environmental Impacts

Potential impacts can be categorized as either major or minor, based on the importance of the ecosystem affected, the spatial extent of the impact, the recovery rate of the ecosystem, the potential for mitigation and the consideration of cumulative effects. For the purpose of this Technical Guide, the definitions of major and minor are as follows:

- **Minor impacts** are those which can be mitigated, that is, the proposed structure/activity will cause impacts which can be mitigated through changes in design and/or timing of activity. Confining impacts to what is considered a minor (as opposed to a major) level is contingent upon having an impact of short duration, availability of mitigation practices, a high rate of recovery, and a low potential for spin-off effects.
- **Major impacts** occur when the structure/activity has significant long-term or permanent adverse impacts on the net productivity of the habitat on or off site. A **major impact** can occur when the impact is of long-term duration, the rate of recovery of the habitat is low, there is a high potential for spin-off or indirect effects and/or the area affected is considered to be critical habitat.

8.4.3 Potential Biological Impacts Resulting From Protection Works

The environmentally sound management of shorelines requires that the change to the physical processes associated with protection works be understood, but also that the impacts of these processes on the biological environment be considered. Specific physical impacts for various protection works were identified in **Part 7: Addressing the Hazards**, of this Technical Guide. In this section the potential biological impacts will be identified.

Readers of this Technical Guide must note that:

> ***The following discussion is general in nature and applies to most situations in the Great Lakes - St. Lawrence River System. It is intended to serve as a guide in identifying potential impacts and possible mitigation measures. The discussion is not exhaustive, and impacts which require specialized mitigation measures may occur in site-specific cases.***

The location of protection works (e.g., onshore, backshore, or nearshore) dictates to a large degree the biological community or habitat which may be potentially affected. For example, structures which occupy the onshore have a greater probability of directly affecting terrestrial habitat than the fish and aquatic habitat in the area. However, the indirect impacts of protection works located on the onshore on aquatic habitat must also be considered. For example, fish and aquatic habitats and wetland areas may be affected by the disruption of surface and groundwater drainage, or an increase in erosion and sedimentation resulting from onshore works. The physical impacts associated with shoreline management approaches located in onshore, backshore and nearshore areas, and the potential habitats affected (e.g., terrestrial, aquatic and wetland) are summarized on Table 8.2.

Table 8.3 provides a summary of the typical physical and biological impacts of structural protection works and mitigation measures. Additional discussion of the potential biological impacts associated with the various physical impacts is provided in the subsections 8.4.3(a) to 8.4.3(c).

Table 8.2: Potential Habitat Areas Affected by Alterations to the Physical Shoreline Processes and Characteristics

General Physical Shoreline Processes and Characteristics	Potential Influences (A._) of Shoreline Management Approaches on Physical Shoreline Processes and Characteristics	Potential Resulting Impacts (B._) on Physical Shoreline Processes and Characteristics	Shoreline Management Approaches													
			Prevention		Non-structural Protection				Structural Protection (plus stable slope & flood/erosion allowances)							
			Onshore		Onshore				Onshore		Backshore		Nearshore			
			HA	PA	Re	FP	BM	DE	FI	D	fR/S	rR/S	BN†	G	AH	DB‡
Supply and Transport of Littoral Materials (Erosion & Deposition Patterns)	**A.1** Decreases supply of sediments to the littoral zone	**B.1** Increased long-term erosional stress to downdrift shorelines									A	A		A	A	A
	A.2 Increases supply of sediments to the littoral zone	**B.2** Decreased long-term erosional stress to downdrift shorelines											A			
	A.3 Impedes alongshore transport of littoral material	**B.3** Accretion updrift and/or in lee of structure											A	A	A	A
		B.4 Increased erosion of downdrift shorelines until bypassing occurs												A	A	A
	A.4 Diverts littoral sediments from close to shore to deeper water	**B.5** Increased erosion immediately downdrift												A	A	A
	A.5 Reduces cross-shore transport of littoral material	**B.6** Less change of beach and nearshore profile during storms													TA	TA
	A.6 Increases wave reflection from shoreline and increases localized currents	**B.7** Localized erosion (scour) along toe of and at alongshore ends of protection work									A	A		A	A	A
Water Circulation	**A.7** Increases sheltering of nearshore waters	**B.8** Decreased nearshore wave action													A	A
		B.9 Decreased mass water exchange/ circulation of nearshore waters													A	A
Backshore & Nearshore Topography	**A.8** Occupies backshore area	**B.10** Altered backshore topography at site (changes terrain and materials)									T	T	T	T		
	A.9 Reduces wave action at backshore	**B.10** Altered backshore topography at site (profile becomes more stable)									T	T	T	T	T	T
	A.10 Occupies nearshore area	**B.11** Altered nearshore topography (changes bathymetry and materials)									A	A	A	A	A	A
Onshore Topography	**A.11** Occupies onshore area	**B.12** Altered onshore topography (changes terrain and materials)					T	T	TW	TW						
	A.12 Stabilizes toe of cliff/bluff/bank	**B.12** Altered onshore topography (with stable toe, crest retreats, as slope flattens to stable condition - often graded during construction)					T	T			T	T	T	T	T	T
Surface & Groundwater Patterns	**A.13** Disrupts surface and/or groundwater drainage from land to lake/channel (depends on structure and setting of site)	**B.13** Altered surface/groundwater drainage pattern in onshore/backshore area					T		TWA	TWA	TA	TA				

LEGEND:
- **T** - terrestrial habitat
- **A** - aquatic habitat
- **W** - wetland
- HA - hazard allowances for flooding and erosion
- PA - property acquisition
- Re - relocation
- FP - floodproofing
- BM - bluff measures
- DE - dune enhancement
- FI - filling
- D - dyking
- fR/S - flexible revetments/ seawalls
- rR/S - rigid revetments/seawalls
- BN - beach nourishment
  - † typically extends across backshore and into nearshore
- G - groynes
- AH - artificial headlands (typically with beach fill)
- DB - detached breakwater
  - ‡ can also be located in shallow offshore

NOTES:

Refer to **Table 7.1**, Part 7, for initial evaluation of shoreline management approaches.

Refer to **Table 7.2**, Part 7, to assess the potential influences and impacts of shoreline management approaches on the physical shoreline processes and characteristics.

Refer to **Table 7.3**, Part 7, to assess the relative significance of the potential impacts with respect to increasing updrift/downdrift flood, erosion and dynamic beach hazards.

Refer to **Tables 8.3 and 8.4**, Part 8, to assess the biological impacts related to shoreline management practices.

Tables to be read in conjunction with accompanying Technical Guide text.

Table 8.3
Summary of Typical Physical and Biological Impacts of Structural Protection Works and Mitigation Measures

Types of Onshore Structural Protection Works

- filling
- dyking

Physical Impacts	Biological Impacts	Mitigation
B.12 • Altered onshore topography (changes terrain and materials)	• Displaces natural terrain and relief.	• None available beyond reducing area filled/dyked.
	• May require the removal of natural vegetation which provides food and cover for terrestrial species.	• Revegetate area with compatible, native species
	• Increased soil erosion due to the removal of existing vegetation.	• Stabilize area with grass cover or appropriate native vegetative species. Revegetate area with compatible native species after construction.
	• Trees adjacent to the construction site may be affected by the severing of roots or the suffocation of roots in the area due to a change in grade.	• Construct or excavate outside the dripline of tree roots or move specimen trees prior to construction. Replant or replace trees after construction completed.
	• May limit access for wildlife from upland areas to the water's edge.	• Incorporate access into design where possible (e.g., flatter slopes).
	• May disturb shore vegetation and wildlife corridors along shoreline.	• Minimize area of vegetation removed. Revegetate area.
	• May disturb the nesting activities of shorebirds, waterfowl and herpetofauna.	• Timing of construction should avoid nesting periods.
	• Increased soil compaction and erosion due to grading and construction of access road.	• Standard sedimentation and erosion control measures (e.g., silt fences, sand bags, straw bales, check dams) should be used during construction. Stabilize route with a grass cover or appropriate native vegetative species and regrade to natural contours where possible after construction in order minimize erosion and disruption of the cleared area.
	• May result in the loss of frequently flooded areas which are often important fish spawning and nursery areas for species such as Northern Pike, as well as waterfowl and herpetofauna habitat.	• Design modification may include filling/dyking a smaller area.
B.13 • Altered surface/groundwater drainage pattern in onshore/backshore area	• Change to groundwater seepage areas may be significant to the spawning habitats of certain fish species such as brook trout. This species may spawn in gravel shallows of lakes if there is a spring upwelling and a moderate current.	• Determine presence of spawning activity prior to construction. • Determine contribution of groundwater to adjacent shoreline areas prior to construction. Provide for infiltration if necessary.
	• If the drainage channel is altered or realigned, fish habitat may be disrupted. This is especially important in drainage channels used for spawning.	• Maintain the existing flow and channel configuration of streams flowing into lakes. Control sediment entering drainage channels. Construction activities should avoid migration and spawning periods.
	• Disruption may influence the water retention and filtering capacity of adjacent wetland areas.	• In areas where surface drainage patterns have been degraded, opportunities for enhancement should be explored. In areas where a provincially significant wetland is adjacent to the site (within 120 m), investigations must be undertaken to determine the effects on wetland functions (see Natural Heritage Training Manual; PPS Policy 2.1).

Table 8.3 (continued)

Types of Backshore Structural Protection Works

- revetment
- seawall

Physical Impacts	Biological Impacts	Mitigation
B.1 • Increased long-term erosional stress to downdrift shorelines	• Changes to existing fish and aquatic habitats, such as removal of surficial sand/gravel/cobble that may be used for spawning	• Determine the presence of spawning activity in downdrift areas prior to construction. Replace lost spawning material (e.g., sand, gravel, cobble) where possible.
B.7 • Localized erosion (scour) along toe and at alongshore ends of protection works	• May increase turbidity and smothering of benthic invertebrates	• Increase porosity and roughness of the structure and flatten the slope to increase absorption of wave energy and reduce wave reflection.
	• Increases depth of water along shore edge	• Increase porosity and roughness of the structure, flatten slope to increase absorption of wave energy, and provide suitable scour protection
B.10 • Altered backshore topography at site	• Often requires the alteration of the natural terrain and relief, which may restrict the access of wildlife, amphibians and reptiles to the shoreline	• Incorporate access in structure design (e.g., flatter slopes), revegetate with compatible native species and regrade to natural contours where possible to minimize disruption., revegetate with compatible, native species.
	• New construction materials may restrict access to the shore edge and along the shoreline	• Opportunities for shore access may be incorporated into the design of the structure
	• Construction activities may disturb the nesting and migration periods of waterfowl	• Timing of construction should avoid nesting and migration periods
	• Clearing of vegetation may reduce wildlife habitat, cause an increase in surface runoff and the amount of suspended sediment reaching the watercourses	• Natural vegetation should be preserved where possible or be replanted immediately after construction. • Use bio-engineering approaches where possible. • Removal of overhanging vegetation adjacent to the shoreline should be avoided where possible. • Employ best management practices during construction to minimize sedimentation.
	• Clearing or removal of vegetation in the backshore may result in the fragmentation of corridors along the shoreline. This may interfere with wildlife movements adjacent to the shoreline	• Minimize area of removed vegetation and revegetate cleared areas
B.11 • Altered nearshore topography (changes bathymetry and materials)	• Structures that extend into the nearshore may alter the shallow (active) wave zone used for spawning by fish species such as alewife and smelt.	• Minimize extent of structure into nearshore
	• For structures extending into the nearshore, construction usually involves introduction of new materials to the shore zone which may alter the nearshore habitat.	• Materials used should attempt to add internal spaces to the protection works. For example, stones and rocks provide structure and protective crevices; vertical walls with smooth, uniform surfaces provide no habitat value.
B.12 • Altered onshore topography (with stable toe, crest retreats, as slope flattens to stable condition - often graded during construction)	• Alters natural terrain and relief	• None available.
	• May require the removal of natural vegetation which provides food and cover for terrestrial species	• Revegetate area with compatible, native species.
	• Increased soil erosion due to the removal of existing vegetation	• Stabilize area with grass cover or appropriate native vegetative species. Revegetate area with compatible native species after construction.
	• Trees adjacent to the construction site may be affected by the severing of roots or the suffocation of roots in the area due to a change in slope	• Construct or excavate outside the dripline of tree roots or move specimen trees prior to construction. Replant or replace trees after construction completed.
	• May limit access for wildlife from upland areas to the water's edge	• Design structure to provide access where possible (e.g., flatter slopes), revegetate with compatible, native species. Regrade to natural contours where possible to minimize disruption.
	• May disturb shore vegetation and wildlife corridors along shoreline	• Minimize area of vegetation removed. Revegetate area.
	• May disturb the nesting activities of shorebirds, waterfowl and herpetofauna	• Timing of construction should avoid nesting periods.
	• Increased soil compaction and erosion due to grading and construction of access road	• Standard sedimentation and erosion control measures (e.g., silt fences, sand bags, straw bales, check dams) should be used during construction. Stabilize route with a grass cover or appropriate native vegetative species and regrade to natural contours after construction in order minimize erosion and disruption of the cleared area.

Table 8.3 (continued)

Types of Backshore Structural Protection Works

- revetment
- seawall

Physical Impacts	Biological Impacts	Mitigation
B.13 • Altered surface/groundwater drainage pattern in onshore/backshore area	• Change to groundwater seepage areas may be significant to the spawning habitats of certain fish species such as brook trout. This species may spawn in gravel shallows of lakes if there is a spring upwelling and a moderate current.	• Determine contribution of groundwater to adjacent shoreline areas prior to construction. Provide for infiltration if necessary.
	• If the drainage channel is altered or realigned, fish habitat may be disrupted. This is especially important in drainage channels used for spawning.	• Maintain the existing flow and channel configuration of streams flowing into lakes. Control sediment entering drainage channels. Construction activities should avoid migration and spawning.
	• May block access to frequently flooded areas which are often important fish spawning and nursery areas for species such as Northern Pike and herpetofauna habitat	• Design modifications may include protecting smaller area or using segmented (i.e., discontinuous) works.
	• Disruption may influence the water retention and filtering capacity of adjacent wetland areas.	• In areas where surface drainage patterns have been degraded, opportunities for enhancement should be explored. In areas where a provincially significant wetland is adjacent to the site (within 120 m), investigations must be undertaken to determine the effects on wetland functions (see Natural Heritage Training Manual; PPS Policy 2.1).

Table 8.3 (continued)

Types of Nearshore Structural Protection Works

- beach nourishment
- groynes
- artificial headlands
- detached breakwaters

Physical Impacts	Biological Impacts	Mitigation
B.1 • Increased long-term erosional stress to downdrift shorelines B.2 • Decreased long-term erosional stress to downdrift shorelines	• Changes to existing aquatic habitats, such as the removal of surficial sand/gravel and cobble that may be used for spawning	• Determine the presence of spawning activity in downdrift areas prior to construction and replace lost spawning material (e.g., gravel, cobble, boulders) where possible. • Provide anchor groynes to retain beach nourishment material
B.3 • Accretion updrift and/or in lee of structure	• May cover substrate (i.e., cobble) with finer sediments, thus disturbing fish spawning areas or smothering eggs	• The potential for fish spawning activity in the area updrift of site should be determined prior to construction. Increase spaces or gaps between structures to provide some "washing" of area. • Design protection works to minimize intrusion into the nearshore.
	• May result in alteration to the shallow active wave zone, used by some species of fish for spawning.	• Determine spawning activity prior to construction. Increase spaces or gaps between structures.
B.4 • Increased erosion of downdrift shorelines until by passing occurs B.5 • Increased erosion immediately downdrift	• Changes to existing aquatic habitats, such as the removal of surficial sand/gravel and cobble that may be used for spawning	• Determine the presence of spawning activity in downdrift areas prior to construction and replace lost spawning material (e.g., gravel, cobble, boulder) where possible.
	• Invertebrates that are carried in the current may be deflected to deeper water where survival rates may be reduced	• Impacts may be reduced by designing the structure to minimize intrusion into the nearshore and incorporating in the design suitable materials or spaces to provide for invertebrates.
B.6 • Less change of beach and nearshore profile during storms	• Dynamic beach profile will be more stable during storm events. This more protected environment may encourage benthic invertebrates to inhabit these areas and/or alter the dominant vegetation.	• Design modifications may include protecting smaller area or using segmented (i.e., discontinuous) works.
B.7 • Localized erosion (scour) along toe and at alongshore ends of protection works	• Increased sedimentation in the nearshore area during spawning periods may result in the covering of eggs.	• Construction should avoid spawning and incubation seasons and areas. • Modify design by providing scour protection, and by increasing the porosity of the structure, the roughness and flatness such that it absorbs wave energy.
	• May bury or limit productivity of benthic invertebrates.	• None. Benthic invertebrate communities will colonize an area following the stress.
B.8 • Decreased nearshore wave action B.9 • Decrease mass water exchange/circulation of nearshore waters	• Alters active wave zone used by some fish species for spawning.	• Determine spawning activity prior to construction. Maximize spaces or gaps between structures where possible.
	• May reduce wave activity and water circulation in the nearshore, which may reduce oxygen supply to the aquatic community in this area	• Placement of culverts or openings in the structure to allow some water circulation
	• Placement of structures offshore that create an embayment may influence temperatures in the nearshore and may moderate temperatures of other thermal layers.	• None.

Table 8.3 (continued)

Types of Nearshore Structural Protection Works

- beach nourishment
- groynes
- artificial headlands
- detached breakwaters

Physical Impacts	Biological Impacts	Mitigation
B.10 ● Altered backshore topography at site (changes terrain and materials)	● Often requires the alteration of the natural terrain and relief, which may restrict the access of wildlife, amphibians and reptiles to the shoreline	● Incorporate access in structure design (e.g., flatter slopes), revegetate with compatible native species and regrade to natural contours where possible to minimize disruption., revegetate with compatible, native species.
	● Construction activities may disturb the nesting and migration periods of waterfowl	● Timing of construction should avoid nesting and migration periods
	● Clearing of vegetation may reduce wildlife habitat, cause an increase in surface runoff and the amount of suspended sediment reaching the watercourses	● Natural vegetation should be preserved where possible or be replanted immediately after construction. ● Use bio-engineering approaches where possible. ● Removal of overhanging vegetation adjacent to the shoreline should be avoided where possible. ● Employ best management practices during construction to minimize sedimentation.
	● Clearing or removal of vegetation in the backshore may result in the fragmentation of corridors along the shoreline. This may interfere with wildlife movements adjacent to the shoreline	● Minimize area of removed vegetation and revegetate cleared areas
B.11 ● Altered nearshore topography (changes nearshore terrain and materials)	● Placement of structure in the nearshore will result in the direct covering of bottom substrate and a possible loss of fish habitat	● The potential for spawning activity on the existing substrate should be determined prior to the alteration of substrate material. If no mitigation is available on-site, there may be opportunities to enhance degraded spawning habitat in the site vicinity. ● Materials used should attempt to add internal spaces to the protection works (i.e., provide aquatic habitat). For example, stones and rocks provide structure and protective crevices; vertical walls with smooth, uniform surfaces provide no habitat value
	● Possible increase of suspended sediments during construction may irritate the gills of fish, place stress on filter feeders and smother benthic invertebrates	● Silt curtain should be used during construction to minimize area impacted by increased sedimentation
	● Removal of aquatic vegetation which provides food and shelter for aquatic organisms	● Plant aquatic vegetation in adjacent areas (This may not be possible due to the wave and current environment.)
B.12 ● Altered onshore topography (with stable toe, crest retreat, as slope flattens to stable condition - often graded during construction)	● Alters natural terrain and relief	● None available
	● Land-based construction access may require the removal of natural vegetation which provides food and cover for terrestrial species	● Revegetate area with compatible, native species
	● Increased soil erosion due to the removal of existing vegetation	● Revegetate area with compatible, native species
	● Trees adjacent to the construction site may be affected by the severing of roots or the suffocation of roots in the area due to change in grade.	● Construct or excavate outside the dripline of tree roots or move specimen trees prior to construction. Replant or replace trees after construction completed.
	● Construction access may disturb shore vegetation and wildlife corridors along shoreline	● Minimize area of vegetation removed. Revegetate area
	● May disturb the nesting activities of shorebirds, waterfowl and herpetofauna	● Timing of construction should avoid nesting periods
	● Increased soil compaction and erosion due to grading and construction of access road	● Standard sedimentation and erosion control measures (e.g., silt fences, sand bags, straw bales, check dams) should be used during construction. Stabilize route with a grass cover or appropriate native vegetative species and regrade to natural contours after construction in order minimize erosion and disruption of the cleared area.

a) Onshore Structural Protection Works

Onshore structural protection works include filling and dyking. Physical impacts associated with onshore works (see Tables 8.2 and 8.3) include:

- **Altered onshore topography (B.12)**, and/or
- **Altered surface/groundwater drainage pattern in the onshore/backshore area (B.13)**.

Potential impacts to the shoreline ecosystem are generally restricted to terrestrial habitat areas, however, aquatic and wetland habitats may be affected by alterations to drainage patterns. The impacts and possible mitigation measures are described below.

Altered onshore topography (B.12)

Protection works occupying the onshore displaces the natural terrain and relief and may require the removal of natural vegetation which provides food and cover for terrestrial species. The removal of existing vegetation may also result in increased localized soil erosion. Trees setback from the construction site may be impacted by the severing of roots or the suffocation of tree roots in the area by changing the grade. These potential impacts can be largely mitigated by constructing or excavating outside of the drip line of tree roots, moving specimen trees prior to construction and replanting with compatible native species.

Construction of dykes and filling may restrict access to the water's edge for small animals and herpetofauna. The provision of access should be incorporated where possible into the design of the structures. Construction may also disturb shore vegetation and wildlife corridors along the shoreline. Areas of vegetation removal should be minimized. The timing of construction should avoid nesting periods as it may disturb the nesting activities of shorebirds, waterfowl and herpetofauna.

Access routes in the onshore area, for construction of protection works or structures in the nearshore or backshore are often required. The land access route must be of suitable width and grade for the construction equipment necessary to build the works. Often the access route is left in place upon completion of the protection work for maintenance purposes. Impacts associated with the access route are of a short duration and may include soil compaction and increased erosion and sedimentation from cleared areas. Standard sedimentation and erosion control measures (e.g., silt fences, sand bags, straw bales, check dams) to trap sediments should be used during construction. Although the route may remain in place, the route should be stabilized with a grass cover, or appropriate native vegetative species and regraded to natural contours as much as possible after construction in order to minimize erosion and disruption of the cleared area.

Filling and dyking may result in the loss of frequently flooded areas which are often important to fish spawning and nursery areas for species such as northern pike, as well as waterfowl and herpetofauna habitat. Design mitigation includes filling and dyking a smaller area.

Altered surface/groundwater drainage pattern in the onshore/backshore area (B.13)

Impacts related to the placement of impermeable structures on the onshore or backshore include the potential to inhibit the lakeward movement of groundwater, and subsequent increase in the elevation of the water table. Changes to groundwater drainage are most important in poorly drained, low plain shorelines. Groundwater seepage areas may also be significant to the spawning habitats of certain fish species such as brook trout. This species may spawn in gravelly shallows of lakes if there is groundwater upwelling and a moderate current (Scott and Crossman 1973). The disruption to groundwater drainage will likely occur throughout the design life of the protection works. The presence of spawning activity in areas of groundwater seepage should be ascertained prior to construction. The potential for a major impact exists in spawning areas that require groundwater inputs.

Surface drainage patterns and surface flow rates may be modified by the placement of protection works in the onshore or backshore. The potential for major impacts is greatest in areas where the flow of a stream entering the lake may be altered or the channel realigned. Many species of fish use the small streams adjacent to the lakes as spawning areas (Scott & Crossman 1973). Alteration in flow, increased sedimentation and restrictions to migration may make these streams unsuitable for certain species. In addition, a change to drainage patterns may influence the water retention and filtering capacity of adjacent wetland areas. In areas where surface drainage patterns have been degraded, opportunity for enhancement exists and should be examined.

The alteration to drainage patterns are likely to persist throughout the design life of the protection works. The impacts are likely to be on-site. Mitigation practices include maintaining the existing flow and channel configuration of the streams flowing into the lakes, and controlling sediment from entering the stream adjacent to a protection work (i.e., swales, check dams). Construction activities should avoid migration and spawning periods. In areas where a provincially significant wetland is adjacent to the site (within 120 m), investigations must be undertaken to determine the effects of drainage alterations on the hydrological functions of the wetland (see Natural Heritage Training Manual; *Provincial Policy Statement*, Policy 2.1).

b) Backshore Structural Protection Works

Backshore structural protection works include revetments and seawalls. Physical impacts associated with backshore works (see Table 8.3) include:

- **increased long-term erosional stress to downdrift shorelines (B.1);**
- **localized erosion (scour) along toe of and at alongshore ends of protection works (B.7);**
- **altered backshore topography at site (B.10);**
- **altered nearshore topography (B.11);**
- **altered onshore topography (B.12);** and/or
- **altered surface/groundwater drainage pattern in onshore/backshore area (B.13).**

Potential impacts to the shoreline ecosystem from protection works in the backshore may occur to terrestrial as well as aquatic habitats. Low-lying areas supporting wetlands may also be impacted. The impacts on the shoreline ecosystem and possible mitigation measures are discussed below.

<u>Increased long-term erosional stress to downdrift shorelines (B.1)</u>

Backshore and nearshore protection works reduce erosion at the site. This can result in a reduction in the supply of sediments to downdrift shorelines and to the nearshore/offshore area at the site. Impacts to the biological environment are manifested in areas downdrift and offshore of the site and are generally restricted to aquatic habitats.

An alteration of erosion and deposition patterns may result in changes to existing habitat areas. For example, surficial sand/gravel/cobble substrate areas, which are used as fish spawning beds, may be removed resulting in a change to a rock or cohesive substrate. The presence of spawning areas in the site vicinity should be ascertained prior to construction, and the potential for alteration to these areas determined. Methods of reducing such impacts may include modifications to the project design, changes to the location of the structure and/or replacement of lost materials (e.g., sand/gravel/cobble). Any harmful alteration to spawning areas will require compensation.

The reduction in a new supply of surficial sediments (e.g., sand, gravel, cobble, boulders) may reduce the amount and distribution of this substrate in the nearshore area. The amount to which the supply of this material is altered relates to the type and erodibility of the backshore material. For example, the protection of a bedrock cliff will have little effect on the supply of new sand/gravel, or cobble/boulder deposits. A cohesive bluff, however, with a high content of glacial materials may contribute substantially to the supply of coarse materials in the nearshore. Determining the potential for impacts may require an investigation and identification of "source areas" in a regional context. Protection works should not be constructed in critical source areas.

Localized erosion (scour) along toe of and at alongshore ends of protection works (B.7)

The effects of altering erosion and depositional patterns are generally manifested in the nearshore areas and have the potential to impact on fish and aquatic habitat and wetland areas.

Wave reflection on the protection works may induce localized scour or erosion in front of and at the ends of the protection works. The impacts to fish habitat are usually localized and may involve increased turbidity and smothering of benthic invertebrates. Increased sedimentation in the nearshore area during spawning periods may also result in the covering of eggs and a lower survival rate. Construction should avoid spawning and incubation seasons and areas. Design modifications to reduce impacts include increasing the porosity of the structure and roughness, and flattening the slope of the structure such that it absorbs wave energy.

Scour along the shore edge of the protection works will result in an increase in the water depth and wave activity at the structure. This may mean a loss of the shallow water wave zone that may be used for fish spawning. The design of the structure should include scour protection.

Altered backshore topography at site (B.10)

Typically, the natural grade of the backshore will be altered by the protection works. For most structures, the grade will be steeper than the natural shore thus limiting access to the shoreline. Alteration of topography in the backshore may also include the grading of this area to a more stable slope. Terrestrial habitat may be impacted by such activities, as well as the adjacent nearshore aquatic habitat. The placement of structures in the backshore, such as seawalls or revetments, usually requires the displacement of the natural terrain and relief and may restrict the access of wildlife, amphibians and reptiles to the shoreline. This impact is likely to be the most significant in low-lying areas. Possible mitigation measures include the provision of access areas such as stepped platforms in the design of the protective structure.

Construction activities may disturb the nesting and migration periods of waterfowl. The timing of construction should avoid these critical periods.

The clearing of vegetation in the backshore may reduce wildlife habitat, may cause an increase in surface runoff and the amount of suspended sediments reaching the watercourse. Natural vegetation should be preserved where possible, or be replanted immediately after construction. Bio-engineering approaches to protective works should be considered where appropriate as they incorporate live plant materials in their design. Removal of overhanging vegetation or shade trees adjacent to the shoreline should be avoided where possible. Sedimentation may be controlled by employing Best Management Practices such as locating stockpiled materials far from the shore and placing a silt curtain around material.

Clearing or removal of vegetation in the backshore may result in the fragmentation of natural corridors along the shoreline, which may interfere with the movement of wildlife along the shoreline. Clearing of vegetation should be minimized where possible and areas cleared should be revegetated.

Altered nearshore topography (B.11)

Backshore protection works can extend into the nearshore and may alter the shallow wave zone used for spawning by fish species such as alewife and smelt. The design should reduce the extent into the nearshore.

The construction of a protection work usually involves the introduction of new materials to the shore zone. Typical construction materials include steel, timber, concrete, earth fill, quarried stone, sand, gravel, cobble and field stone which may alter the nearshore habitat (i.e., size and internal spaces). Materials used should attempt to add internal spaces to the protection works.

Refer to Section 8.4.3(c) for further discussion of the potential impacts of altering the nearshore topography.

Altered onshore topography (B.12)

Refer to previous Section 8.4.3(a) for a discussion of the potential impacts of altering the onshore topography. In addition, if the toe of the bluff is stabilized through the placement of protection works, the bluff slope may flatten as it achieves a stable inclination. This change may impact the type of vegetation which can colonize the slope as well as the wildlife (e.g., cliff swallows).

Altered surface/groundwater drainage pattern in onshore/backshore area (B.13)

Refer to previous Section 8.4.3(a) for a discussion of the potential impacts of altering the surface/groundwater drainage pattern in onshore/backshore areas. Impacts may be major if revetment or seawall blocks the natural connection between a wetland and open water.

c) Nearshore Structural Protection Works

Nearshore structural protection works include groynes, headland breakwaters and detached breakwaters. Physical impacts associated with nearshore works (see Table 8.3) include:

- **increased long-term erosional stress to downdrift shorelines (B.1)**;
- **decreased long-term erosional stress to downdrift shorelines (B.2)**;
- **accretion updrift and/or in lee of structure (B.3)**;
- **increased erosion of downdrift shorelines until bypassing occurs (B.4)**;
- **increased erosion immediately downdrift (B.5)**;
- **less change of dynamic beach and nearshore profile during storms (B.6)**;
- **localized erosion (scour) along toe of and at the alongshore ends of protection works (B.7)** ;
- **decreased nearshore wave action (B.8)** ;
- **decreased mass water exchange/circulation of nearshore waters (B.9)**;
- **altered backshore topography at the site (B.10)**;
- **altered nearshore topography (B.11)**; and/or
- **altered onshore topography (B.12)**;

Potential impacts to the shoreline ecosystem occur primarily to aquatic habitats. Wetlands, where they occur, may also be affected. These impacts and mitigation measures are discussed below.

Increased long-term erosional stress to downdrift shorelines (B.1)

Refer to previous Section 8.4.3(b) for discussion of the potential impacts of increasing the long-term erosion stress to downdrift shorelines.

Decreased long-term erosional stress to downdrift shorelines (B.2)

Nearshore protection works such as beach nourishment increase the supply of sediment and may result in decreased erosion on-site and at downdrift shorelines.

Accretion updrift and/or in the lee of the structure (B.3)

Protection works that extend out from the shoreline (e.g., groynes, artificial headlands) or structures located in the nearshore or shallow offshore (e.g., detached breakwaters) may trap surficial sediment updrift and/or in the lee of the structure. Impacts are generally restricted to the nearshore area and may affect the aquatic habitat. The deposition of sediment updrift of the structure may cover spawning substrates. The potential for fish spawning activity at the site and in the area updrift of the site should be determined prior to construction.

Protection works should be designed to minimize intrusion into the nearshore. This may include increasing spaces or gaps between structures. Any harmful alteration to spawning beds is a major impact and will require compensation.

Newly constructed protection works or structures with compartments or crevices, such as a rock rubble groynes, may initially provide suitable habitat for fish such as rock bass, as well as invertebrates (e.g., crayfish). As these crevices are filled in with sediment, the suitability of this habitat decreases. This occurrence should be kept in mind if the design of a structure is to provide a specific type of habitat. The benefit of this type of mitigation may be temporary, as the structure may become filled with sediment.

Accretion updrift and/or in the lee of the structure may result in the alteration of the active wave zone used by some species for spawning. The potential for fish spawning activity at the site and in the area updrift of the site should be determined prior to construction.

Increased erosion at downdrift shorelines until bypassing occurs (B.4) and/or
Increased erosion immediately downdrift (B.5)

Protection works or structures that extend out perpendicular from the shoreline (e.g., groynes, artificial headlands) trap sediments at the site and may result in increased erosion at downdrift shorelines. This also results in the diversion of sediments into deeper waters. Impacts are limited to the fish and aquatic habitat and may include the removal/uprooting of aquatic vegetation and the removal of existing substrates. Utilization of these areas by fish for spawning and nursery areas should be determined prior to construction.

Invertebrates that are carried in the current may be deflected into deeper water where survival rates may be reduced. Impacts may be reduced by designing the structure to minimize intrusion into the nearshore, and/or incorporating suitable materials or spaces to provide for invertebrates.

Less change of beach and nearshore profile during storms (B.6)

The beach and nearshore profile will be more stable during storm events. This more protected environment may encourage benthic invertebrates to inhabit these areas and may also result in a change in the dominant vegetation.

Induced localized erosion (scour) along the toe of and at alongshore ends of protection works (B.7)

Refer to previous Section 8.4.3(b) for discussion of potential impacts of inducing localized erosion (scour) along the toe of protection work and inducing localized erosion at the alongshore ends of protection works.

Decreased nearshore wave action (B.8)
Decreased mass water exchange/circulation of nearshore waters at site (B.9)

The placement of a protection work, such as a detached breakwater, in the nearshore may reduce wave activity and water circulation in these areas. This may result in areas of stagnant water and may reduce the oxygen supply to the aquatic community in the areas. The placement of offshore protection works may also influence the temperatures in the nearshore. Possible mitigation includes the placement of culverts or openings in the structure to allow some water circulation to the shore area.

The shallow (active) wave zone would be altered by the presence of the structure (e.g., detached breakwater). This area may be used for spawning by species such as alewife and smelt. This may be mitigated by placing the structure outside the active wave zone where possible.

Altered backshore topography at site (B.10)

Refer to previous Section 8.4.3(b) for discussion of the impacts of altering the backshore topography at the site.

Altered nearshore topography (B.11)

The placement of any protection work or structure in the nearshore will result in the direct covering of bottom substrate. This may result in the direct loss of fish habitat. The significance of impacts on the productive capacity of fish is related to the nearshore habitat type. For example, exposed bedrock and exposed cohesive substrates have low productivity compared to other substrates such as cobble/boulder and wetland areas. In some instances, the covering of substrates such as exposed cohesive sands by cobbles and boulders will increase habitat diversity and productivity. Studies of artificial reefs placed over a firm compacted sand bottom have shown an increase in colonization of the substrate by invertebrates and forage fish as well as spawning activity by several fish species (Kevern et al. 1985). The potential for spawning activity on the existing substrate should be determined prior to the alteration to substrate materials. The direct loss of spawning areas will require compensation.

In the nearshore, the materials used should attempt to add internal spaces to the protection works. For example, stones and rocks provide crevices where small fish and their food organisms can be protected from predators. Vertical walls with smooth, uniform surfaces, i.e., steel sheet pile, should be avoided as they provide no habitat value.

The alteration of topography in the nearshore may also result in other impacts to the aquatic organisms in the nearshore. An increase of suspended sediments during construction may irritate the gills of fish, place stress on filter feeders and smother benthic invertebrates. Sediment control measures should be used during construction to minimize area impacted by sedimentation and increased turbidity. Placement of the structure may also result in the removal of aquatic vegetation which provides food and shelter for aquatic organisms. These organisms are an essential food source for waterfowl as well as fish. Opportunities for the establishment of aquatic vegetation in adjacent areas should be explored.

Structures or protection works in the nearshore/backshore may also result in the loss of frequently inundated areas. These areas serve as important fish spawning and nursery areas for species such as northern pike, as well as important waterfowl and herpetofauna habitat. Design modifications may include the placement of lower structures.

The occupation nearshore by a structure or protection work is a long-term impact which occurs throughout the design life of the structure or protection works. As area is directly displaced, mitigation is often not able to reduce effects and suitable compensation measures will be required.

Altered onshore topography (B.12)

Refer to previous Section 8.4.3(b) for discussion of the impacts of altering the onshore topography.

8.4.4 Assessment of Major and Minor Impacts

Based on the descriptions of ecosystem susceptibility to disturbance (Section 8.3), and potential effects on the biological and physical environment (Section 8.4), an assessment of the potential level of impact (e.g., major, minor, none) can be made.

As discussed in Section 8.4.2, major impacts occur when a protection measure occupies a portion of the shore considered to be sensitive from a biological standpoint and where habitats and their associated communities may be permanently lost. Exceptions may occur when the area disturbed is not considered to be biologically productive.

The potential impacts to terrestrial habitat from protection works generally occur as a result of changes to the onshore or backshore topography. Changes to the slope or material, or the removal of protective cover (i.e., vegetation) may limit the access of wildlife from upland areas to the water's edge and may also restrict movement from one portion of the shoreline to another (i.e., migration corridors). Other related impacts include the clearing of vegetation which provides a source of food and disturbance to wildlife during critical periods (i.e., nesting, migration).

Generally, impacts to terrestrial habitats from protection works are of a minor nature. Protection works may be designed to allow for the movement of wildlife from upland areas to the shoreline. The removal of vegetation should be minimized and may be re-established to provide suitable habitat. Construction periods should avoid critical seasons. Impacts may be of a major nature if the proposed site is located within an important wildlife habitat area. These may include the habitat of an endangered species (listed in Appendix A8.1). Other habitat areas of local or regional significance should also be determined. This information is available at the MNR District Offices.

The potential for impacts to wetland communities occurs when a protection work directly displaces a wetland or wetland vegetation or from indirect impacts such as filling and dyking the onshore. The area most affected by the latter activity occurs in the periodically flooded zone landward of the protection work during high water levels (separately or annually). This zone may support aquatic vegetation and be used for spawning and nursery areas for fish species such as pike and nesting sites for waterfowl. The result of such an impact will be of a long-term duration and is considered major. The *Provincial Policy Statement* direction for wetlands (i.e., Policy 2.1; see *Natural Heritage Training Manual*) prohibits development in provincially significant wetlands and requires an environmental impact statement to be completed for proposed work in the 120 m area adjacent to the wetland. The location of provincially significant as well as other locally significant wetlands is available at District MNR offices (see also Glooschenko et al. 1987).

The potential for impacts resulting from protection works is generally the greatest on fish and aquatic habitat. These range from direct impacts on the habitat from the placement of a structure on the nearshore to indirect impacts due to increased sedimentation, decreased supply of new coarse material to the nearshore area, etc.

Protection works which cover existing habitat (nearshore substrate) should be considered major. These impacts are of long-term duration and may occur in an important spawning, nursery or migration area. Any harmful alteration, disruption or destruction of fish habitat requires compensation and approval by DFO. The District MNR Office should be contacted regarding possible critical habitat areas.

Indirect impacts on aquatic habitat occur predominantly from changes to the erosion and deposition patterns. As discussed in Section 8.3, some nearshore substrates are more susceptible to disturbance than others. As Table 7.3 (Part 7: Addressing the Hazards) shows, the magnitude of this type of impact is greater in sand/gravel environments, typically where supply of sediments is the greatest. The potential for major physical effects is also great in gravel/cobble/boulder nearshores of beach environments. Cobble/boulder substrates are also important to the fish and aquatic community. The many crevices of this substrate provide protective cover for species such as crayfish, etc., and spawning activity for many fish species.

The impact on substrates such as bedrock and fine-grained cohesive may be of a minor nature as these areas are not as susceptible to disturbance and are not generally as biologically productive.

Table 8.4 summarizes the level of impact (none minor, major) that is likely to occur on the terrestrial, wetland and aquatic habitats of the shoreline ecosystem if a particular protection work were put in place. Onshore, backshore and nearshore locations are considered, as are the various types of shores and nearshore substrates. These impacts are discussed in Table 8.5.

Table 8.4 Significance of Potential Impacts to the Shoreline Environment

Shoreline Class[1]			Significance of Potential Impacts to the Shoreline Environment													
General Shoreline Type	**Controlling Substrate**	**Surficial Substrate**	Prevention		Non-structural Protection				Structural Protection (plus stable slope and flood/erosion allowances)							
Onshore/ Backshore (composition and profile)	Nearshore (predominant underlying material)	Nearshore (can appear above water as a beach)[5]	Onshore		Onshore				Onshore		Backshore		Nearshore			
			HA	PA	Re	FP	BM	DE	FI	D	fR/S	rR/S	BN†	G	AH	DB‡
Bedrock Cliff[2]	bedrock	bedrock							t	t	ta	ta	tA	A	A	A
		cobble/boulder							t	t	tA	tA	tA	A	A	A
		sand/gravel							t	t	ta	ta	tA	A	A	A
		silt/organic[4]							tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
Bedrock Low Plain[3]	bedrock	bedrock							t	t	ta	ta	tA	A	A	A
		cobble/boulder							t	t	tA	tA	tA	A	A	A
		sand/gravel							t	t	ta	ta	tA	A	A	A
		silt/organic[4]							tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
Cohesive/ Non-cohesive Bluff[2]	bedrock	bedrock					t		t	t	ta	ta	tA	A	A	A
		cobble/boulder					t		t	t	tA	tA	tA	A	A	A
		sand/gravel					t		t	t	ta	ta	tA	A	A	A
		silt/organic[4]					t		tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
	cobble/boulder till	cobble/boulder					t		t	t	tA	tA	tA	A	A	A
		sand/gravel					t		t	t	ta	ta	tA	A	A	A
		silt/organic[4]					t		tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
	fine-grained cohesive	cobble/boulder					t		t	t	tA	tA	tA	A	A	A
		sand/gravel					t		t	t	ta	ta	tA	A	A	A
		fine-grained cohesive					t		t	t	ta	ta	ta	A	A	A
		silt/organic[4]					t		tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
Cohesive/ Non-cohesive Low Plain[3]	bedrock	bedrock							t	t	ta	ta	tA	A	A	A
		cobble/boulder							t	t	tA	tA	tA	A	A	A
continued...		sand/gravel							t	t	ta	ta	tA	A	A	A
		silt/organic[4]							tAW	tAW	tAW	tAW	tAW	AW	AW	Aw

Table 8.4 (Continued)

Shoreline Class[1]			Significance of Potential Impacts to the Shoreline Environment													
General Shoreline Type Onshore/ Backshore (composition and profile)	**Controlling Substrate** Nearshore (predominant underlying material)	**Surficial Substrate** Nearshore (can appear above water as a beach)[5]	Prevention		Non-structural Protection				Structural Protection (plus stable slope and flood/erosion allowances)							
			Onshore		Onshore				Onshore		Backshore		Nearshore			
			HA	PA	Re	FP	BM	DE	Fl	D	fR/S	rR/S	BN†	G	AH	DB‡
Cohesive/ Non-cohesive Low Plain[3] (continued)	cobble/boulder till	cobble/boulder							t	t	tA	tA	tA	A	A	A
		sand/gravel							t	t	ta	ta	tA	A	A	A
		silt/organic[4]							tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
	fine-grained cohesive	cobble/boulder							t	t	tA	tA	tA	A	A	A
		sand/gravel							t	t	ta	ta	tA	A	A	A
		fine-grained cohesive							t	t	ta	ta	ta	A	A	A
		silt/organic[4]							tAW	tAW	tAW	tAW	tAW	AW	AW	Aw
Dynamic Beach Backed by Cliff/Bluff[5]	gravel/cobble/boulder	gravel/cobble/boulder					T		T	T	TA	TA	TA	A	A	A
	sand	sand					T		T	T	Ta	Ta	Ta	A	A	A
Dynamic Beach Low Plain[5] (mainland dune)	gravel/cobble/boulder	gravel/cobble/boulder							T	T	TA	TA	TA	A	A	A
	sand	sand							T	T	Ta	Ta	Ta	A	A	A
Dynamic Beach Barrier[5]	gravel/cobble/boulder	gravel/cobble/boulder							T	T	TA	TA	TA	A	A	A
	sand	sand							T	T	Ta	Ta	Ta	A	A	A
Artificial							Should be evaluated on a site specific basis									

LEGEND:

T - major impact on terrestrial habitats
t - minor impact on terrestrial habitats
A - major impact on aquatic habitats
a - minor impact on aquatic habitats
w - major impact on wetlands

HA - hazard allowances for flooding and erosion
PA - property acquisition
Re - relocation
FP - floodproofing
BM - bluff measures
DE - dune enhancement
Fl - filling
D - dyking

fR/S - flexiblerevetments and seawalls
rR/S - rigid revetments and seawalls
G - groynes
AH - artificial headlands (typically with beach fill)
DB - detached breakwater
‡ can also be located in shallow offshore
BN - beach nourishment
† typically extends across backshore and into nearshore

1 - This Table does not include classification of shoreline exposure and planform (exposed, partial headland, headland-bay, well sheltered).
2 - Cliff/bluff - steeper than 1:3 (vert:horz) and >2 m high.
3 - Low plain - landward slope flatter than 1:3 (vert:horz) or <2 m high.
4 - Typically only found in naturally well-sheltered areas where controlling substrate may not be applicable.
5 - a beach is not classified as a *dynamic beach*, where: 1) beach or dune deposits do not exist landward of the still water line; 2) beach or dune deposits overlying bedrock or cohesive material are generally less than 0.3 metres in thickness, 10 metres in width and 100 metres in length; or 3) beach or dune deposits are located in embayments, along connecting channels or in other areas of restricted wave action.

NOTES:

Refer to **Table 7.1**, Part 7, for initial evaluation of shoreline management approaches.

Refer to **Table 7.2**, Part 7, to assess the potential influences and impacts of shoreline management practices on the physical shoreline processes and characteristics.

Refer to **Table 7.3**, Part 7, to assess the relative significance of the potential impacts with respect to increasing updrift/downdrift flood, erosion and dynamic beach hazards.

Refer to **Tables 8.2 and 8.3**, Part 8, to assess the biological impacts related to shoreline management practices.

Tables to be read in conjunction with accompanying Technical Guide text.

Table 8.5 Assessment of Typical Major and Minor Impacts of Structural Protection Works

ONSHORE		
Terrestrial Habitats	**Aquatic Habitats**	**Wetlands**
Major • In sensitive habitat areas (i.e., ESA's, ANSI's, rare or endangered species habitat nesting areas). • In dune environments where the placement of a structure may alter the natural development and maintenance of the dune ecosystem.	Major • May occur where substantial alterations to drainage channels are required (this is not associated with many protection works).	Major • In areas backed by wetlands, alterations to groundwater and surface drainage patterns may disrupt wetland communities. Usually confined to poorly drained, low plain shorelines with silt/organic surficial sediments. • Filling and dyking result in direct loss of wetland area.
Minor • The removal of vegetation immediately adjacent to the shoreline may reduce wildlife access to the water's edge, and reduce food source and shade for aquatic organisms. • Impacts are generally minor on most shoreline types. Impacts are often of a short-term duration, and can be reduced through the re-establishment of vegetation, the timing of construction, and/or the provision of wildlife access. The effects are generally on-site with no updrift or downdrift effects.	Minor • Impacts are minor on most shoreline types. • Impacts are of a short duration and may include increased sedimentation during construction. Best Management Practices for sediment control should be employed.	

BACKSHORE		
Terrestrial Habitats	**Aquatic Habitats**	**Wetlands**
Major • In sensitive habitat ares (i.e., ESA's, ANSI's, rare or endangered species habitat and nesting areas). • May occur in beach/dune areas where the presence of structure alters the topography such that vegetation cannot re-establish.	Major • May occur where spawning habitats in downdrift areas experience increased erosion or sedimentation. This is of greater concern in areas with a cobble/boulder surficial sediment. • May occur where works occupy significant part of nearshore and shallow water habitat zone is lost. • Changes to groundwater upwelling areas may have major impact to spawning areas.	Major • In areas backed by wetlands, alterations to groundwater and surface drainage patterns may disrupt wetland communities. Impacts are usually confined to poorly drained, low plain shorelines with silt/organic surficial sediments. • May be major if blocking of natural connection between wetland and open water by revetments or seawalls disrupts the natural function and habitat of the wetland.
Minor • Potential for minor impacts along all shoreline types. Impacts relate to removal of vegetation, interruption to wildlife corridors and restriction of wildlife access to the water. Most impacts can be mitigated to reduce impacts.	Minor • Potential for minor impacts along all shoreline types. Impacts relate to increased sedimentation and turbidity. Most impacts can be mitigated to reduce impacts.	Minor • May occur where changes to drainage patterns affects the water retention and filtering capacity of wetlands.

NEARSHORE		
Terrestrial Habitats	**Aquatic Habitats**	**Wetlands**
Major • Major impacts are generally restricted to aquatic habitats and wetlands or where the works significantly alter the backshore/onshore dune environment.	Major • Are likely to occur where protection structure covers bottom substrate. The significance of impacts on the productive capacity of fish are likely to be related to nearshore habitat type. Impacts are major in spawning and nursery areas but may be minor on substrates with low productivity such as fine-grained cohesive materials. • May occur where existing spawning areas in updrift or downdrift areas are covered by sediments or removed due to altered erosional/deposition patterns.	Major • May occur where the placement of the structure affects wetland functions.
Minor • The removal of vegetation immediately adjacent to the shoreline may reduce wildlife access to the water's edge, and reduce food source and shade for aquatic organisms.	Minor • Short-term impacts may result from the removal of shoreline vegetation. • Construction related impacts such as temporary suspension of sediments. • Changes to water circulation which may be mitigated.	Minor • Construction related impacts such as temporary suspension of sediments.

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8.6 GLOSSARY OF TERMS

The following terms and their definitions are intended for the purposes of the interpretation and implementation of the Provincial Great Lakes - St. Lawrence River Shoreline Policy and supporting Implementation Guidelines and Technical Guidelines:

- **Biodiversity** is a short form for biotic or biological diversity and refers to the variety of wildlife species, the genetic variability of each species, and the variety of different functions they perform.
- **Ecosphere** the thin layer at the surface of the earth in which life is possible
- **Ecosystem** the physical and biological sphere of the environment comprised of terrestrial and aquatic organisms and their physical environment.
- **Effect** a change to the existing environment, and may be either positive, negative or neutral.
- **Environment** can be generally defined as air, land, water, plant and animal life including man, and the social, economic and cultural conditions that influence the life of a community.
- **Environmentally Sound Management** refers to those principles, methods and procedures involved in addressing the protection, management and enhancement of the shoreline ecosystem which are used in disciplines such as geology, geomorphology, botany and zoology and applied in the study of shoreline processes, vegetation, wildlife and aquatic habitat resource management.
- **Habitat** is the combination of living and non-living things which provide a particular species with the resources it needs to complete its life-cycle; soil, water, air, rocks, rain, heat and the other plants and animals which provide the food needed for survival.
- **Impact** a detrimental change to the environment.
- **Wild Life** includes all wild mammals, birds, reptiles, amphibians , fish, invertebrates, plants, fungi, algae, bacteria, and other wild organisms

TECHNICAL GUIDE FOR
GREAT LAKES - ST. LAWRENCE RIVER SHORELINES

APPENDIX A8.1

ENDANGERED SPECIES OF ONTARIO:

GREAT LAKES - ST. LAWRENCE RIVER SYSTEM SHORELINE

ENDANGERED SPECIES OF ONTARIO:
GREAT LAKES - ST. LAWRENCE RIVER SYSTEM SHORELINE

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A8.1 ENDANGERED SPECIES OF ONTARIO: GREAT LAKES - ST. LAWRENCE RIVER SYSTEM SHORELINE

Table A8.1.1
Endangered Species of Ontario: Great Lakes - St. Lawrence River System Shoreline

Endangered Species*		Habitat Characteristics
Common Name	**Scientific Name**	
Insects		
Frosted Elfin	*Callophrys* (I.) *irus*	
Karner Blue Butterfly	*Lycaeides melissa samuelis*	
Amphibians		
Blanchard's Cricket Frog	*Acris crepitans blanchardi*	
Reptiles		
Lake Erie Water Snake	*Nerodia sipedon insulorum*	Can only be found in the vicinity of Lake Erie. It frequents the rocky shores of islands such as Pelee. It feeds on small fish such as smelt and alewife.
Blue Racer	*Coluber constrictor foxi*	Before settlers came to Ontario, it occupied the prairie grasslands and open woodland habitat of the southwest part of the Province.
Timber Rattlesnake	*Crotalus horridus horridus*	Habitat includes rocky limestone ledges where deep fissures provide winter den sites below the frost line. Since 1941, no Ontario sightings have been confirmed.
Birds		
White Pelican	*Pelecanus erythrorhynchos*	Ontario's only breeding colony nests on Lake-of-the-Woods. Nests solely on remote and inaccessible islands. White Pelican also requires feeding areas which generally is restricted to larger lakes with a relatively abundant supply of fish species.
Bald Eagle	*Haliaeetus leucocephalus alascanus*	Once found nesting in Ontario from the lower Great Lakes to the tree line. Found now in the northwest part of the Province. Breeding habitat consists of forest tracts with tall nest trees near lakes or rivers. Populations are protected by preventing development within known nesting areas and guarding against disturbance during the breeding season.
Golden Eagle	*Aquila chrysaetos*	Nests on cliff ledges and haunts open terrain. Its main prey is small mammals. Very sensitive to disturbance and will abandon a nest if humans encroach. Nesting records are from remote northern areas, away from human disturbance.
Peregrine Falcon	*Falco peregrinus*	Lay eggs directly on the ground in a shallow depression. Nesting sites include cliff ledges or steep embankments or occasionally a tall building with ledges. Most nest sites look out over water. Peregrines hunt mainly in open ares and tundra.
Piping Plover	*Charadrius melodus*	Reported to have nesting in Ontario from the lower Great Lakes and St. Lawrence River northward to Georgian Bay. Nests on sand or pebble beach. Susceptible to disturbance. Nesting has recently been noted on Crown land in northern Ontario.
Eskimo Curlew	*Numenius borealis*	Unconfirmed sighting of the species in the west coast of James Bay in 1976, the first sighting in over 100 years.

Endangered Species*		Habitat Characteristics
Common Name	Scientific Name	
Kirtland's Warbler	*Dendroica kirtlandii*	This species has very specific nesting habitat. Lays eggs directly beneath the low, living branches of young jack pines. The pine stands must be dense and interspersed with open grassy areas and the soil must be well drained and support a good growth of ground cover. New habitat is managed for the species in Michigan. In 1978 no nests were found in Ontario.
Mammals		
Eastern Cougar	*Felis concolor couguar*	Once occupied the Ontario range of its main prey species, the white-tailed deer. As settlement progressed, the shy, secretive cats became very scarce. Since 1900 there has been no direct evidence of the cougar's presence, however some sightings have been reported.
Plants		
Cucumber Tree	*Magnolia acuminata*	Occurs naturally in only the regional municipalities of Niagara and Haldimand-Norfolk.
Prickly Pear Cactus	*Opuntia humifusa*	The only locations in Ontario where natural populations are known to exist are on Pelee Island and in Point Pelee National Park.
Heart-leaved Plantain	*Plantago cordata*	In Ontario there are approximately 300 plants at a single location in Lambton County.
Small White Lady's Slipper Orchid	*Cypripedium candidum*	Ontario has only three known populations of the small white lady's slipper in a remnant track of open wet prairie in Lambton County, in a fen in Hastings County and in a marsh in the Regional Municipality of Haldimand-Norfolk. The orchid grows in fens, swampy calcareous meadows, remnant prairie habitats and on the edge of thickets.
Large Whorled Pognonia	*Isotria verticillata*	Recorded in only four locations in Ontario including Oxford County, Regional Municipality of Haldimand-Norfolk and Middlesex County.
Small Whorled Pogonia	*Isotria medeoloides*	A population of small whorled pogonia was discovered in Elgin County in 1978. It generally occurs in second growth deciduous or deciduous-coniferous forest with an open canopy. The sites have a open shrub layers with few herbs and are strongly acidic.

* *Source: "Rare, Endangered, Extirpated or Extinct Species of Ontario", June 1992, Ontario Ministry of Natural Resources: Wildlife Policy Branch*

Table A8.1.2
Endangered Species of Ontario: Great Lakes - St. Lawrence River System Shoreline, Ontario Fish Species

Ontario Fish Species**		Status/ Date	Habitat Characteristics
Common Name	Scientific Name		
Bigmouth buffalo	*Ictiobus cyprinellus*	Vulnerable - 1989	• in Ontario occurs only in western Lake Erie • adults move out of lakes and large rivers into small tributary streams and into marshes or flooded lake margins to spawn from mid-May to early June
Blackfin cisco	*Coregonus nigripinnis*	Threatened - 1988	• once ranged through all the Great Lakes except Lake Erie, but now has entirely disappeared from Lakes Ontario and Michigan and there were no recent records from Lake Huron or Lake Superior • information on spawning not complete • non-spawning blackfin are considered to inhabit deeper waters than most other species
Bigmouth buffalo	*Ictiobus cyrinellus*	Vulnerable - 1989	• found in western Lake Erie • Spring spawner, May/June in marshes of flooded lake margins/shallow water • adults inhabit shallow depths in slow, sluggish or still waters of large rivers
Brindled madtom	*Noturus miurus*	Vulnerable - 1985	• found only in tributaries of Lake Erie, the Niagara and the Syndenham Rivers • spawning occurs in July/August when temperatures reach 78°C in rivers with slow current and silt, or mud bottom with vegetation • adults inhabit clear fast-flowing streams with gravel bottom
Central stoneroller	*Campostoma anomalum*	Vulnerable - 1985	• reportedly caught in the Lake St. Clair drainage area in 1972
Deepwater cisco	*Coregonus johannae*	Extinct - 1988	• was indigenous to the Great Lakes Basin and occurred in deep portions of Lakes Huron and Michigan • spawning grounds have not been found
Deepwater sculpin	*Myoxocephalus thompsoni*	Threatened - 1987	• range between 150 to 600 ft. • little known on spawning activity
Gravel chub	*Erimystax x-punetatus*	Extirpated - 1987	• found in the Thames River • little is known about spawning habitat • adults in habit slow-moving, deep, gravel bottom streams and rivers
Kiyi	*Coregonus kiyi*	Vulnerable - 1988	• spawning occurs from November to January at depth of 91.4 to 168 m and at temperatures ranging from 1.7°C to 3.4°C • lives at depths of 55-183 m
Lake Simcoe Whitefish	*Coregonus clupeaformis* sp.	Threatened - 1987	• a continual decline has been noted in Lake Ontario • spawns in the fall, usually November and December • spawns in shallow water at depths of less than 7.6 m over a hard or stoney bottom but sometimes over sand • in the Great Lakes, they move from deep waters to the shoals in early Spring and back to deeper water as warming occurs
Long jaw cisco	*Coregenus alpenae*	Extinct - 1985	• thought to have spawned in November
Northern brook lamprey	*Lehthyomyzon fossesr*	Vulnerable - 1991	• found throughout Great Lakes and St. Lawrence River basin, Georgian Bay and the northshore tributaries of Lake Superior • spawns in streams and small rives, on the bottom of coarse gravel, shingle and stones 25-152 m in diameter

Ontario Fish Species**		Status/ Date	Habitat Characteristics
Common Name	**Scientific Name**		
Pugnose minnow	*Opsopoeodus emiliae*	Vulnerable - 1985	• found in western Lake Erie, Lake St. Clair, Thames River • no spawning information • adults inhabit clear, slow-moving water with an abundance of vegetation • intolerant of turbid or muddy water
Purgnose shiner	*Notropis anogenus*	Vulnerable - 1985	• location is restricted to the Great Lakes basin, primarily the eastern outflow of Lake Ontario at Gananoque and western Lake Erie near Rondeau Bay and Long Point
Redside dace	*Clinostomus elongatus*	Vulnerable - 1987	• found in clear streams flowing into western Lake Ontario, in Counties of Brant, Bruce, Halton, Peel, Wentworth and York • spawning occurs in late May, close to bottom in or near gravelly nests of creek chub • habitat is clear, cool, flowing water with gravel or stoney bottom • sensitive to turbidity
River redhorse	*Moxostoma carinatum*	Vulnerable - 1987	• found in the St. Lawrence River, tributaries of the Great Lakes • spawning in the Spring in large rivers and the upper reaches of tributaries • intolerant of pollution and heavy siltation
Shortjaw cisco	*Coregonus zenithicus*	Threatened - 1987	• complete range is not fully known, recorded in Lakes Huron and Superior • spawning occurs in the Fall • lives at depths from about 18 to 183 m in the Great Lakes
Shortnose cisco	*Coregonus reighardi*	Threatened - 1987	• extremely rare in Lake Ontario • spawn in Spring • found at depths of 23 to 92 m
Silver chub	*Macrhybopsis storeriana*	Vulnerable - 1085	• only marginal distribution found in Lake Ontario and disappeared from Lake Erie • Spring spawner, later May or early June • inhabits slow-moving streams with clean sand or gravel bottom
Spoonhead sculpin	*Cottus ricei*	Vulnerable - 1989	• time of spawning is not known, evidence suggests late summer or early fall • little known on habitat and depth distribution
Spotted gar	*Lepisosteus oculatus*	Vulnerable - 1983	• limited in Ontario to central and western Lake Erie, Detroit River and Lake St. Clair • spawns in Spring, in shallow warm-water where aquatic vegetation is abundant
Spotted sucker	*Minytrema melanops*	Vulnerable - 1983	• spawns in late Spring or early Summer • lives in lakes, overflowing ponds, and clean sluggish streams with sandy, gravelly or hard clay bottoms without silt • seems intolerant to turbidity, pollutants and clay silt bottoms

** *Source: OMNR Fish Species Tables: COSEWIC Designations.*