Hamilton Harbour and Watershed Fisheries Management Plan

A cooperative resource management plan developed by the Ontario Ministry of Natural Resources and the Royal Botanical Gardens

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Executive Summary

Introduction

The Hamilton Harbour and Watershed Fisheries Management Plan (HHWFMP) provides information about the characteristics of the watershed, the state of fisheries resources, and guidance for the management of fisheries resources in the watershed. The need for the HHWFMP developed directly from successes of the Hamilton Harbour Remedial Action Plan (RAP) to restore water quality and fish habitat in Hamilton Harbour and its watershed.

Hamilton Harbour is a large embayment at the western tip of Lake Ontario. The main tributaries of Hamilton Harbour include Spencer Creek, Grindstone Creek, and Red Hill Creek. The Hamilton Harbour watershed, which includes the contributing streams and creeks, covers an area of approximately 500 km^2. It encompasses some of the regions most scenic and diverse landscapes: the Niagara Escarpment is a prominent physical feature, and Cootes Paradise is one of the largest and most significant coastal wetlands of Lake Ontario.

Water quality in Hamilton Harbour and Cootes Paradise is the most important factor that currently limits the successful restoration of sustainable, self–reproducing native fish community. In 1987, Hamilton Harbour was officially designated as an Area of Concern (AOC) by the International Joint Commission, pursuant to the Great Lakes Water Quality Agreement. A RAP was initiated in 1989 and implementation of rehabilitation activities, to improve the quality of the Hamilton Harbour, began in 1992.

Public Input

Public input was sought through two rounds of Public Open Houses and through participation of the Angler's Working Group and Steering Committee in the planning process. The Anglers Working Group provided advice and information about fishing-related initiatives, concerns and ideas in the watershed. The Steering Committee was responsible for making decisions about the direction of the plan. Key issues and management objectives concerning fish communities in the Hamilton Harbour watershed were identified by the public during open houses, a public survey, and through meetings and ongoing discussions with the Steering Committee and the Angler's Working Group.

Goal and Objectives

The goal of this Fisheries Management Plan is *to support diverse, well-balanced, and healthy aquatic ecosystems that provide sustainable benefits to meet society's present and future needs*. The HHWFMP has three broad objectives (adapted from SPOF II):

1. to protect healthy aquatic ecosystems
2. to rehabilitate degraded aquatic ecosystems
3. to improve cultural, social and economic benefits from the aquatic resources of Hamilton Harbour and its watershed

Watershed Characteristics

The Niagara Escarpment is the most notable physiographic feature in the Hamilton Harbour watershed, and greatly affects the distribution and habitat of fish. Numerous waterfalls along the Escarpment form a natural barrier to access of fish from Lake Ontario. Many headwater areas exist above the escarpment, where fractures in the dolomite bedrock or overlying sands and gravels make it valuable for groundwater recharge and storage. Above the escarpment, the landscape is relatively flat but is littered with glacial deposits of drumlins, eskers, kames, and outwash deposits of sand, silt and gravel. Between the Niagara Escarpment and the Iroquois Plain is a steep slope, and cut into the bedrock are numerous valleys, including the Dundas Valley in the western parts of the watershed.

Management Areas

Hamilton Harbour and its watershed have been divided into five key management areas

- North Shore watershed;
- Grindstone Creek watershed;
- Spencer Creek watershed (including Cootes Paradise);
- Red Hill Creek watershed; and
- Hamilton Harbour.

A highly urbanized portion of the City of Hamilton has been excluded from the plan as almost all streams have been buried into the underground stormwater network. No fisheries resources are found here.

Fisheries Management Zones

All water bodies in the Hamilton Harbour watershed are classified into one of eight fisheries management zones based primarily on the stream size and water temperature. The management zones for the Hamilton Harbour watershed include (Figure 4.1):

- Small Coldwater Riverine,
- Small Warmwater Riverine,
- Intermediate Coldwater Riverine,
- Intermediate Warmwater Riverine,
- Inland Lakes and Reservoirs,
- River Mouth,
- Hamilton Harbour Nearshore , and
- Hamilton Harbour Offshore.

Key Issues

Key issues were developed under three themes: Aquatic Community, Aquatic Habitat, and Planning. Many of these themes were interconnected, both between and within the themes. For instance, many problems with fish communities are related to degradation of habitat, and so in some cases it may be difficult to peg an issue into a single theme or issue. Nevertheless, the separation of the issues may help with understanding the problems and solutions. In addition issues were ranked in importance by the public, the Steering Committee, and the Angler's Working Group.

Primary issues are those that are both within the scope of the management plan and have been identified by the public as a high priority concern. The primary issues are:

Aquatic Community

- Dams and barriers to fish passage
- Contaminants in fish
- Declines in native species abundance
- Invasive species
- Species at risk

Aquatic Habitat

- Loss or degradation of aquatic habitat
- Water Quality
- Sediment erosion into water bodies
- Maintaining stream flow

Planning

- Coordination of activities

Secondary issues are within the scope of the HHWFMP, but are identified by the public as having a relatively low priority. The secondary issues are:

Aquatic Community
- Unbalanced fish community
- Angling opportunities
- Nuisance Species

Aquatic Habitat
- Public Awareness
- Protection of riparian lands

Tertiary issues are those that have been identified by the public, but are not a primary focus of the HHWFMP, and may be dealt with indirectly through addressing primary and secondary issues as well as through other programs and initiatives. The tertiary issues are:

Aquatic Community
- Stocking

Aquatic Habitat
- Funding
- Contaminants

Planning
- Knowledge

Fish Management Objectives

Fish Management Objectives provide a vision for fish communities in each Fisheries Management Zone within each watershed and Hamilton Harbour. The Niagara Escarpment is a dominating force in determining fish community and habitat, and so the Fish Management Objectives for riverine zones have been separated above and below the escarpment.

In the following sections we have listed the general Fish Management Objectives across all watersheds. The objectives may differ in some watersheds, in which case the specific objectives for each watershed should take priority.

<u>Riverine and Lake Zones – above Niagara Escarpment</u>

The low gradient of the streams above the Niagara Escarpment are more suited to brook trout, and a variety of other coldwater and coolwater species, including redside dace. Temperature, flow regime, and silt still hinder restoration of these species. Because water flows down a river, any impacts to the river are carried downstream. Accordingly, the dependence of downstream reaches on the activities within the whole upstream watershed contributes to conflicting objectives in upstream and downstream parts of the watershed. For example, reservoirs increase water temperature, making reaches downstream unsuitable for coldwater species. These conflicts cannot be resolved here, but should be considered in future reviews of this FMP.

Small Coldwater Riverine Objectives - The capacity for brook trout should increase, and they should play a prominent role in most of these streams, and in Spencer Creek, redside dace populations should increase in accordance with the redside dace recovery plan. Priority to brook trout should be given to those streams with greater potential for lower water temperature, and priority to redside dace should be giver to those coldwater streams with less potential to lower the water temperature.

Intermediate Coldwater Riverine Objectives – The capacity for brook trout should increase, and they should play a prominent role in most of these streams. In Spencer Creek, redside dace populations should increase in accordance with the redside dace recovery plan. Where habitat cannot be restored adequately for brook trout, brown trout may be considered in their place.

Small and Intermediate Warmwater Riverine Objectives - Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters). If the temperature can be lowered enough to convert a warmwater stream to a coldwater stream, then priority should be given to redside dace and brook trout, as the physical habitat determines.

Inland Lakes and Reservoirs Objectives - Northern pike, largemouth bass, and sunfishes can provide angling opportunities in the larger inland lakes and reservoirs. The objectives for smaller in-line ponds are the same as the stream that flows through them.

Riverine Zones – below Niagara Escarpment

The high gradient and large substrate below the Niagara Escarpment is especially suited to Atlantic salmon and trout species. Temperature, flow regime, and silt still hinder restoration of these species. Because water flows down a river, any impacts to the river are carried downstream. The dependence of downstream reaches on the activities within the whole upstream watershed contributes to conflicting objectives in upstream and downstream parts of the watershed. These conflicts cannot be resolved here, but should be considered in future reviews of this FMP. The river mouth zones (especially Cootes Paradise) play a critical role in meeting the objectives for Hamilton Harbour, by acting as migratory corridors, and spawning and nursery habitat for fish species that reside elsewhere much of their lives.

Small Coldwater Riverine Objectives - The capacity for brook trout should increase, and they should play a prominent role in reaches of these streams that are not greatly impacted by rainbow trout and brown trout.

Intermediate Coldwater Riverine Objectives - The capacity for rainbow trout and brown trout should increase, and they should play a prominent role in most of these streams. Atlantic salmon reintroduction can be considered where brown trout prove that the quality of spawning habitat is suitable, as determined by the Atlantic salmon recovery plan.

Small Warmwater Riverine Objectives - Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters). If the temperature can be lowered enough to convert a warmwater zone to a coldwater zone, then priority should be given to brook trout, rainbow trout, or brown trout as the physical habitat determines.

Intermediate Warmwater Riverine Objectives - Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters). Increase the spawning capacity for migrants from Hamilton Harbour, such as walleye, white sucker, and smallmouth bass. If the temperature can be lowered enough to convert a warmwater zone to a coldwater zone, then priority should be given to rainbow trout, or brown trout as the physical habitat determines.

River Mouth (including Cootes Paradise) Objectives - Increase the spawning capacity for migrants from Hamilton Harbour, such as northern pike and largemouth bass. Reduce carp and goldfish populations.

Hamilton Harbour

Hamilton Harbour may be a key area for restoration of the lake herring population, and consequently, the fish community in western Lake Ontario. Lake herring can provide an alternative to alewife, as a food source for walleye, salmon and trout in Lake Ontario or Hamilton Harbour. Unlike alewife, lake herring

are not susceptible to the winterkills, and they do not contain thiaminase which causes a thiamine deficiency and reduced natural reproduction among salmon and trout in Lake Ontario. Remnant lake herring populations in Lake Ontario spawn in large embayments, such as the Bay of Quinte, Weller's Bay, and West Lake. In western Lake Ontario, Hamilton Harbour is the only embayment of similar size and potential for lake herring spawning. Among all embayments in Lake Ontario, only the Bay of Quinte has more coldwater habitat than Hamilton Harbour. Restoration of Hamilton Harbour may be a necessary condition for the restoration of a native fish community in western Lake Ontario. For instance, large muskellunge require large prey. Muskellunge may benefit from restoration of lake herring, white suckers, walleye, and lake whitefish.

Nearshore Objectives - Increase the capacity for largemouth bass, smallmouth bass, northern pike, walleye, yellow perch, and sunfishes. Increase the spawning capacity for lake herring and lake whitefish.

Offshore Objectives - Increase the capacity for lake herring and walleye. Maintain stocking of brown trout and Chinook salmon for Lake Ontario.

Acknowledgements

We greatly appreciate the efforts of the three guiding committees of the Hamilton Harbour and Watershed Fisheries Management Plan: Angler's Working Group, Steering Committee, and Science and Technical Committee. The membership of the guiding committees is found in Appendix 7.3.2. Maps were created with the helpful assistance of LOMU staff. This plan was partially funded by the Canada-Ontario Agreement.

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This chapter provides an overview of the key fisheries and/or management-related concepts, the guiding principles for fisheries management plans, and the public input into the plan. As well, we introduce the key issues, and provide our goals and objectives. The second chapter illustrates the roles and responsibilities of the government, other institutions and stakeholders in producing and implementing this plan. Chapters 3 and 4 provide background information on the watershed characteristics, fisheries management zones, and fish communities. The major issues and management options are addressed in Chapter 5. The remaining portion of the document is supporting information.

1.1 Background

Hamilton Harbour is a large embayment at the western tip of Lake Ontario (Figure 1.1). The Hamilton Harbour watershed, which includes the contributing streams and creeks, covers an area of approximately 500 km^2. It encompasses some of the regions most scenic and diverse landscapes: the Niagara Escarpment is a prominent physical feature, and Cootes Paradise is one of the largest and most significant coastal wetlands of Lake Ontario. The main tributaries of Hamilton Harbour include Spencer Creek, Grindstone Creek, and Red Hill Creek. However, many smaller tributaries extend from the headwater areas to the Harbour. The streams and creeks in the watershed, Cootes Paradise, and Hamilton Harbour serve as popular destinations for hikers, naturalists, anglers, and boaters.

Hamilton Harbour and its watershed are home to diverse fish communities and significant aquatic habitats. Hamilton Harbour supports fish species such as bullheads, largemouth bass, walleye, and stocked salmon and trout. The watershed supports stream-dwelling species, such as creek chub, brook trout, and white suckers. More than 106 fish species have been found in Hamilton Harbour and its watershed. Today there are about 83 fish species, and 72 of these species are native to Ontario.

In 1987, Hamilton Harbour was officially designated as an Area of Concern (AOC) by the International Joint Commission, pursuant to the Great Lakes Water Quality Agreement. A RAP was initiated in 1989 (Stage 1 Report) and implementation of rehabilitation activities, to improve the quality of the Hamilton Harbour, began in 1992 (Stage 2 Report). During the 1990s, the watersheds of the AOC were recognized as contributing to the degradation of the harbour. As a result of the RAP, water quality and fish habitat in Hamilton Harbour improved significantly, and fish communities have responded positively. Consequently, many fisheries and habitat initiatives have been undertaken throughout the Hamilton Harbour and its watershed. This Fisheries Management Plan was created, in part, through needs of the RAP to direct activities according to fisheries management objectives for Lake Ontario and the watersheds surrounding Hamilton Harbour.

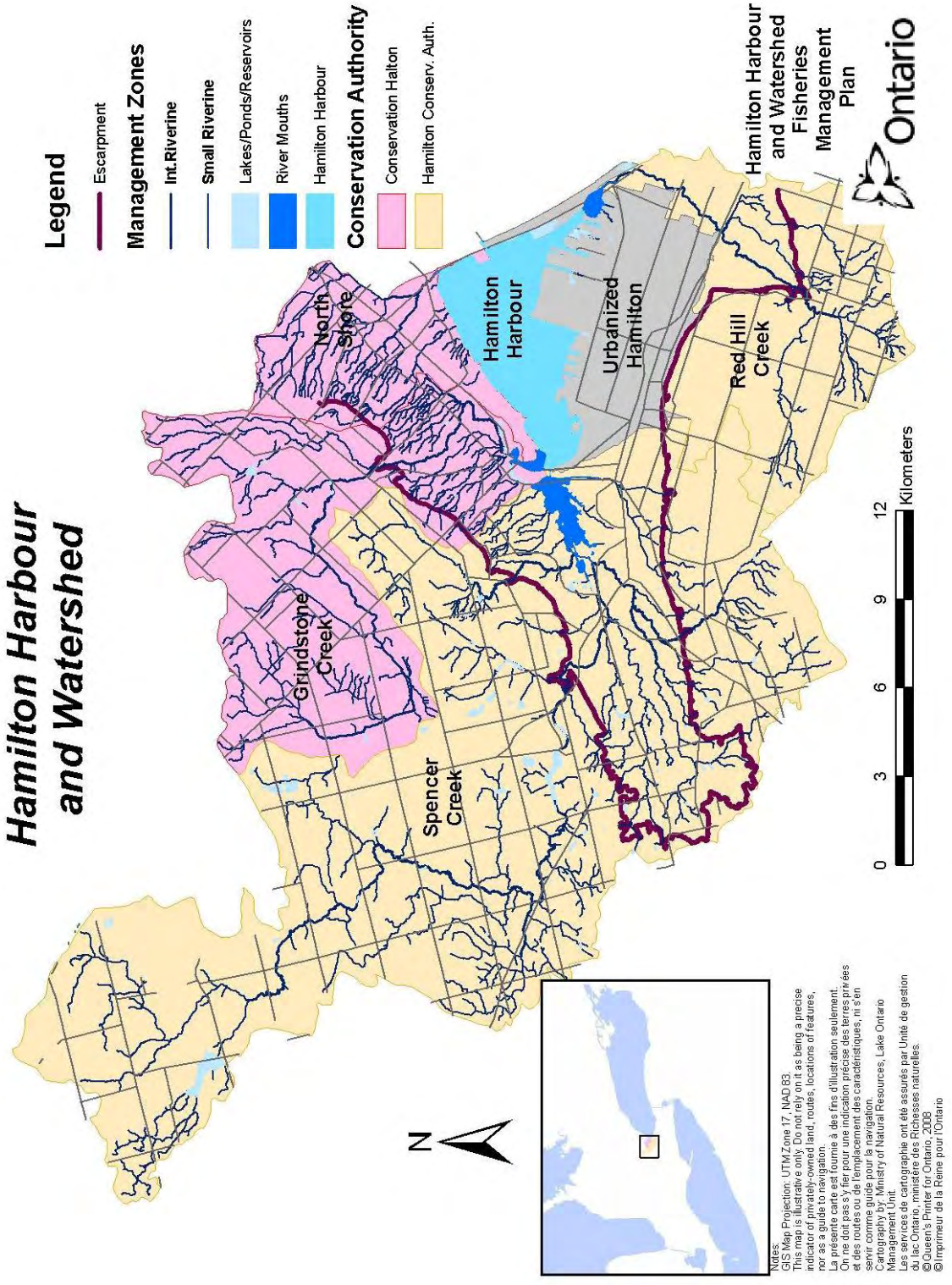


Figure 1.1. Map of Hamilton Harbour and watershed.

1.2 Key Concepts and Guiding Principles

Various fisheries related targets were previously established in District Fisheries Management Plans, and through the RAP framework. Through the HHWFMP, these fisheries targets have been revisited to reflect key concepts and guiding principles, specific public consultation, and OMNR's local fisheries management interests.

Key concepts and guiding principles from many OMNR strategic documents were consulted (Appendix 7.1), for example, "Protecting What Sustains Us: Ontario's Biodiversity Strategy", "Our Sustainable Future – Ministry of Natural Resources – Strategic Directions" (OMNR 2005a), the "Strategic Plan for Ontario Fisheries (SPOF II)", an "Aquatic Ecosystem Approach to Managing Fisheries" (OMNR 1992), and Watershed-based Fisheries Management Plan Guideline were consulted. As well, the Department of Fisheries and Oceans Canada's "Policy for the Management of Fish Habitat", and bi-national agreements such as "A Joint Strategic Plan for Management of Great Lakes Fisheries", the Lakewide Management Plan (LaMP), and "Fish-Community Objectives for Lake Ontario" were consulted. Thus, the fisheries management plan for the Hamilton Harbour and its watershed harmonizes with broader resource management initiatives and strategically guides future fisheries remedial actions in this region.

Specific Fish-Community Objectives for Lake Ontario that pertain to Hamilton Harbour

Nearshore Fish Community

- Maintenance of existing walleye populations and expansion of walleye populations into favourable habitats
- Maintenance of existing yellow perch populations and expansion of yellow perch populations into favourable habitats
- A population recovery of the lake sturgeon sufficient for its removal from New York's list of threatened species
- Population levels of smallmouth bass, largemouth bass, and sunfishes attractive to anglers
- Increasing numbers of American eels consistent with global efforts for their rehabilitation

Offshore Pelagic Fish Community

- A diversity of salmon and trout
- Chinook salmon as the top predator
- Abundant populations of rainbow trout (steelhead)
- Fishable populations of coho salmon and brown trout
- Populations of stocked Atlantic salmon at levels consistent with investigating the feasibility of restoring self-sustaining populations
- Amounts of naturally produced (wild) salmon and trout, especially rainbow trout, that are consistent with fishery and watershed plans
- A diverse prey-fish community with the alewife as an important species

Offshore Benthic Fish Community

- Lake trout as the top predator
- A population expansion of lake whitefish from north-eastern waters to other areas of the lake
- Rehabilitated native prey fishes

1.3 Scale of the Plan

The HHWFMP was developed at a watershed scale, since the watershed is the basic ecosystem unit used for planning and managing resources in the Hamilton Harbour area. In the HHWFMP Management Zones were designated based on Hamilton Harbour's watersheds: North Shore, Grindstone Creek, Spencer Creek, Red Hill Creek, and on Hamilton Harbour, itself.

Watershed management is critical to fisheries management because activities on the land affect the quality and quantity of water resources, and in turn, fish habitat and fish communities. Land use activities and land use planning must consider impacts of development and activities on the water resources, to ensure the quality of aquatic resources. In addition, Hamilton Harbour and Cootes Paradise function as part of the Lake Ontario ecosystem to a much greater extent than the surrounding watershed. Hamilton Harbour is open to exchanges of water and aquatic community with Lake Ontario. Historically, warmwater and coldwater fish from Lake Ontario depended on Hamilton Harbour for spawning and nursery. This function has been lost along with the habitat in the Harbour. Restoring this

What is a "watershed?

- A watershed is an area of land where all surface runoff, including water sediments, nutrients and contaminants, drains into a common point such as a lake, river, stream, creek, or estuary.

What are the advantages of a watershed-based approach for fisheries management?

- Watersheds are defined biophysical units and represent a logical ecosystem boundary;
- The interconnections between land-use activities on water resources are acknowledged;
- The linkages between upstream activities on downstream uses are considered; and
- Watersheds are often used as a planning unit (in Ontario) which is useful for the implementation of management actions.

function with Lake Ontario requires a unique set of management recommendations for Hamilton Harbour compared to its contributing watershed. This fisheries management plan specifically relates to fish and water. However, it also acknowledges relationships with other components in the watershed. Accordingly, the HHWFMP can be integrated into respective watershed plans in the area.

1.4 Public Input

Public participation is important for success of any Resource Management Planning process as it helps to ensure that the plan will address public issues and incorporate community activities. Everyone who shares an interest in the aquatic resources of Hamilton Harbour and its watershed must have open and easy access to information, and opportunities to provide input to shape the decisions that affect both their lives and the resource. Public input was sought through two rounds of Public Open Houses and through participation of the Angler's Working Group and Steering Committee in the planning process.

1.4.1 Public Open Houses

The first round of Public Open Houses was held to help determine ideas of the public regarding the key issues and management of the fish communities in Hamilton Harbour and its watershed. Questionnaires were given out participants in these open houses. These Public Open Houses were held on July 12, 2005 at Royal Botanical Gardens (RBG) and on July 14, 2005 at the Beverley Community Centre in the Town of Flamborough. These locations improved the access for the public near Hamilton Harbour and in the upper watershed. The second round of Public Open Houses was held to distribute the results of the first round of public consultations and the proposed goals, objectives, and management zones for the HHWFMP. One Public Open House was held on December 6, 2005 at RBG. Details of public input from these Public Open Houses are found in Appendix 7.3.1.

Key findings from the questionnaire at the first Public Open Houses were:

- Most respondents identified themselves as anglers or environmentalists
- Respondents are primarily concerned with quality and health of water resources, loss of aquatic habitat, and the need for more local fishing opportunities,
- All respondents agreed that fish are an important element of our natural heritage
- Respondents support increasing public awareness/education about fisheries-related issues

The respondents identified the following as priority issues:

- Loss of habitat
- Water quality
- Contaminants
- Loss of wetlands

The respondents identified the following as management priorities:

- Increasing public awareness
- Restoring and protecting native fish species
- Limiting incompatible land-uses
- Removing fish barriers
- Increasing and/or improving fishing opportunities

The respondents identified the following fish as requiring management action:

- Smallmouth and largemouth bass
- Walleye
- Northern pike and muskellunge
- Yellow perch, sunfish, pan fish, crappies
- Common carp Round goby
- Brook trout, rainbow trout, salmonids
- Native minnows

1.4.2 Guiding Committees

Three committees were established for the development of this plan, and they were invaluable in its evolution: Anglers Working Group, Steering Committee, and Science and Technical Committee (Appendix 7.3.2). The Anglers Working Group provided advice and information about fishing-related initiatives, concerns and ideas in the watershed. The representatives who sat on this committee served as a liaison, of sorts, between anglers groups and other committees.

The Steering Committee was responsible for making decisions about the direction of the plan. Members had a broad range of interests, so that community interests were represented as best as possible. Ontario Ministry of Natural Resources (OMNR) is responsible for fisheries management and planning in the Province of Ontario. OMNR provides information, technical advice, and guidance on fisheries program and policy matters. OMNR Aurora District and Lake Ontario Management Unit co-chair the steering committee. Various levels of government, and a broad range of stakeholders, including non-government organizations, private companies, special interest groups, and individual members of the public have been, and will continue to be important for the development, implementation and success of this fisheries management plan.

The Science and Technical Committee communicated regularly throughout the planning process and provided technical and scientific expertise about fisheries resources in Lake Ontario, Hamilton Harbour and its broader watershed. They helped provide background information, interpret the data, delineate management zones and develop management recommendations based on the information available.

1.5 Goals and Objectives

The goal of this Fisheries Management Plan is *to support diverse, well-balanced, and healthy aquatic ecosystems that provide sustainable benefits to meet society's present and future needs*. The HHWFMP has three broad objectives (adapted from SPOF II):

4. to protect healthy aquatic ecosystems
5. to rehabilitate degraded aquatic ecosystems
6. to improve cultural, social and economic benefits from the aquatic resources of Hamilton Harbour and its watershed

2 Relevant Institutional Arrangements and Watershed Stakeholders

2.1 Introduction

Government and non-government organizations are involved in managing and protecting fisheries resources in the Hamilton Harbour watershed. All stakeholders can play a role in protecting and rehabilitating fisheries resources. The Ontario Ministry of Natural Resources (OMNR) has primary responsibility for fisheries management and planning in Ontario. Federal and municipal governments, Conservation Authorities, and non-government organizations also play a part in the management of local fisheries resources. Numerous pieces of legislation, policies, and programs have been developed by many of the agencies and organizations operating in the watershed, which help to guide the management of fisheries resources. These documents were considered in the development of this plan, so as to complement, not overlap, existing fish management policies and programs.

An overview of the relevant institutional arrangements that relate to fisheries management is outlined in the following subsections of this chapter. In addition, some of the key stakeholders and their fish-related mandates are highlighted in Appendix 7.2.

2.2 International Institutional Arrangements

The Great Lakes Water Quality Agreement (GLWQA) is the most crucial bi-national agreements impacting the Hamilton Harbour ecosystem (Appendix 7.2.2). This agreement, between the United States and Canada, expresses the commitment of each country to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem and includes a number of objectives and guidelines to achieve these goals. The International Joint Commission (IJC) administers this agreement with the Canadian and United States federal governments, as well as the Provincial and State governments that border the Great Lakes. Under this Agreement, Hamilton Harbour has been designated an Area of Concern, due to concerns relating to pollution, water contamination, and loss of fish and wildlife habitat. Subsequently a Remedial Action Plan for Hamilton Harbour was established under the GLWQA, to develop a plan to restore and mitigate affected environmental conditions.

Hamilton Harbour Remedial Action Plan

In accordance with the Great Lakes Water Quality Agreement (GLWQA) a Remedial Action Plan (RAP) was established for the Hamilton Harbour AOC in 1987. In 1989 a report defining the problems in the harbour (Stage One) was submitted to the International Joint Commission followed by a report suggesting goals, options and recommendations (Stage Two) which was submitted in 1992. While these submissions were to meet the formal requirements under the GLWQA, this is not to say that remedial work waited until 1992. There have been many ongoing initiatives, which have led to improvements in the AOC.

A process to update the RAP Stage 2 report began in 1998, with the formation of a RAP Forum. The purpose of the Forum was to produce a draft document for public consultation. The Forum was made up of just over 50 stakeholders, which included a number of participants in place at the time of the publication of the original RAP Stage 2 Report in 1992. A draft Stage 2 Update was completed in 2002 and public consultation occurred shortly after. Having completed their duties, the RAP Forum was dissolved in December 2002.

The RAP Stage 2 Update is now complete and was presented to the federal and provincial governments and the International Joint Commission in September 2003. It provides the current status of the RAP and identifies 57 recommendations for implementation.

The Hamilton Harbour Area of Concern is one that will not be delisted in the short-term; delisting is targeted for 2015. Many of the issues affecting the harbour will require years of work to turn around. In the immediate future, there are a number of initiatives that will require the focus of a number of partners.

Sediment remediation is the top priority for Environment Canada. While efforts have been made in this area, much more work is required to show successful results. Work will continue on Randle Reef.

It is estimated that 40-50% of the water in the Harbour comes from discharges from the four Wastewater Treatment Plants (WWTP) and the Combined Sewer Overflow system. Upgrades to the Region of Halton's Skyway WWTP resulted in measurable improvements to water quality. The City of Hamilton is part way through a program to capture direct sewage discharges and upgrade their three WWTPs. However, this is a major undertaking that is estimated to take at least 15 years and cost approximately $480 million to meet RAP delisting objectives.

From: www.on.ec.gc.ca/water/raps/hamilton/develope_e.html

2.3 Federal Institutional Arrangements

Numerous pieces of federal legislation relate to fisheries management (Appendix 7.2.3). The Fisheries Act is the most important federal legislation for fisheries resources, as it outlines the regulatory requirements for fishing through the Ontario Fisheries Regulations and protecting and managing fish habitat. The Department of Fisheries and Oceans and OMNR are responsible for various sections of the Fisheries Act.

Fishing seasons, sanctuaries, methods and limits are regulated by the Ontario Ministry of Natural Resources under the Ontario Fisheries Regulations of the federal Fisheries Act. The Fisheries Act is used to regulate fishing seasons, catch and possession limits, size limits, gear types and sanctuaries.

Protecting and Managing Fish Habitat

Any works that occur in or near water may require authorization under the *Fisheries Act*. Under Section 35(1) of the Act, no person shall carry out any work or undertaking that harmfully alters, disrupts or destroys fish habitat, unless authorized by the Minister of Fisheries and Oceans Canada under Section 35(2). In addition to Section 35, the *Fisheries Act* sets out general habitat and pollution provisions which are binding on all levels of government and the public in areas such as:

- need for safe fish passage around migration barriers
- recovery of costs for obstruction to fish passage
- requirements for sufficient water flows
- protection of fish in or near fish-ways
- fish guards and screen
- destruction of fish
- destruction of habitat
- pollution of fish habitat
- obligations of proponents

Other pieces of legislation such as the Canadian Environmental Assessment Act (CEAA) are also important for the protection of fish resources. Carried out by Environment Canada, CEAA is meant to help predict the environmental effects of proposed initiatives before they are carried out and can cause harm to fisheries resources.

The management of species at risk is encouraged though policy and legislation by both the federal and provincial governments. The Government of Canada's Species at Risk Act (SARA) and the Province of Ontario's Endangered Species Act (ESA) provide protection for wildlife species at risk. These Acts are meant to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and encourage the management of other species to prevent them from becoming at risk. Nine fish species at risk may still be present in the Hamilton Harbour watershed.

2.4 Provincial Institutional Arrangements

Guiding documents such as the Strategic Plan for Ontario Fisheries (SPOF II), highlighted in chapter 1, are important policy documents for fish management in the Province of Ontario. However, numerous fisheries management-related pieces of legislation relate to the protection or management of fish or fish habitat (Appendix 7.2).

As previously noted OMNR has primary responsibility for fisheries management and planning in the province of Ontario. However, a number of other provincial agencies administer legislation that can affect fisheries resources. In particular, the Ontario Ministry of the Environment has primary responsibility for water quality and quantity matters.

2.5 Local Institutional Arrangements

Numerous policies and programs are implemented at the regional or local levels that support the management or protection of fisheries resources in the Hamilton Harbour watershed. At the local level, Conservation Halton, Hamilton Conservation Authority, City of Hamilton, City of Burlington, Region of Halton, and a number of angling or environmental groups are involved in activities that can benefit the fisheries resources in the watershed. Conservation authorities and municipalities are involved in both regulatory and non-regulatory initiatives that can have an impact on fish and fish habitat. For example, municipalities are involved in developing bylaws to set standards for development setbacks from rivers or

for implementing conservation easements in critical recharge areas. The Conservation Authorities will be vitally involved in carrying out this Fisheries Management Plan.

2.6 Public Involvement

Several non-government organizations (NGOs) also play key roles in fisheries management in the Hamilton Harbour watershed. NGOs and angling groups are involved in the implementation of many of the management recommendations of a fisheries management plan. Foremost in the development of this plan has been Royal Botanical Gardens, as a partner in producing this plan and in the management of many aspects of the aquatic resources of Hamilton Harbour, Cootes Paradise, Grindstone Creek, Spencer Creek, and tributaries.

The Hamilton Harbour RAP Office plays the key role of coordinating the planning activities and implementation for all groups involved in the restoration of the Hamilton Harbour AOC. The Bay Area Implementation Team (BAIT) is an instrument of the RAP and is composed of the Government Agencies and NGOs working towards the goals of the RAP. This Fisheries Management Plan is being produced under the umbrella of the RAP and its production is a BAIT target (FW – 11.8). Moreover, implementation of many parts of this plan will be coordinated through BAIT. The Bay Area Restoration Council provides public input to the RAP process.

Anglers and angling groups have become greatly involved the management of local aquatic resources. For example, ten angling groups were involved in the development of this plan (Appendix 7.3.2.1). Many of these angling groups, along with the Hamilton Waterfront Trust, and other institutional partners have worked to make the Hamilton Harbour Family Fishing Festival a great success, and this festival has raised public awareness about fisheries resources in Hamilton Harbour.

3 Watershed Characteristics

3.1 Introduction

The Hamilton Harbour watershed covers an area of approximately 500 square kilometres. The main tributary watersheds include Spencer Creek, Grindstone Creek, and Red Hill Creek, all of which drain into the Hamilton Harbour. Two large exposed sandbars form the harbour, one at the Beach Strip on the Lake Ontario side and another at Burlington Heights, separating it from Cootes Paradise. Cootes Paradise, located at the west end of the Harbour, is one of the largest and most significant coastal wetlands of Lake Ontario. The Niagara Escarpment is a prominent physical feature in the watershed and serves as a natural divide that distinguishes headwater areas from the river Mouth areas located below the escarpment.

More than 650,000 people live in the watershed. The main municipal centres include the Cities of Burlington and Hamilton, and former Towns of Ancaster, Dundas and Waterdown. Urban areas account for nearly thirty percent of the total land area. Another forty percent of the total land-use in the watershed is for agricultural purposes.

This chapter provides the context of the natural environment to this plan, describing the physiography, soils, climate, water quality and quantity, wetlands and forests that determine the fish community in the Hamilton Harbour watershed. As well, this chapter describes aspects of the human environment, such as land use and instream barriers that impact the fish community.

3.2 Natural Environment

3.2.1 Physiography and Soils

The Niagara Escarpment dominates the land around much of Hamilton Harbour. The overlying soils and physiographic features of the Hamilton Harbour watershed have resulted from glaciers and glacial rivers. Key physiographic areas of the watershed include the Iroquois Plains, Norfolk Sand Plains, Flamborough Plain, South Slope and the Niagara Escarpment (Figure 3.1).

The Niagara Escarpment is the most notable physiographic feature in the Hamilton Harbour watershed. The Niagara Escarpment is a limestone and dolomite ridge that extends from the Niagara River to Tobermory in the Bruce Peninsula. It extends south to north through Hamilton, Ancaster, Dundas, Burlington and Flamborough. The Niagara Escarpment is both a hydrological feature and a geological feature. In some areas, the escarpment is a sheer exposed rock face and other areas it is found beneath glacial deposits. Many headwater areas exist above the escarpment, where fractures in the dolomite or overlying sands and gravels make it valuable for groundwater recharge and storage. The Niagara Escarpment bisects much of the watershed. Above the escarpment, the landscape is relatively flat but is littered with glacial deposits of drumlins, eskers, kames, and outwash deposits of sand, silt and gravel.

The Iroquois Plains are located in the lower reaches of the North Shore and Grindstone Creek watersheds. This area is composed of the former lake bed and shorelines of glacial Lake Iroquois. The Norfolk Sand Plains are located in western portions of the basin, more specifically in the middle portions of the Spencer Creek watershed. This is an area of well-drained, sandy soils that are ideal for agriculture. The Flamborough Plains are located in the middle to upper reaches of the Spencer Creek watershed. This area yields drumlins throughout the limestone plain, as glacial deposits of sand and gravel are scattered throughout. Swamps are plentiful in this area and soils tend to be wet, stony, and shallow. The South

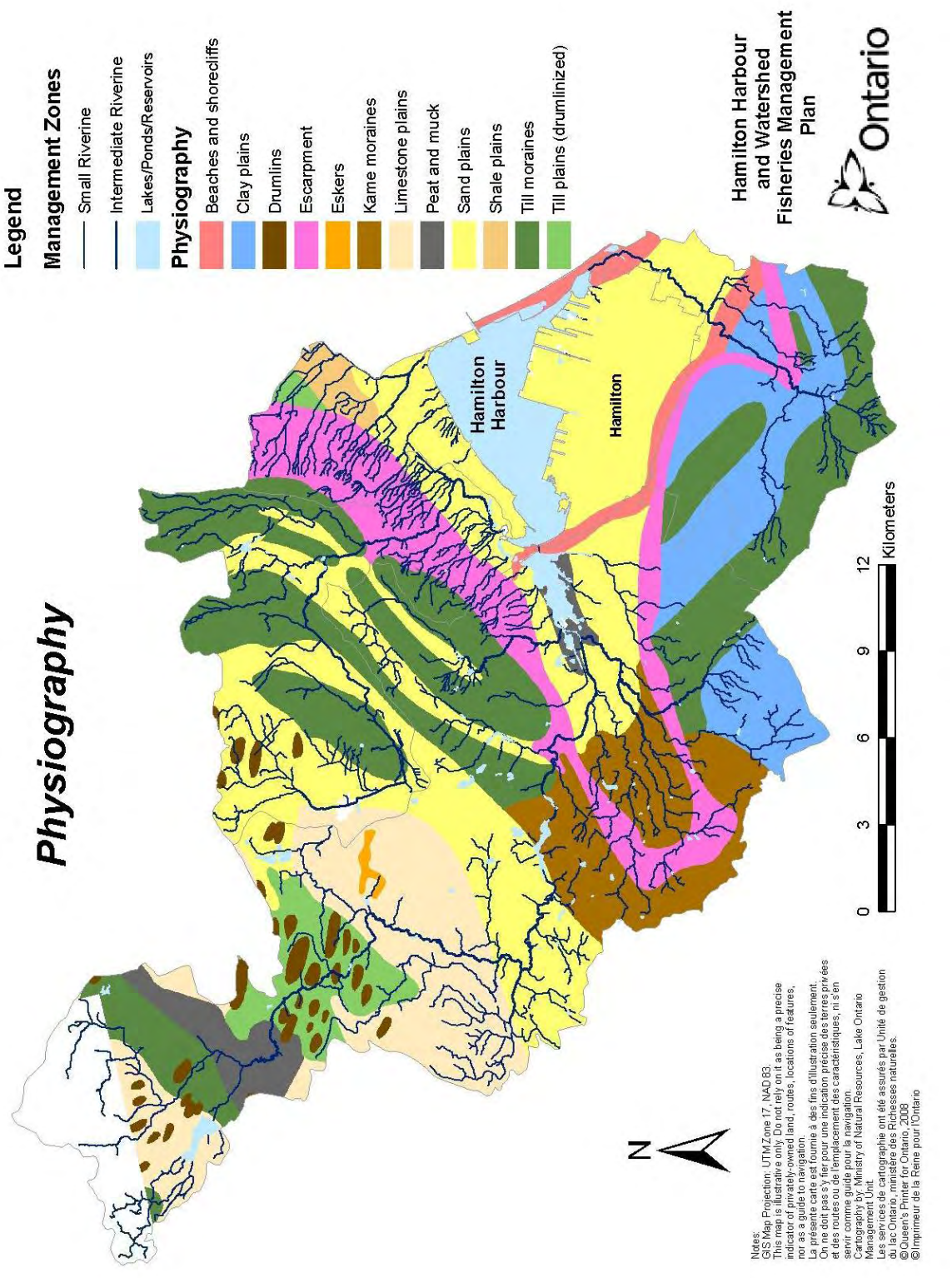


Figure 3.1. Map of the physiography of the Hamilton Harbour watershed.

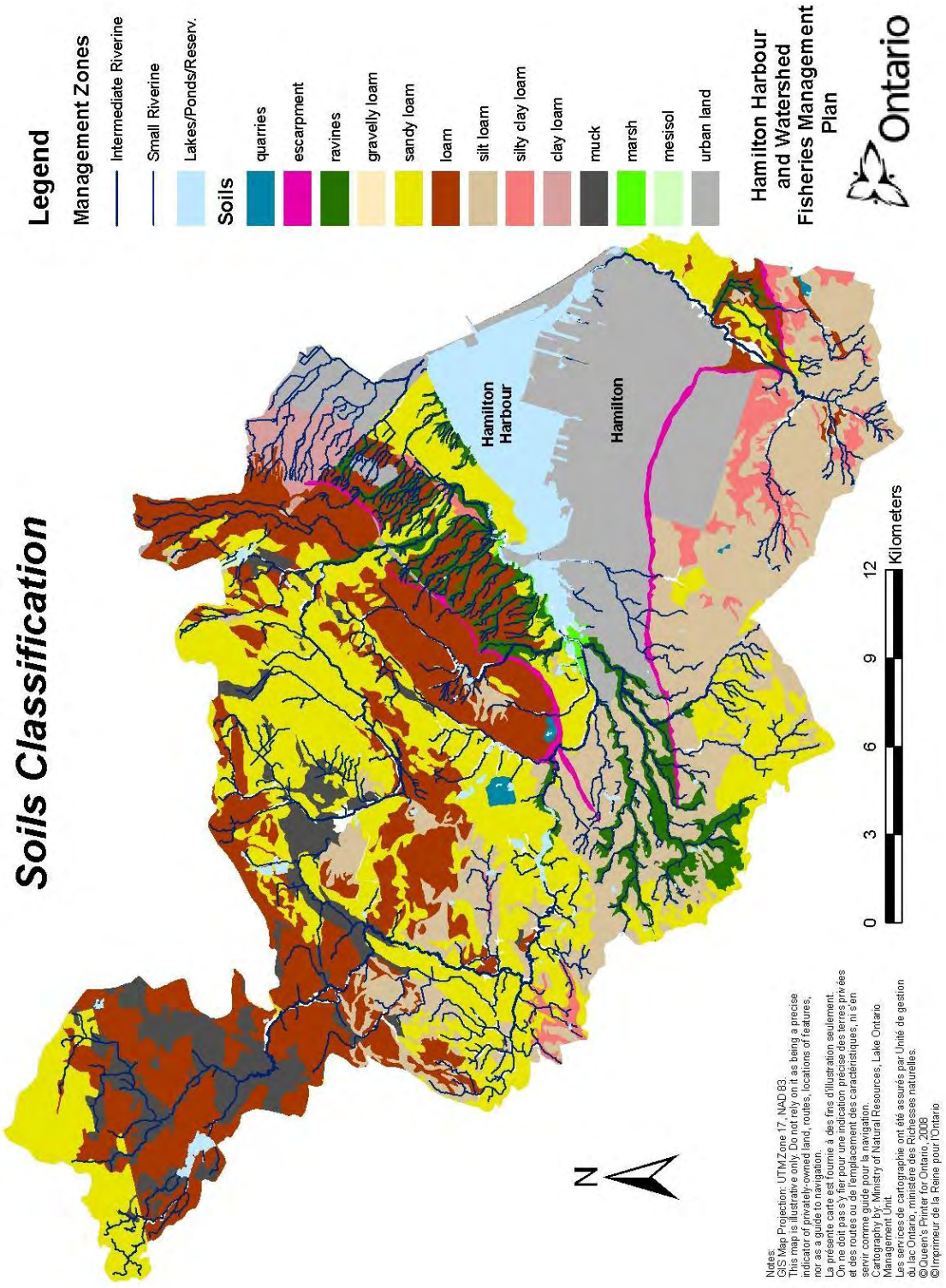


Figure 3.2. Map of the soils of the Hamilton Harbour watershed.

Slope is located between the Niagara Escarpment and the Iroquois Plain. It is an area rich in red, clay shale, and soils tend to be clay and silty loam (Figure 3.2). There are numerous valleys cut into the bedrock. The Dundas Valley is located in the western parts of the watershed. It is characterized by deep ravines and valleys.

3.2.2 Climate

The climate of the Hamilton Harbour watershed is a function of its latitude and longitude, and proximity to Lake Ontario. The Niagara Escarpment serves as a natural divide between two micro-climate zones in the watershed. Areas above the escarpment tend to be cooler and moister, whereas the drier and warmer region is below. Areas below the escarpment are greatly influenced by the "lake effect"; Lake Ontario has a moderating effect on lower, highly urbanized and developed reaches of the watershed. The lower watershed is cooler in summer and warmer in winter. Above the Niagara Escarpment mean annual temperature, length of growing season, and frost-free period decreases as one moves away from the lake. The average annual precipitation in the watershed is approximately 760mm.

3.2.3 Hydrological Characteristics

Areas of groundwater discharge and recharge have not been extensively determined in most of the Hamilton Harbour watershed. A groundwater study was conducted for the Grindstone Creek watershed area, as part of Conservation Halton's 1997 Watershed Study; three major recharge zones and two major discharge zones were identified based on the geology and the overlying soils. In addition, recent studies have shown that groundwater seepage occurs in various locations in the Hamilton Harbour. Groundwater potentially accounts for approximately 1 percent of the total volume of the Harbour (Harvey et al 1997a, Harvey et al 1997b).

Why is groundwater important to fish?

Groundwater is the result of water infiltrating into the ground through soil and rock, to depths where the voids can become completely filled with liquid. Groundwater in south-western Ontario is usually 8-10^{o}C. This is critical for the survival of many fish species, because it tends to moderate ambient stream temperatures during summer and winter. During summer, groundwater discharge into a stream can create a thermal refuge for fish that are sensitive to the higher temperatures. Groundwater discharges help maintain river flow during summer periods, when surface runoff is at its lowest point. Groundwater may provide oxygenated water that is necessary for life stages of some fish species. However, groundwater may be low in oxygen in some locations. The presence of several fish species, in particular brook trout, tends to be correlated with the presence of groundwater.

The streams, ponds, lakes and wetlands comprise the surface water resources in the Hamilton Harbour watershed, and include Northshore tributaries, Grindstone Creek, Spencer Creek, Red Hill Creek, Lake Medad, Valens Reservoir, Christie Reservoir, Beverly Swamp, Cootes Paradise, and Hamilton Harbour. The characteristics of these water bodies are described in more detail below.

3.2.3.1 Water Quality

Water quality in Hamilton Harbour and Cootes Paradise is the most important factor that currently limits the successful restoration of sustainable, self–reproducing native fish community. In 1987, Hamilton Harbour was designated one of 43 Areas of Concern under the in the Great Lakes Water Quality Agreement (GLWQA), a joint undertaking between the governments of Canada and United States. Inputs from wastewater treatment plants (WWTPs), industrial activity, and runoff from urban and agricultural areas produced significant increases of nutrients in the Cootes Paradise Marsh and Hamilton Harbour. In turn, water quality and aquatic life declined in the Hamilton Harbour area. In 1987, a Remedial Action Plan (RAP) under the GLWQA was developed to explain how environmental problems would be addressed in the Hamilton Harbour. Since establishment of the RAP, municipal WWTPs have upgraded their facilities to improve the effectiveness of treatment processes with the intent of reducing the release of nutrients and other contaminants into the Harbour and Cootes Paradise. For instance, most urban stormwater is treated in these treatment plants. These upgrades have successfully reduced contaminants

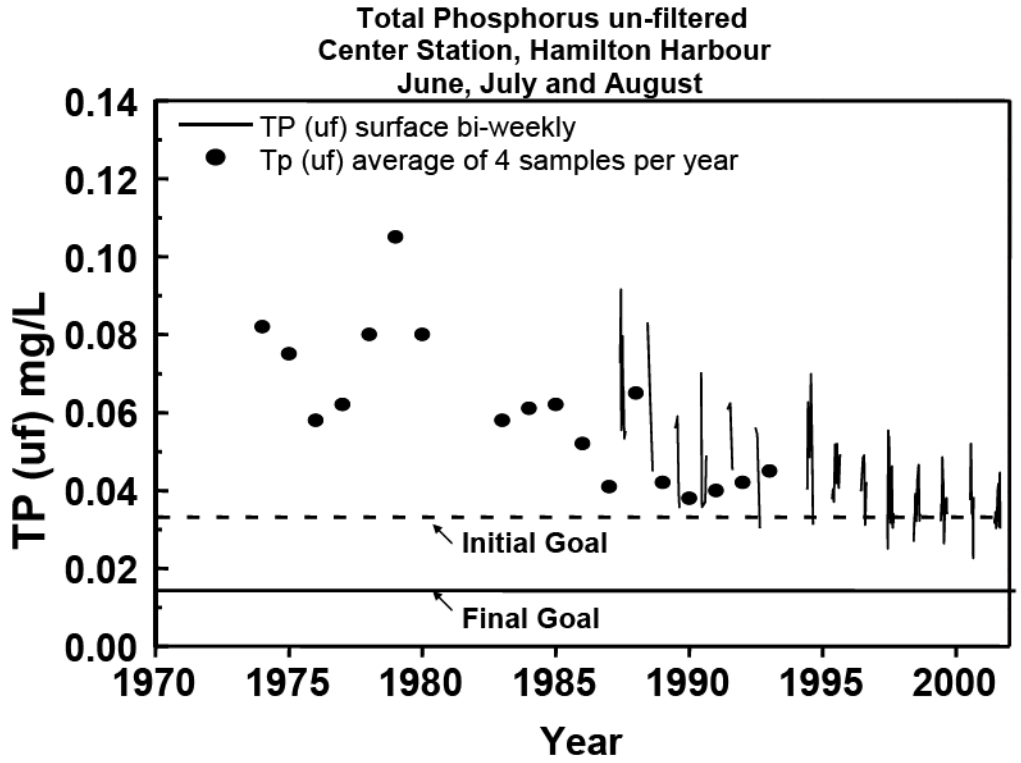


Figure 3.3. Total phosphorus concentration during June, July, and August at the centre of Hamilton Harbour (Figure from Stage 2 RAP Update, Environment Canada).

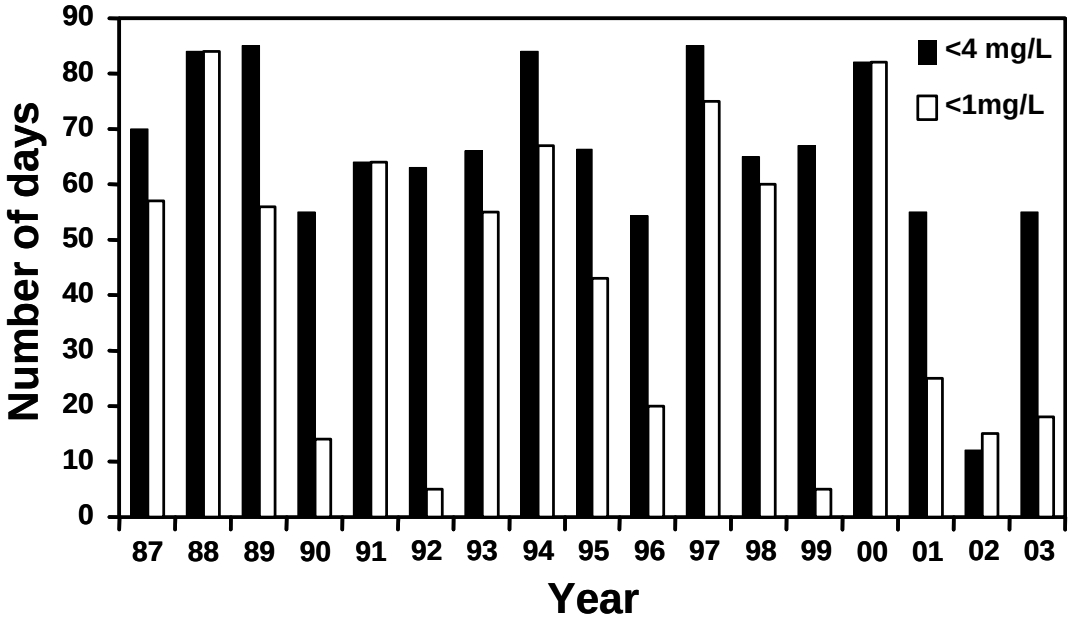


Figure 3.4. Number of days during summer when oxygen is too low for fish 1m off bottom at the centre station in Hamilton Harbour (data from Environment Canada). Initial and final RAP goals are 1 and 4 mg/L, respectively.

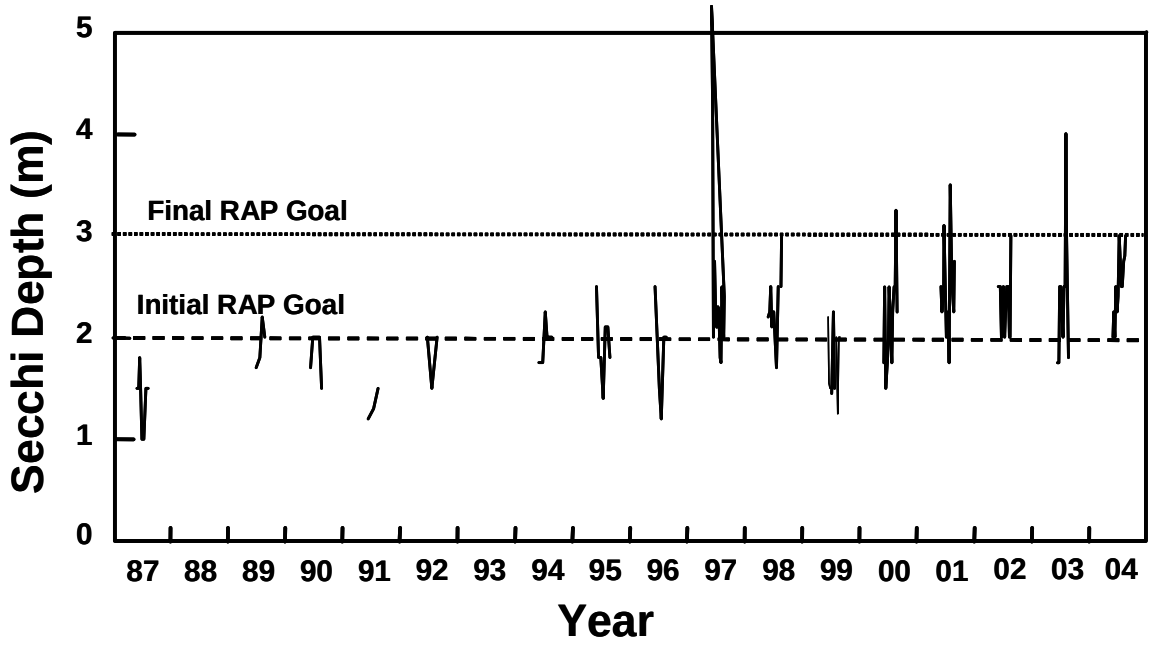


Figure 3.5. Water clarity (depth a Secchi disk remains visible from the surface) at the centre station in Hamilton Harbour (data from Environment Canada).

loadings into the harbour. As well, loadings from industries and non-point sources have been reduced. The level of phosphorus in Hamilton Harbour has declined substantially toward the RAP goal of 17 µg/L (Figure 3.3). However, phosphorus remains elevated in Hamilton Harbour, contributing to high algae growth and low water clarity (Figure 3.4), which impairs the quality of habitat for visual feeding fish, such as bass, pike, and yellow perch. Moreover, high algae concentration reduces oxygen in the harbour, and at times dissolved oxygen levels fail to meet the RAP goal of 4 mg/L, considered the minimum threshold needed for fish survival (Figure 3.5).

Increases in settlement, agricultural activities, forest clearing, constructions of dams and mills, and industrial activity have impacted the temperature, flow and quality of water resources in the watershed and Harbour. In particular, a shift from coldwater species, such as brook trout, to coolwater and warmwater species (see below) indicates an increase in the temperature of most of the creeks in the watershed. The quality of water resources in the Hamilton Harbour watershed is variable. Some reaches of the watershed's streams meet provincial water quality guidelines yet the majority of urban reaches are contaminated. Some creeks and marsh areas yield high levels of nutrients and bacteria from agricultural and urban runoff.

3.2.3.2 Water Quantity

Spencer Creek has the greatest average flow and base flow of the streams in the Hamilton Harbour watershed followed by Grindstone Creek and then Red Hill Creek (Table 3.1). Basin yields in Spencer Creek indicate it has the highest groundwater discharge, particularly in reach from Westover to Highway 5 (Table 3.1). However, it is unclear if this groundwater enters Spencer Creek or its tributaries. From Highway 5 to Dundas the flow of Spencer Creek declines, indicating the creek is recharging the groundwater table. The basin yield in Grindstone Creek and Red Hill Creek showed some similarities (Table 3.1). The basin yield in Red Hill Creek declines below the Niagara Escarpment. In contrast groundwater flows in Grindstone Creek may increase below the escarpment, as indicated by shifts

Table 3.1. Stream flow statistics for streams in Hamilton Harbour watershed (data from Environment Canada). Summer low flow index = summer low flow/average flow.

Stream	Location	Average flow ($m^3 s^{-1}$)	Base flow ($m^3 s^{-1}$)	Summer low flow ($m^3 s^{-1}$)	Drainage area (km^2)	Basin yield ($m^3 d^{-1} km^{-2}$)	Summer low flow index
Grindstone	Aldershot	0.634	0.266	0.089	82.6	278.6	0.14
Spencer	Westover	0.613	0.265	0.047	63.5	360.8	0.08
Spencer	Highway 5	1.625	0.682	0.073	132.0	446.6	0.05
Spencer	Dundas	1.457	0.461	0.049	169.0	235.5	0.03
Red Hill	Albion Falls	0.287	0.076	0.050	23.5	277.7	0.17
Red Hill	Queenston Rd.	0.611	0.140	0.065	60.9	199.2	0.11
	Change in flow from:						
Spencer	Westover to Highway 5	1.012	0.417	0.026	68.5	526.1	
Spencer	Highway 5 to Dundas	-0.168	-0.222	-0.024	37.0	-517.7	
Red Hill	Albion Falls to Queenston Rd.	0.324	0.065	0.015	37.4	149.8	

in the fish community. Groundwater is especially important for maintaining the temperatures for coldwater fish. As well, summer low flow indicates the amount of habitat in streams during a critical time for coldwater fish. Young salmon and trout are rarely seen in other Lake Ontario tributaries with a summer low flow index less than 0.08, and the index for better trout streams is usually greater than 0.2 (Lake Ontario Management Unit data). Accordingly, the stream flow data for mid or lower sections Grindstone, Red Hill, and Spencer Creeks suggest some potential for salmon and trout production.

Altered drainage and impervious surfaces found in the Red Hill Creek and North Shore watersheds pose problems during storm events because high flows from urban sewer systems dramatically alter stream dimensions and erosion of the channel.

3.2.3.3 Riparian Zone

Riparian zones are the transitional areas between land and water, connecting aquatic and terrestrial habitats adjacent to a stream channel or lake. Healthy riparian areas are important factors in the maintenance of in-stream water quality and fish habitat. Riparian vegetation can help to maintain the stability of stream banks, reduce erosion, provide cover and shade for fish. The shading of riparian vegetation can help reduce stream temperatures during the warm months of the year. Terrestrial vegetation provides a food source to some stream invertebrates.

Spencer Creek has a high percentage of stream length with riparian buffer (Table 3.2). None of the streams meet Environment Canada's recommendation that 75% of a stream should be naturally vegetated with riparian zones of 30 m on both sides. More of the riparian zone in Red Hill Creek has been destroyed by urban development, and so, achieving 75% riparian buffer is less likely in this watershed. However, a restoration plan using a natural channel design has been developed for the construction of the Red Hill Valley Expressway, and riparian vegetation along Red Hill Creek is expected to increase.

Table 3.2. The amount of natural riparian buffer in Hamilton Harbour watersheds.

Stream	Length (km)	Riperian buffered (% width >30 m)	Riperian buffered (%)
Spencer	421	61.5	85.5
Red Hill	76	42.3	68.3
Grindstone	196	65.7	90.5
North Shore	107	42.6	67.5
ALL	801	58.2	82.7

3.2.4 Natural Heritage

The natural heritage features that exist in the Hamilton Harbour watershed are a function of many factors, including physiography, soils and climate. Natural heritage refers to key natural areas such as forests, valley lands, wetlands, meadows, streams and habitats of species of conservation concern. For the purposes of this report, the following natural heritage features will be highlighted in this section: riparian areas, forest cover, and wetlands (Figure 3.6, 3.7). Riverine and lake habitats and their fish communities are covered with more detail in Chapter 4 of this plan.

3.2.4.1 Wetlands

A wetland is seasonally or permanently covered by shallow water, or is where the water table is close to or at the surface. Wetlands have both terrestrial and aquatic characteristics, which leads to further classifications as marsh, swamp, fen, or bog.

Most losses of wetlands in the Hamilton Harbour watershed occurred prior to the 1960s. During the late 19th and early 20th century, extensive marshes at the southern shoreline of Hamilton Harbour were filled-in and converted to port or industrial land to serve the growing commercial needs of the Hamilton area. Presently, wetlands constitute about 8% of the total land area in the watershed (Table 3.3). The majority are located in Beverly Swamp in the upper reaches of the Spencer Creek watershed. As well, Spencer Creek empties into Cootes Paradise, a river Mouth marsh. The Hayesland-Christie and Flamborough complexes are important wetlands in the Grindstone Creek watershed above the Niagara Escarpment, and the Hendrie Valley marshes are at the Mouth of Grindstone Creek. Van Wagner's marsh is the wetland at in the Mouth of the Red Hill Creek. A remnant wetland is found at the Mouth of Indian Creek in the North Shore watershed.

Table 3.3. The percent of major natural heritage features and land use in Hamilton Harbour watersheds.

Watershed	Area (Ha)	% Wetland	% Urban	% Agriculture	% Forest
Spencer	25,753	11	15	45	23
Red Hill	6,640	0	50	27	2
Grindstone	9,918	13	9	50	23
North Shore	3,344	0	70	5	20
Urban Hamilton	3,965	0	100	0	0
Harbour	2,150	0	0	0	0
ALL	52,020	8	28	36	17

3.2.4.2 Forest Cover

The benefits of forest cover in the riparian zone of Hamilton Harbour watershed were discussed above. Forest cover in upland areas benefit streams by and reducing the rate runoff of from spring snow melt and major storms, thereby of reducing erosion and encouraging recharge to groundwater. Most of the forest cover in the Hamilton Harbour watershed is found in the Spencer Creek and Grindstone Creek watersheds (Table 3.3).

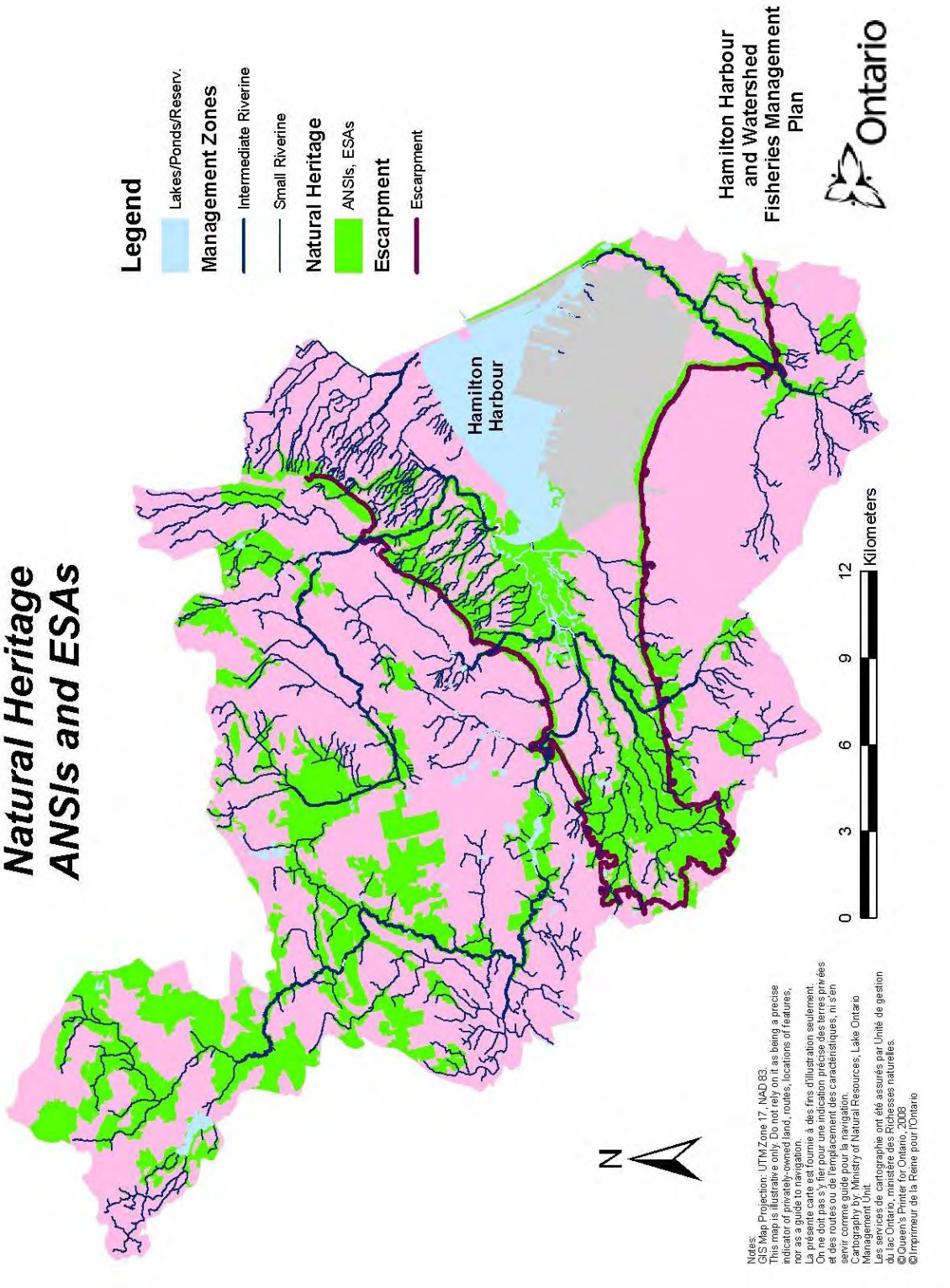


Figure 3.6. Map of Areas of Natural Interest (ANSIs) and Environmentally Sensitive Areas (ESAs) in the Hamilton Harbour Watershed.

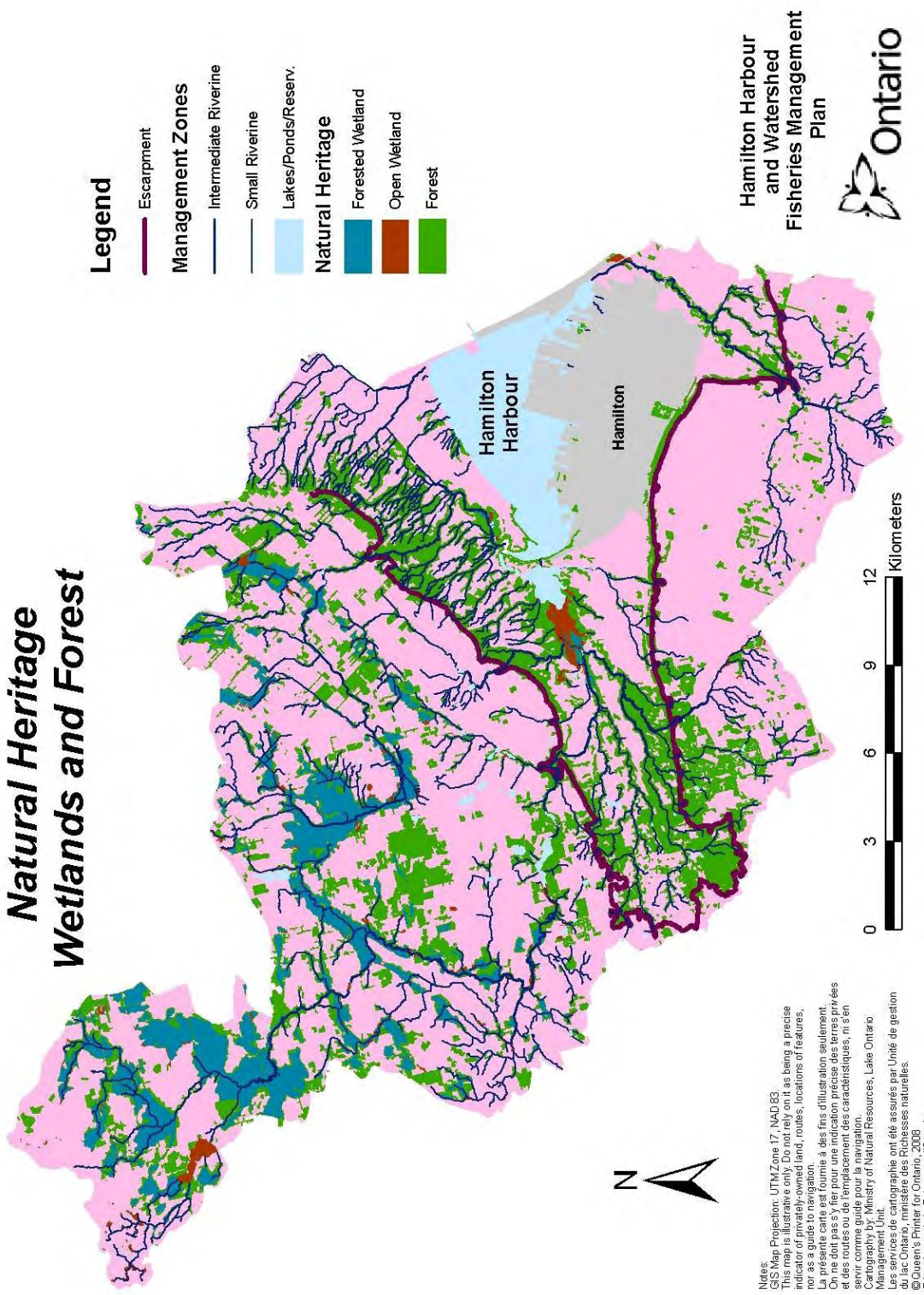


Figure 3.7. Map of forests and wetlands of the Hamilton Harbour Watershed.

3.3 Human Environment

3.3.1 Settlement

The first inhabitants of the Hamilton Harbour watershed were First Nations peoples. Several Iroquoian tribes made their home in the area through the 1600s and 1700s as Europeans began to visit and eventually settle. By the 1800s much of the area was settled by Europeans, who cleared forests and drained wetlands for agriculture and residential development. The need for saw and grist mills led to the construction of dams on streams in the watershed. Industrial development, particularly with respect to iron and steel, was a key reason for this region's growth. The two major steel industries in the area are AcelorMittal Dofasco and U.S. Steel. The Hamilton Harbour boasts the largest Canadian port in the Great Lakes (O'Connor 2003).

Today more than 650,000 people live in the Hamilton Harbour watershed. Although, the impacts of industrial development have long been a concern for humans and animal life, human population growth is an increasing impact on the Hamilton Harbour watershed. The major urban areas in the watershed include the Region of Halton, and Cities of Burlington and Hamilton. The population of the City of Burlington is expected to average 1.1% growth from 2000 to 2011, and the City of Hamilton is expected to increase from nearly 500,000 in 2001 to more than 620,000 in 2031.

Known as the "Golden Horseshoe", the leading sectors of employment in the watershed includes manufacturing, trade, education, health and social service and general service. The Hamilton Harbour area is experiencing growth in the same way as many other communities in North America, meaning that there is an increase in peripheral growth and suburban sprawl. This spill over from urban areas causes a loss of natural open space areas, losses of agricultural lands, increased traffic congestion, air and water pollution.

3.3.2 Land Use

The majority of land in the Hamilton Harbour watershed is designated as agricultural (Table 3.3), and the majority of agricultural lands are located above the Niagara Escarpment (Figure 3.8). Urban areas account for nearly 30% of the watershed's land use, and mostly are found below the escarpment, in the cities of Hamilton and Burlington. More than 29% of the watershed is designated as environmentally significant (or sensitive) areas (ESA). This includes the Cootes Paradise marshlands, some forested areas, and areas with unique landforms. ESAs are subject to a number of policies or regulations that prevent or limit development from occurring in ecologically sensitive areas.

3.3.3 Fragmentation of Habitat

Natural and human-made barriers in streams cause fragmentation of habitats, restrict the movement of fish, and result in geographic isolation of fish populations. Natural barriers, such as beaver dams or fallen trees, may temporarily restrict the movement of fish. More permanent barriers to fish movement, such as the Niagara Escarpment, determine the natural fish distribution or biodiversity of a stream. Fish downstream of the waterfalls on the Niagara Escarpment may not access the upstream reaches. This may protect some native species from competition with natural or exotic invaders to the watershed. Beaver dams diversify habitat by temporarily creating ponds. However, many man-made barriers in streams have disrupted migrations, movements, and distribution of fish across a watershed.

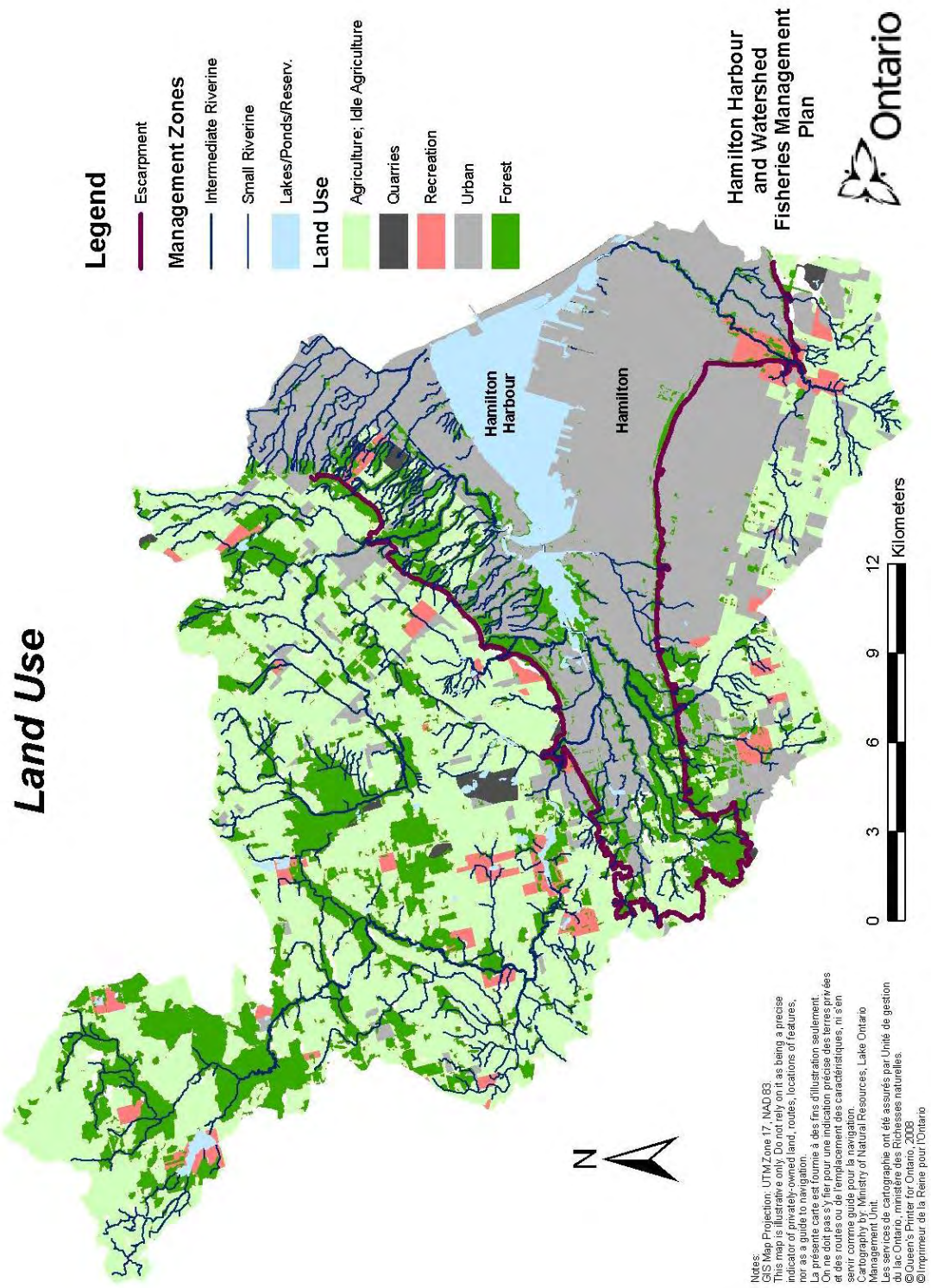


Figure 3.8. Map of land use in the Hamilton Harbour watershed.

The most obvious man-made barriers to fish are dams for hydro generation, mills, and flood control. As well, road culverts, and channel hardening for erosion control may restrict fish movement. These barriers may impede the migration of some fish to spawning and nursery habitats, and dramatically alter the habitat by regulating flow and altering stream temperatures. In the Hamilton Harbour watershed fish communities have been altered by instream barriers. For example, the warming of water in Valens Reservoir turns a cold water tributary of Spencer Creek into a warm water creek, no longer suitable for brook trout.

The Hamilton Harbour watershed contains at least 140 instream barriers (Table 3.4). Significant barriers in Spencer Creek include Valens Reservoir, Christie Reservoir, and Crook's Hollow Reservoir. The North Shore watershed has more barriers per kilometre than other streams. A more comprehensive survey of the Hamilton Harbour watershed is being conducted to determine the number and type of barriers and to determine the best way to mitigate their impacts.

Table 3.4. The estimated number of barriers in Hamilton Harbour watersheds in 2005.

Stream	Number of barriers
North Shore	46
Grindstone Creek	39
Spencer Creek	48
Red Hill Creek	7

The Hamilton Harbour watershed also has unique man-made barriers, designed to reduce access for carp and goldfish to Cootes Paradise and other Royal Botanical Gardens Nature Sanctuaries. Carp and goldfish are not native to the area, and have interfered with the spawning and reproduction of native fish and wildlife species. Carp and goldfish uproot aquatic vegetation, and increase the water turbidity, making it difficult for aquatic vegetation to become established. The Cootes Paradise carp barrier is the largest of these barriers. It was completed in 1996 as part of a larger plan to restore the Cootes Paradise marshlands and other Royal Botanical Gardens Nature Sanctuaries. The carp barrier captures fish moving between the Cootes Paradise and Hamilton Harbour. Fish are lifted from the cages, identified, counted, measured, and weighed. Carp and goldfish are returned to Hamilton Harbour, and other fish are released across the barrier. Fish that are smaller than 5 cm in width (the width of the grates) pass freely through the carp barrier. The barriers have reduced carp from entering Cootes Paradise by over 95%. However, it remains unclear how this barrier may have restricted movements of other species.

4 Management Areas and Fisheries Management Zones

4.1 Introduction

Hamilton Harbour and its watershed have been divided into five key management areas (Figure 4.1):

- North Shore watershed;
- Grindstone Creek watershed;
- Spencer Creek watershed (including Cootes Paradise);
- Red Hill Creek watershed; and
- Hamilton Harbour.

A highly urbanized portion of the City of Hamilton has been excluded from the plan as almost all streams have been buried into the underground stormwater network. No fisheries resources are found here.

All water bodies in the Hamilton Harbour watershed are classified into one of eight fisheries management zones based primarily on the stream size and water temperature. The management zones for the Hamilton Harbour watershed include (Figure 4.1):

- Small Coldwater Riverine,
- Small Warmwater Riverine,
- Intermediate Coldwater Riverine,
- Intermediate Warmwater Riverine,
- Inland Lakes and Reservoirs,
- River Mouth,
- Hamilton Harbour Nearshore , and
- Hamilton Harbour Offshore.

To classify each stream, consideration was given to the size and drainage area, biological, chemical and physical conditions of the stream/waterbody, local soils, slope, and geology, and fish community types (historical and existing).

This chapter details our approach to classifying portions of each management area into zones to facilitate fisheries management. Fish communities in each management zone are described here, and detailed in Appendix 7.4. Fish Community Objectives for each management zone are found in Chapter 5. Fish community descriptions below for the most part are based on diverse electrofishing data representing a variety of studies from HCA, CH, RBG, and DFO unless otherwise noted.

4.1.1 Stream Classifications

4.1.1.1 Stream Size

The Hamilton Harbour watershed contains small and medium size streams considered "small riverine" and "intermediate riverine" management zones. The Hamilton Harbour watershed contains no rivers that might be considered as "large riverine".

How do you determine Stream Size?

Stream order is often used to describe the size of a stream, whereby a first order stream is smaller and sixth order stream is larger. A first order stream is a single, unbranched, permanently-flowing tributary. When two first order streams meet, they become a second order stream, and so on. As stream size and drainage area increases, the complexity of habitat and the number of species it can support also increases. The determination of stream order is dependent on the quality of mapping.

Small Riverine - Small riverine management zones encompass small streams that are usually categorized as first to third order streams. The drainage areas of these streams do not usually exceed 10 km^2. Small riverine zones may encompass wetlands and/or swamps connected to the stream.

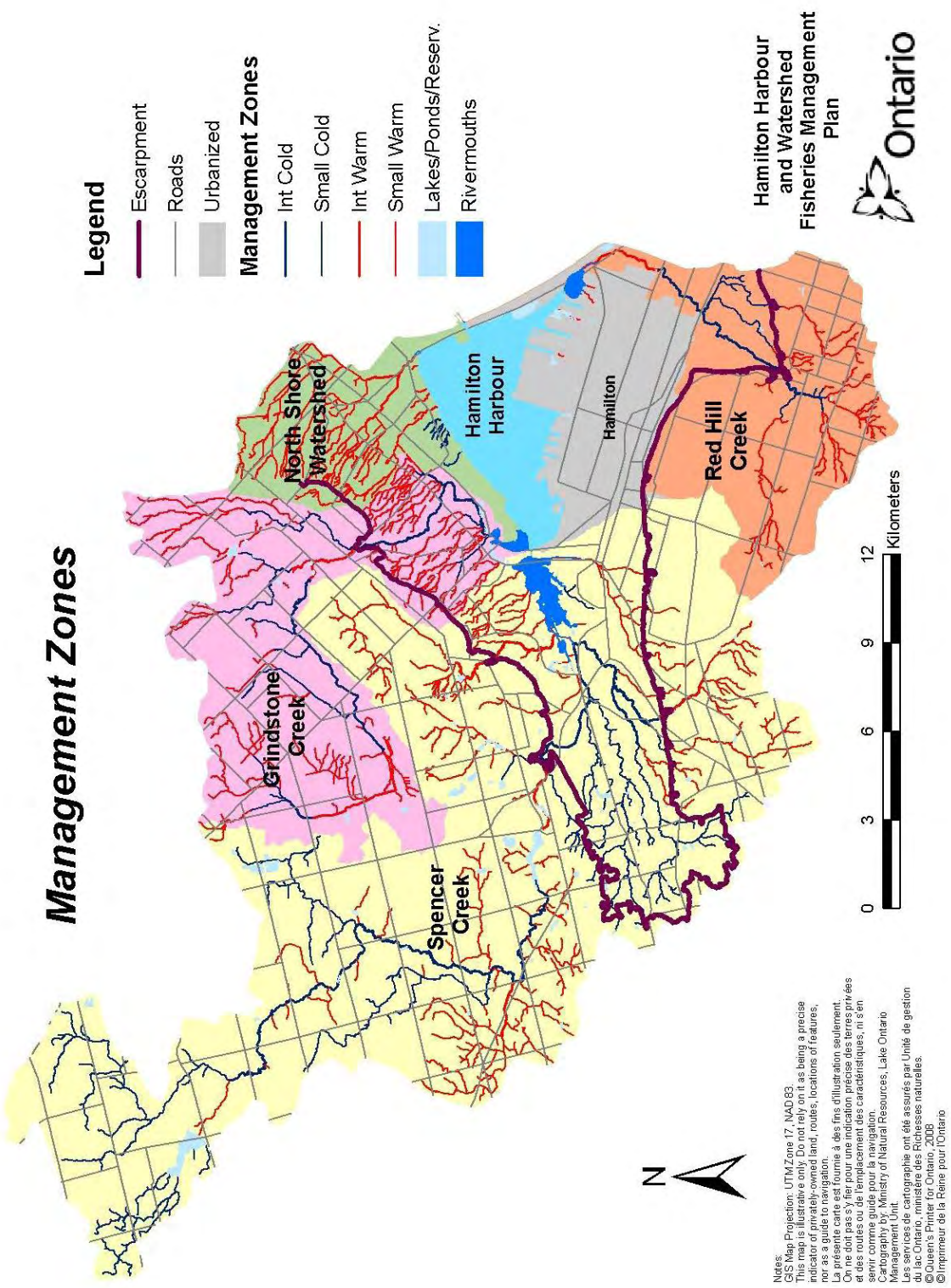


Figure 4.1. Map of Management Zones for the Hamilton Harbour Watershed.

Intermediate Riverine - Intermediate riverine management zones encompass medium streams that are usually categorized as fourth or fifth order streams. The drainage areas of these streams usually exceed 10 km^2. Intermediate riverine zones may encompass wetlands and/or swamps connected to the stream.

4.1.1.2 Stream temperature

All streams were divided further based on thermal regime as either warmwater or coldwater zones. The physical and biological conditions of the stream helped to define whether it was typically warm or cold.

Coldwater - An upper limit of 26ºC was chosen to define coldwater habitat as it is suitable for both coldwater and coolwater species (Bowlby 2008). Brook trout may be found up to 26ºC (Bowlby and Roff 1986) in streams with thermal refuges, usually resulting from springs in the stream bed or small cold tributaries. In addition, stream reaches with a history including brook trout, mottled sculpins, or rainbow trout, or with a fish community greatly dominated by coldwater or coolwater species (Appendix 7.4.1) were classified as coldwater.

Coldwater streams are usually found in groundwater rich areas where springs tend to cool the stream. In these zones coarse permeable soils contribute to greater infiltration of precipitation and higher baseflows.

Temperature Zones and Fish Temperature Guilds

The same terminology has been used to define the summer temperature of aquatic habitat and the fish temperature guilds or fish communities generally associated with those habitats. Unfortunately, this use of the same terms has led to much confusion. Fish species have varying temperature tolerances, and so some species may be found in coldwater or warmwater habitat.

Temperature guilds are defined by a species temperature preference and/or optimum temperature for growth (Coker et al. 2001):

- **Coldwater species**, (*e.g.* mottled sculpin and brook trout, rainbow trout) prefer temperatures under 18ºC.
- **Coolwater species** (*e.g.* northern pike, walleye, redside dace, and creek chub) prefer temperatures between 18ºC and 25ºC they tolerate a wider range of water temperatures and may be found in coldwater or warmwater zones.
- **Warmwater species** (*e.g.* smallmouth bass, sunfish, and fathead minnows) have a temperature preference above 25ºC.

Warmwater - Warmwater streams usually exceed 26ºC. These streams usually contain coolwater and warmwater fish species. Warmwater streams are usually found in areas where groundwater discharge is lower. Typically, the soils are variable and less permeable than coldwater zones. Thus, groundwater discharge and baseflow are low and more seasonal. Accordingly, intermittent streams were generally assumed to be warmwater.

4.1.2 Inland lakes and reservoirs

Lake Medad is one of the few natural lakes within the broader watershed area. Reservoirs include Christie and Valens. All waterbodies with this zone designation are less than 125 Ha in size. These waterbodies may be thermally stratified or variable in temperature during summer. Some are man-made reservoirs or retired gravel pits while others are natural.

4.1.3 River Mouth

The river mouth zone encompasses coastal wetlands or marshes including Cootes Paradise. This zone is situated in low gradient areas and serves as the connector between the watersheds and Hamilton Harbour. Water levels fluctuate in the river mouth zone according to the seasonal and long-term fluctuations of Lake Ontario and the associated streams.

4.1.4 Nearshore

This zone includes areas of Hamilton Harbour shallower than 15 metres (Stewart et al. 1999). This area tends to be greatly exposed to wind, and consists of both sheltered and windblown sand and gravel shorelines. These areas are subject to lake level fluctuations.

4.1.5 Offshore

This zone includes areas of Hamilton Harbour with depths greater than 15 metres. The maximum depth is approximately 25 metres. Thermal stratification of waters in this zone results in temperatures suitable for coldwater species. However, this deeper part of this zone currently experiences oxygen deficiency each summer, and elevated ammonia during winter making it unsuitable for fish.

4.2 North Shore

4.2.1 Key Characteristics

The North Shore watersheds are located north of the Hamilton Harbour, and cover an area of approximately 33 square kilometres (Figure 4.2). Most of this watershed is located within the City of Burlington, and a small portion is located within the City of Hamilton. The major streams in this watershed include Falcon, Indian, Edgewater-Stillwater, Hager, West Aldershot, LaSalle, Glenwood, Forest Glen, Teal, and Rambo Creeks and several smaller unnamed tributaries. Rambo Creek originally flowed directly into Lake Ontario. The upper portions of Rambo Creek and Hager Creek have been diverted into Indian Creek through the Hager/Rambo Diversion Channel and ultimately into Hamilton Harbour. The diversion was constructed in 1976 to mitigate downstream flood damage through the diversion of flows away from downtown Burlington.

The Niagara Escarpment and adjacent rolling hills, valleys, and bluffs are prominent physical features affecting the headwaters of the streams in this watershed. Many of the smaller headwater features that emanate from the Niagara Escarpment are largely still in excellent condition, though flows may be intermittent. A high level of urbanization has drastically altered the natural landscape, streams, riparian zones, and the fish habitat. The dramatic increase of impervious surfaces has lead to greater surface runoff and susceptibility to flooding. Many of the streams have been channelized or piped underground through enclosures, and can no longer support significant aquatic life. Culverts and enclosures resulting from development and transportation corridors have fragmented streams, and led to a lack of riparian buffers and linkages between natural areas.

4.2.2 Description of Management Zones in the North Shore Watershed

4.2.2.1 Small Riverine

Nearly 94% of the streams in the North Shore watershed are small riverine. The small coldwater riverine zones in the North Shore watershed can be found in the headwater areas or areas above the Niagara Escarpment (e.g. West Aldershot Creek and Falcon Creek). Most are located upstream of enclosures and storm sewers. West Aldershot, LaSalle, Glenwood, Forest Glen and Teal Creeks have been classified as coldwater largely due to temperature surveys. Groundwater inputs are likely emanating from the sand deposits from the Old Lake Iroquois shoreline.

Although small riverine warmwater zones are found above and below the Niagara Escarpment, most of the warmwater zones are found below the escarpment (e.g. Indian Creek).

4.2.2.2 Intermediate Riverine

The lower portion of Indian Creek is classified as intermediate warmwater riverine zones and represents 6% of the North Shore watershed. The Hager/Rambo diversion enters this reach and significantly impacts the habitat. In particular the increase in flow from the diversion and stormwater has affected natural channel processes. The City of Burlington has begun significant fish habitat restoration on the stream channel of this section of Indian Creek, as part of the RAP.

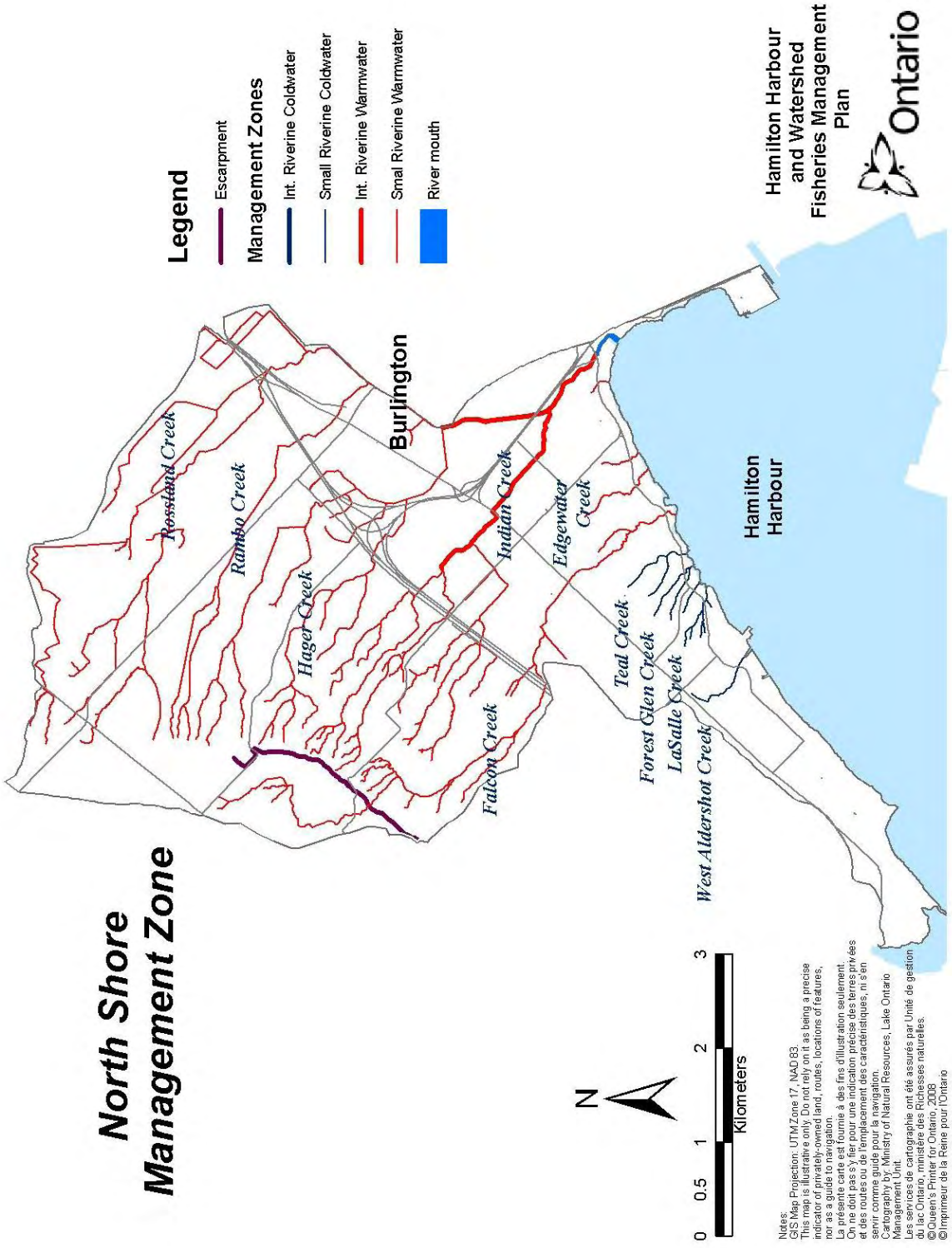


Figure 4.2. Map of Management Zones in the North Shore watershed.

4.2.2.3 River Mouth

Many of the wetlands and marshlands that existed in the North Shore watershed were drained for agricultural and urban development purposes. Today, less than 1% of the North Shore watershed is covered by wetlands. Most of the watershed's remaining wetlands are found at the river mouths as remnants. The City of Burlington has begun significant fish habitat restoration on the river mouth of Indian Creek, as part of the RAP.

4.2.3 Fish Community

4.2.3.1 Present Fish Community

North Shore streams are dominated by creek chub and a mixture of coolwater and warmwater fish (Figure 4.3).

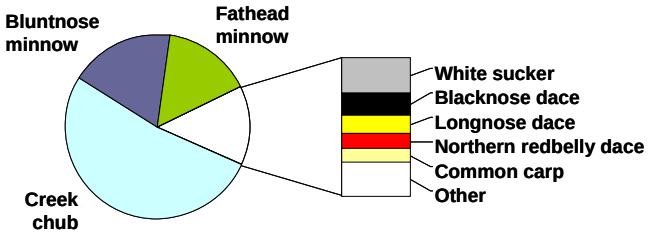


Figure 4.3. Relative abundance of fish species in the North Shore streams.

4.3 Grindstone Creek

4.3.1 Key Characteristics

The Grindstone Creek watershed is located north of Hamilton Harbour, and covers an area of approximately 90 square kilometres (Figure 4.4). The Niagara Escarpment bisects the watershed creating two distinct characteristics in the watershed and stream habitat. Above the Niagara Escarpment stream gradients of are low, and so, wetlands are prominent features along with surrounding drumlins. This area contributes significantly to groundwater recharge. Agriculture is the predominant land use, and in places it impacts the quality of these streams through the lack of sufficient buffer (Table 3.2).

The gradient, substrate size, and groundwater discharge increase greatly in Grindstone Creek below the Niagara Escarpment. Although a greater amount of the riparian zone below the Niagara Escarpment is forested, the tributaries that start along the escarpment are high gradient and that part of the watershed is very susceptible to erosion.

4.3.2 Description of Management Zones in the Grindstone Creek watershed

4.3.2.1 Small Riverine

Nearly 86% of the streams in the Grindstone Creek watershed are designated small riverine management zones (Figure 4.4). The thermal classification of many of the smaller tributaries is poorly understood. As well, many smaller tributaries are seasonal. The distribution of warmwater and coldwater zones is complex in Grindstone Creek due to the large number of online ponds and the variable nature of groundwater discharge into the creek. For example, significant groundwater discharges into the tributary between Milgrove and the 6th Concession East (HRCA 1998) to create significant coldwater habitat with the potential for brook trout restoration. However, online ponds in this reach degrade the water temperature.

4.3.2.2 Intermediate Riverine

Nearly 14% of Grindstone Creek is intermediate riverine zone, confined mostly to the main branch of Grindstone Creek. Most of this zone is coldwater. The entire intermediate warmwater zone is found in two reaches above the Niagara Escarpment and results from online ponds which increase the water temperature and barriers to fish migration. One series of online ponds is located on the intermediate riverine zone creek between Hwy 6 and Waterdown and the second series is part of the Hayesland Swamp. Groundwater inflows cool Grindstone Creek below the Hayesland Swamp and as it flows through the Niagara Escarpment changing the creek to intermediate coldwater zone in the reach downstream of the falls in Waterdown. The gradient in the stream channel below the Niagara Escarpment increases greatly, resulting in large substrate, suitable for Atlantic salmon and other salmonids, and this

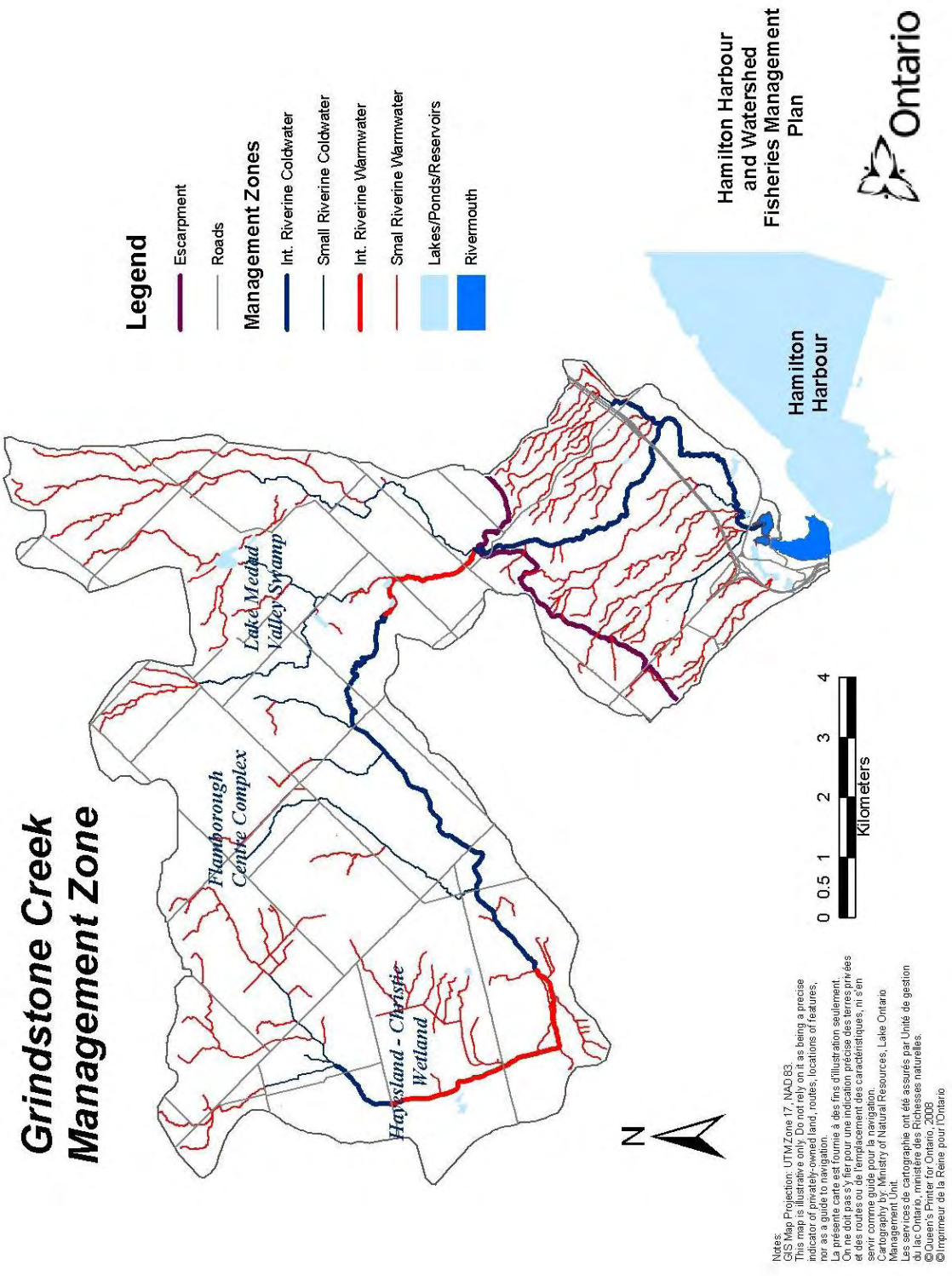


Figure 4.4. Map of Management Zones in the Grindstone Creek watershed.

reach of Grindstone Creek is one of the most significant intermediate coldwater riverine zones in the Hamilton Harbour watershed.

4.3.2.3

4.3.2.4 Inland Lakes and Reservoirs

Five provincially significant wetlands can be found in the Grindstone Creek watershed, including Lake Medad and Medad Valley, Hayesland Swamp and Flamborough Centre, which are all located in the headwaters above the Niagara Escarpment. Wetlands originally covered about 22% of the watershed. Many of the wetlands that existed in the Grindstone Creek watershed were drained in the 1960s for agricultural purposes. Approximately 13% of the watershed is currently covered by wetlands.

Lake Medad is the only natural lake in the Hamilton Harbour watershed. It is bordered to the east by a golf course, and to the west by Halton Conservation Authority lands. The outlet of Lake Medad flows south-westerly through a large swamp complex. Very little is known about its water chemistry or its current fish community.

4.3.2.5 River Mouth

The Grindstone Creek marshes and river mouth join Carroll's Bay in the north-western corner of Hamilton Harbour. The Grindstone Creek river mouth was the original outlet for Cootes Paradise until the Desjardins Canal was constructed in the 1830s. The connection between the Grindstone Creek estuary and Cootes Paradise was lost completely with construction of rail lines in the 1850s. Historically, this was important spawning habitat for many fish species including northern pike. Increased human settlement in the region and lake level regulation in Lake Ontario, further stressed these marshes and the native marsh and species diversity declined. By 1985, only 5.1 Ha of emergent aquatic vegetation remained in the river mouth, a decline from 37.8 Ha since 1934. Carp became the dominant fish species. Since 1990, efforts to restore these marshes and increase the available spawning habitat for northern pike and other fish species have been underway, and include multiple small scale carp barriers.

4.3.3 Fish Community

Fish communities in Grindstone Creek are separated by the falls at the Niagara Escarpment in Waterdown. Warmwater and coldwater zones above the escarpment have distinct fish communities that match the temperature classification (Figure 4.5). The coldwater zone is dominated by coldwater and coolwater species including brook stickleback, creek chub, and central mudminnows. The warmwater zone is dominated by brown bullhead, pumpkinseed, carp, and largemouth bass which reflect the numerous online ponds and the Hayesland Swamp along the main branch.

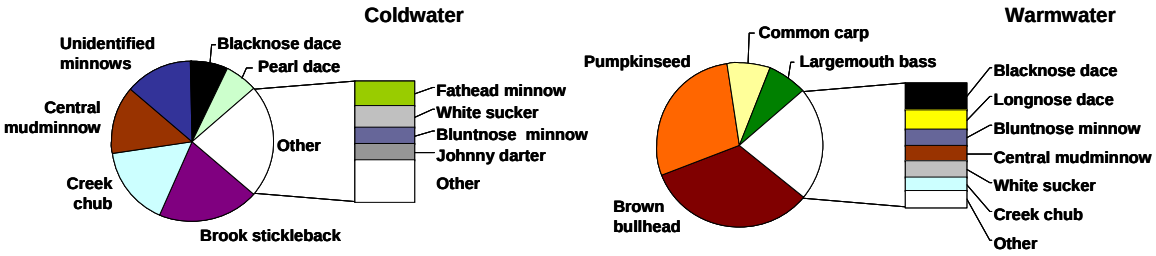


Figure 4.5. Relative abundance of fish species in the upper Grindstone Creek watershed.

Downstream of the Niagara Escarpment, Grindstone Creek provides suitable conditions for many migratory and resident fish species typical of Hamilton Harbour and Lake Ontario. The Niagara Escarpment provides high gradient, large substrate, coldwater habitat suitable for juvenile rainbow trout and white suckers which migrate to Lake Ontario. Accordingly, this reach of Grindstone Creek shows promise for restoration of Atlantic salmon. Coldwater and coolwater minnows and rainbow trout

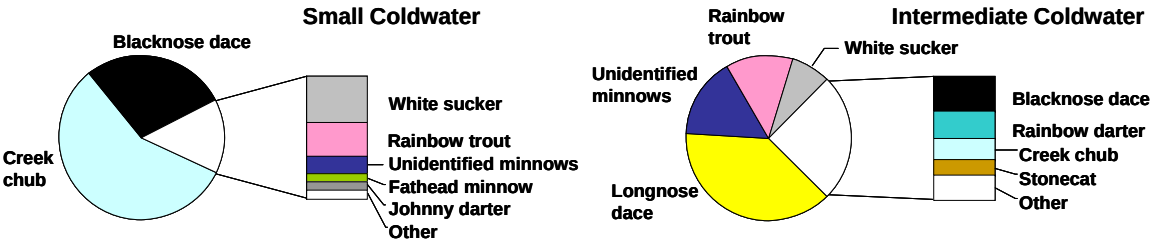


Figure 4.6. Relative abundance of fish species in the lower Grindstone Creek watershed.

dominate the fish community (Figure 4.6). Rainbow trout numbers have recently declined considerably for reasons that are unclear. In 2001 over 100 rainbow trout spawning sites were located in the creek, but in 2006 and 2007 only 7 spawning sites could be found, despite intensive searches by RBG and Conservation Halton.

The fish community of the river mouth of Grindstone and Creek Carroll's Bay are dominated by sunfishes and bluntnose minnows (Figure 4.7). The river mouth of Grindstone Creek provides significant spawning and nursery habitat for northern pike.

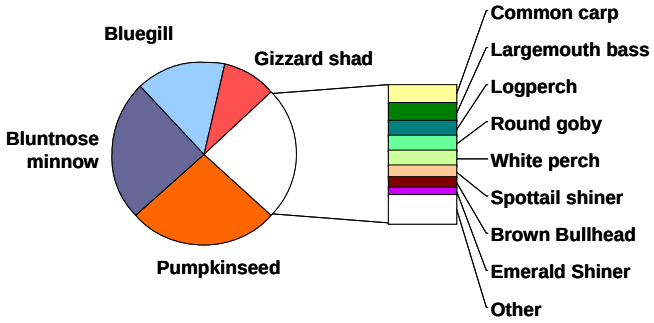


Figure 4.7. Relative abundance of fish species in the Grindstone Creek river mouth.

4.4 Spencer Creek

4.4.1 Key Characteristics

The Spencer Creek watershed is located west of Hamilton Harbour, and covers an area of approximately 291 square kilometres (Figure 4.8). Cootes Paradise forms an extensive coastal marsh at the river mouth of Spencer Creek. Tributaries of Spencer Creek include: Ancaster Creek, Fletcher Creek, Flamborough Creek, Logie's Creek, Spring Creek, Sulphur Creek, Sydenham Creek, Tiffany Creek, Westover Creek, and West Spencer Creek. As well, Borers Creek, Chedoke Creek and numerous smaller tributaries, such as a restored spring creek in Westdale, drain directly into Cootes Paradise.

The Niagara Escarpment forms a unique "U" shape through the municipalities of Hamilton, Ancaster, Dundas, and Flamborough in the lower section of the Spencer Creek watershed. Waterfalls, gorges, deep valleys, and hilly terrain have formed where Spencer Creek and its tributaries flow over the Niagara Escarpment. The gradient, substrate size, and groundwater discharge increase in these streams below the Niagara Escarpment. The headwaters of Spencer Creek are found above the Escarpment in the northern parts of the watershed, where many swamps and wetlands exist. Streams above the Escarpment are low in gradient and variable in groundwater discharge. Accordingly, stream bank vegetation is important to maintain cool water temperatures.

4.4.2 Description of Management Zones in the Spencer Creek Watershed

4.4.2.1 Small Riverine

Nearly 85% of the streams in the Spencer Creek watershed are classified in the small riverine zone. Fletcher Creek, upper Spencer Creek, Sulphur Creek, Spring Creek and Ancaster Creek form some of the most significant small coldwater riverine zones in the Hamilton Harbour watershed. The steep gradient and large substrate of Ancaster Creek, Sulphur Creek and Spring Creek below the Niagara Escarpment

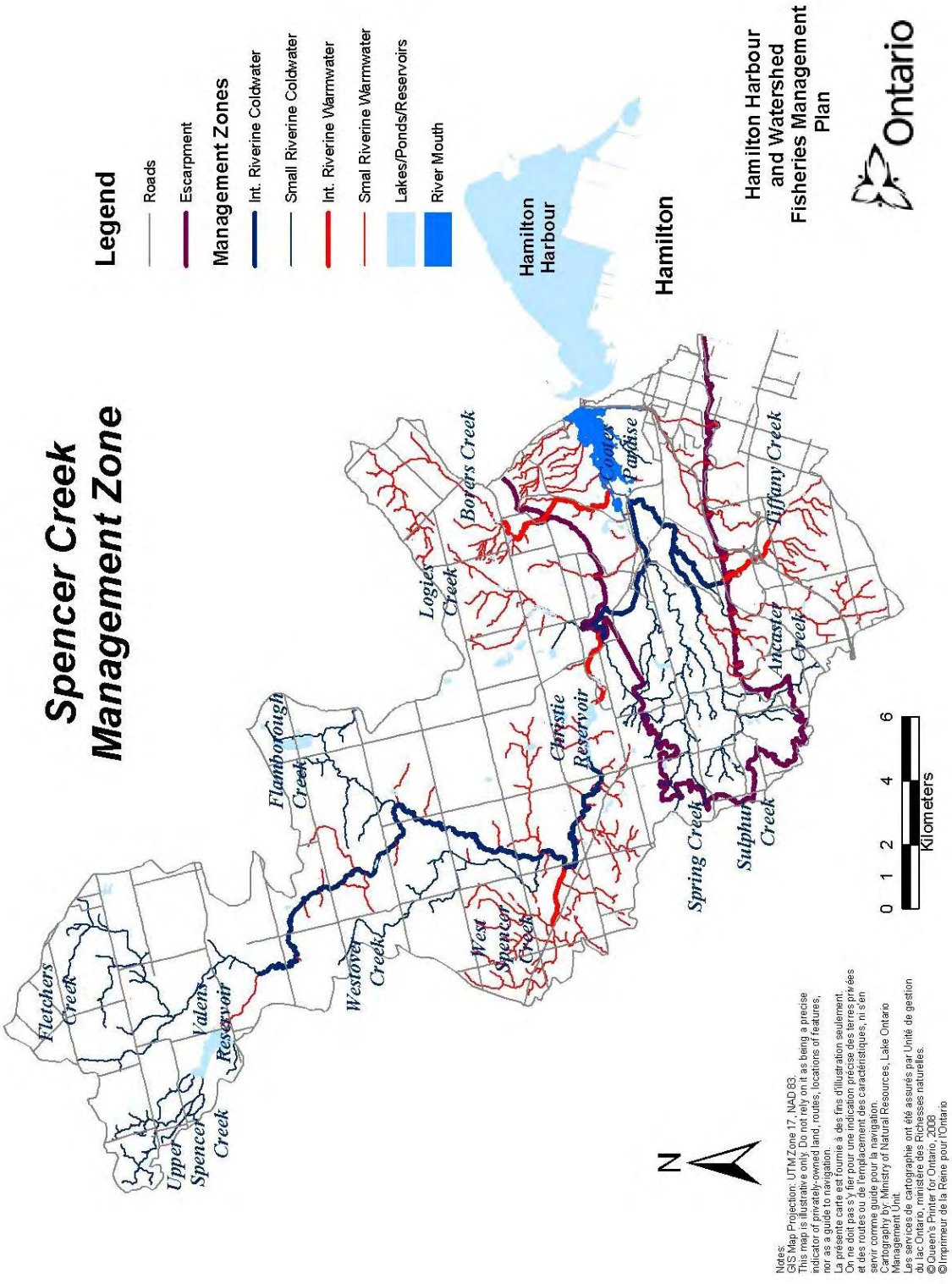


Figure 4.8. Map of Management Zones in the Spencer Creek watershed.

may be suitable habitat for Atlantic salmon restoration. Those streams above the Escarpment, such as Fletcher Creek and upper Spencer Creek are more suitable for brook trout restoration.

Most small warmwater riverine zones are found above the Niagara Escarpment, for example, Tiffany Creek and West Spencer Creek. The habitat in these streams may appear similar to those in coldwater zones, relative to the Niagara Escarpment. However, these streams are more variable in flow and temperature due to less groundwater discharge. Some sections may cease to flow in dry periods in the summer months.

4.4.2.2 Intermediate Riverine

The remaining streams and creeks in the Spencer Creek watershed (15%) are intermediate riverine. From Fletcher Creek to Christie Reservoir, Spencer Creek is classified as intermediate coldwater riverine zone. Christie Reservoir warms Spencer Creek sufficiently to classify it as intermediate warmwater riverine zone from there to the Niagara Escarpment. Sections of Sulphur, Ancaster, and Borers Creek below the Niagara Escarpment are designated as coldwater. These are moderate to high gradient streams with medium to large substrate. Tributaries of Spencer Creek below the Niagara Escarpment, (e.g. Sulphur Creek and Ancaster Creek) form some of the most significant intermediate coldwater riverine zones in the Hamilton Harbour watershed, and have potential for Atlantic salmon restoration. However, much of Spencer Creek has been channelized below the Niagara Escarpment and some sections are constrained with concrete.

4.4.2.3 Inland Lakes and Reservoirs

Spencer Creek has 3 larger reservoirs: Valens, Christie and Crook's Hollow. Valens Reservoir is the largest (76 Ha) and was built in 1966. It drains an area of approximately 11 km^2 in the headwater tributaries of Spencer Creek. The maximum storage capacity of this reservoir is 2,035,000 m^3. However, summer storage levels are usually half of that volume. Christie Reservoir (60 Ha) was built in 1977 above the Niagara Escarpment on the main branch of the Spencer Creek. It drains an area of 154 km^2 and has a maximum storage capacity of 2,282,000 m^3. However, water levels are kept much lower during fall for flood control. Crook's Hollow Reservoir (5 Ha) is located between Christie Reservoir and Webster's Falls on the main stem of Spencer Creek. The dam at this reservoir operates on a seasonal basis, during the summer. Fish populations, downstream of the reservoir, are confined to a relatively small section of the creek as they cannot pass the dam.

Many of the wetlands that once existed within this management area were drained in the 1960s for agriculture. Most of the loss occurred in the middle sections of the watershed, between Flamborough Creek and Christie Reservoir. The percentage of wetlands that presently exists in the Spencer Creek watershed is 10.7%. The majority of the remaining wetlands, including Beverly Swamp, are above the Niagara Escarpment in the upper reaches of the Spencer Creek and Fletcher Creek.

4.4.2.4 Cootes Paradise (River Mouth)

Cootes Paradise at the western end of Hamilton Harbour is one of the most significant coastal marshes in the main basin of Lake Ontario. The marsh is a large wetland (250 Ha) formed by the river mouth of Spencer Creek. A diverse fish community spawns in Cootes Paradise, and significant numbers of migratory birds in the Atlantic Flyway stopover here. The quality of Cootes Paradise has declined due to high nutrient loadings from a waste water treatment plant, lake level manipulations, contaminants from industry, and common carp. These factors led to declines in water quality, and the loss of most of the emergent and submergent aquatic vegetation. The wetland has changed from a densely vegetated marsh, to a shallow turbid body of water. The quality of spawning and nursery habitat for many fish species was significantly reduced. High turbidity from excessive algae growth and rooting in the sediments by carp has prevented the restoration of aquatic vegetation and fish habitat. Intensive restoration efforts began in the 1990s with the aim of re-establishing the ecosystem functions of the marsh. In 1996 construction of

sewer overflow tanks began, and a fish barrier was built to exclude carp from Cootes Paradise. However, control of nutrient inputs as recommended by the RAP, needs to be completed for the restoration of Cootes Paradise, as carp exclusion, alone, is not sufficient to reduce turbidity enough to restore aquatic vegetation in the marsh (Lougheed et al. 1998).

4.4.3 Fish Community

The Spencer Creek watershed is very rich in the number of fish species with at least 55 species recorded, and 49 species found above the Niagara Escarpment. Compared with other Lake Ontario tributaries these numbers are quite high, especially above the Niagara Escarpment. A majority of the fish species above the escarpment are likely introduced either intentionally or through accidental release.

4.4.3.1 Small Coldwater Riverine

Brook trout are found in Fletcher Creek, upper Spencer Creek, and Flamborough Creek (Figure 4.9) where groundwater discharge is higher than much of the remaining Spencer Creek watershed above the Niagara Escarpment. Brook trout require strong groundwater discharges for spawning. However, the adults may move to other habitats if the temperature is suitable. In upper Spencer Creek, Valens Reservoir warms the water during summer and limits habitat for brook trout directly downstream and in Spencer Creek below the confluence with Fletcher Creek. As well, Valens Reservoir appears to contribute pumpkinseed and largemouth bass to the upstream fish community. The lower part of Logies Creek and Westover Creek have also been classified as coldwater due to presence of a variety of coldwater and coolwater species (Figure 4.9). In addition to the species listed in Figure 4.9, small numbers of mottled sculpin and redside dace have been observed in Westover Creek,.

Brook trout are rarely found in the small coldwater riverine zone below the Niagara Escarpment. In the southernmost tributaries of Spencer Creek (Spring Creek, Sulphur Creek, Tiffany Creek, and Ancaster Creek) brook trout have been replaced by rainbow trout. It is

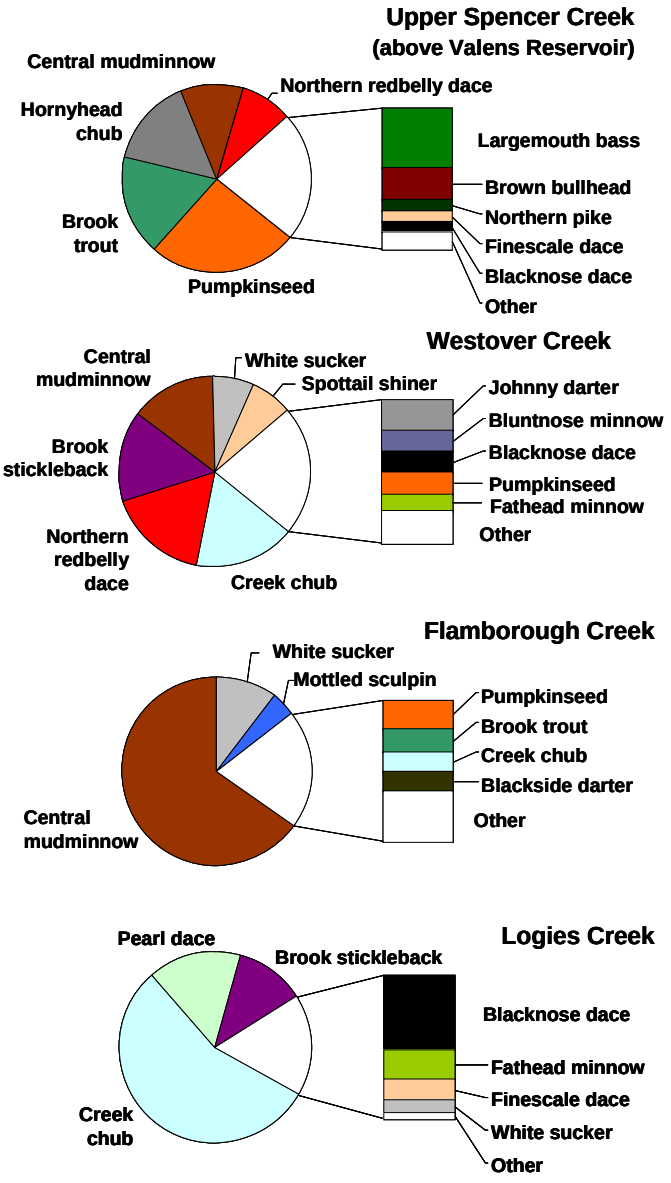


Figure 4.9. Relative abundance of fish species in Small Riverine Coldwater zones of Spencer Creek above the Niagara Escarpment.

unclear whether this replacement was due to changes in habitat or fish community. Along with rainbow trout, coolwater species such as blacknose dace, longnose dace and rainbow darter dominate the fish community in these streams (Figure 4.10). Young of the year rainbow trout have declined in Ancaster Creek since 1998, but adults showed no clear trend at the Cootes Paradise carp barrier (Figure 4.11). These declines in young of the year rainbow trout are consistent with spawning and nursery habitat deterioration resulting from urban development in the watershed. Other tributaries of Spencer Creek must be responsible for maintaining the adult population.

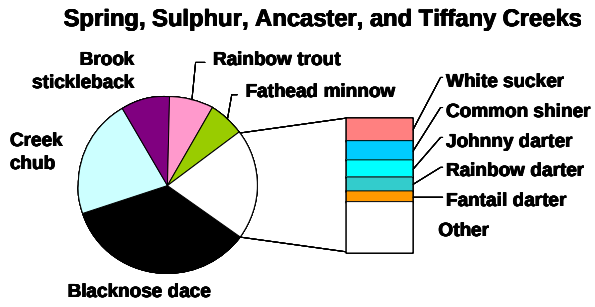


Figure 4.10. Relative abundance of fish species in Small Riverine Coldwater creeks entering Spencer Creek below the Niagara Escarpment.

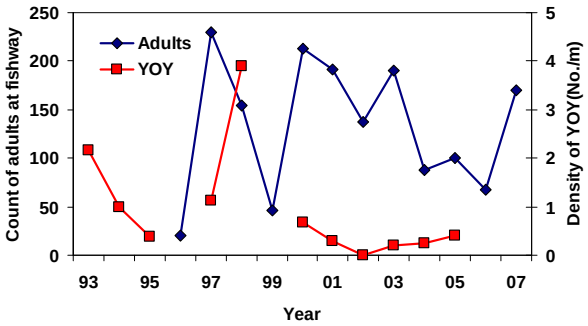


Figure 4.11. Trends in rainbow trout adult counts in the Cootes Paradise Carp barrier and young of the year (YOY) in Ancaster Creek. Since 2001 the barrier has been seasonally opened and the actual population is higher. (Data from RBG and Lake Ontario Management Unit)

4.4.3.2 Small Warmwater Riverine

The species composition of small warmwater riverine streams may appear variable, but a common thread is the presence of members of the sunfish family, including largemouth bass, pumpkinseed and crappie (Figure 4.12, 4.13). These species are not considered as typical stream residents, and are usually found in ponds and lakes. Upper Spencer Creek has a warmwater reach below Valens Reservoir. Borers Creek and West Spencer Creek have in-line ponds that may be the source of bass and sunfish.

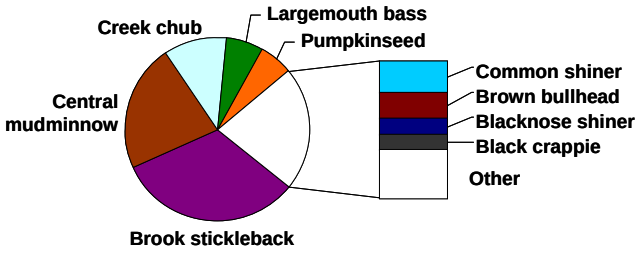


Figure 4.12. Relative abundance of fish species in upper Spencer Creek below Valens Reservoir.

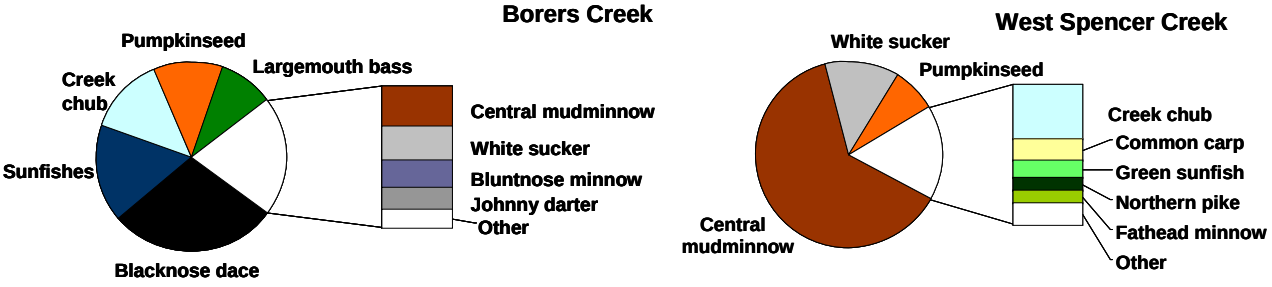


Figure 4.13. Relative abundance of fish species in Small Riverine Warmwater zone of Spencer Creek.

4.4.3.3 Intermediate Riverine

The reach of Spencer Creek from the meeting of upper Spencer Creek and Fletchers Creek downstream to Christie Reservoir is in the intermediate coldwater zone. This reach is dominated by coolwater species such as common shiners and white suckers (Figure 4.14). More redside dace (listed as Threatened under the *Endangered Species Act, 2007* of Ontario) have been observed in this reach of Spencer Creek than the rest of the Hamilton Harbour watershed. Redside dace is a coolwater species dependent on the high quality of the water and habitat in this reach.

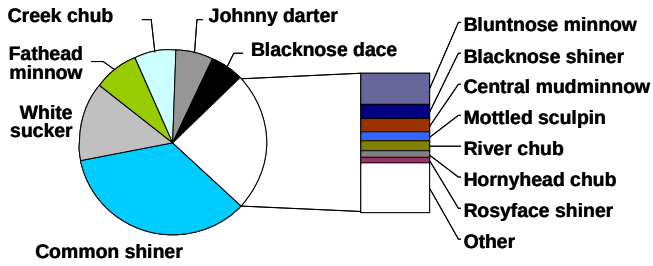


Figure 4.14. Relative abundance of fish species in Spencer Creek from Fletchers Creek to Christie Reservoir.

The reaches of Spencer Creek below Christie and Crooks Hollow Reservoirs are warmed by these reservoirs, and to the Niagara Escarpment are designated in the intermediate warmwater zone. These reaches are dominated by two coolwater species, longnose dace and creek chub, adapted to the higher gradient riffles and pools of this reach (Figure 4.15). The reservoirs influence this fish community, as many of the remaining fish are warmwater species, such as common carp, river chub, and largemouth bass.

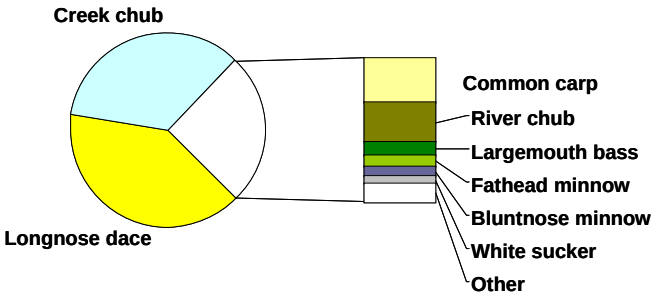


Figure 4.15. Relative abundance of fish species in Spencer Creek from Christie Reservoir to the Niagara Escarpment.

Spencer Creek becomes a coldwater zone below the Niagara Escarpment, as it is cooled by Webster's Falls and increased groundwater discharge. Longnose dace dominate the fish community and four darter species were notable in this reach (Figure 4.16), reflecting the higher gradient.

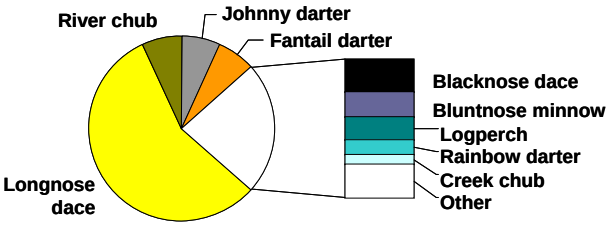


Figure 4.16. Relative abundance of fish species in Spencer Creek below the Niagara Escarpment.

4.4.3.4 Inland Lakes and Reservoirs

Valens Reservoir is dominated by the sunfish family, including pumpkinseed, black crappie and largemouth bass (Figure 4.17), consistent with the shallow, weedy nature of the reservoir.

The fish communities of Christie and Crooks Hollow Reservoirs are dominated by bluntnose minnows, largemouth bass, and white suckers (Figure 4.17).

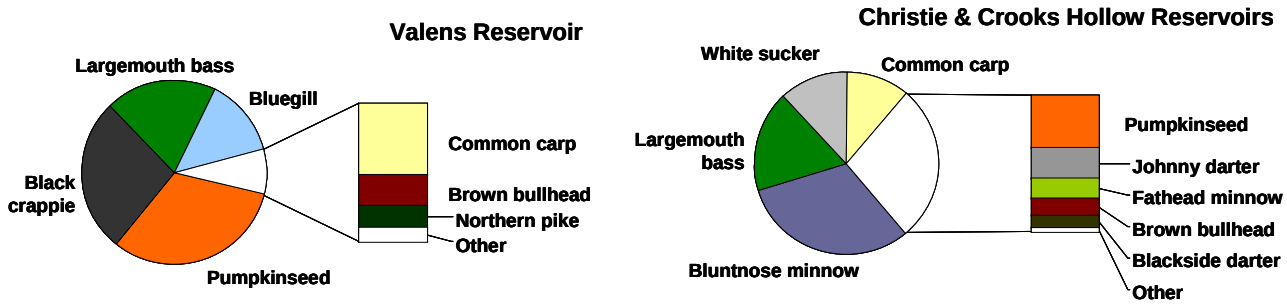


Figure 4.17. Relative abundance of fish species in Spencer Creek reservoirs.

4.4.3.5 Cootes Paradise (River Mouth)

The fish community of Cootes Paradise is seasonal as most of this zone becomes frozen from top to bottom during winter. The channel formed by Spencer Creek at the upper end of the marsh creates a refuge for some fish, and the remaining must vacate or perish. Accordingly, each spring fish colonize Cootes Paradise mostly from Lake Ontario and Hamilton Harbour, and also from Spencer Creek. The carp exclusion barrier near the mouth of the Desjardins Canal intercepts fish wider than 5 cm and prevents most carp and goldfish from migrating back into Cootes Paradise. Small fish have free passage through the barrier, and larger fish, other than carp and goldfish, are actively lifted into and out of Cootes Paradise.

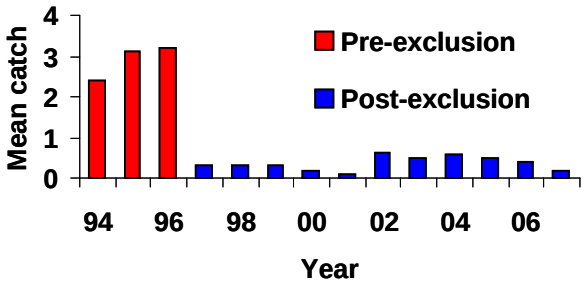


Figure 4.18. Catch per electrofishing transect of large carp in Cootes Paradise before (1994-96) and after (1997-2007) the exclusion of carp (Data from Theysmeyer 2007).

The carp barrier reduced the number of carp in Cootes Paradise dramatically (Figure 4.18). The density of large carp in Cootes Paradise declined from over 800 kg/Ha to about 40 kg/Ha after building the barrier. However, the impact of the barrier on young carp and young native fishes is less clear (Figure 4.19). Other factors may be involved in the production of young fish in Cootes Paradise.

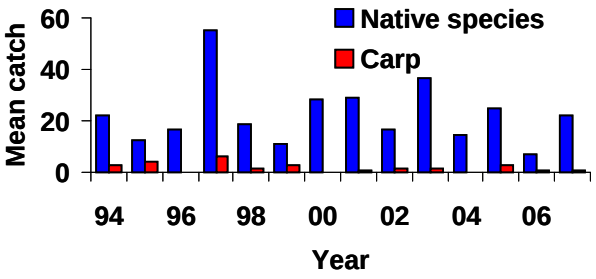


Figure 4.19. Catch per electrofishing transect of young of the year fish in Cootes Paradise before (1994-96) and after (1997-2007) the exclusion of carp (Data from Theysmeyer 2007).

Fewer carp and goldfish were observed at the carp barrier in 2004-2006 (Figure 4.20), suggesting the carp population in Hamilton Harbour may be

declining. As well, bullheads and channel catfish have increased in Cootes Paradise (Figure 4.20). Other species show no clear trends. These shifts in fish community structure may be related to the exclusion of carp from Cootes Paradise or the general increase in water quality in Hamilton Harbour over the same time period.

The fish community in Cootes Paradise is extremely diverse, owing to its position of an interface between Lake Ontario and the Spencer Creek watershed. Brown bullhead, pumpkinseed, gizzard shad, and white perch dominate the fish community, and largemouth bass is the most abundant piscivore (Figure 4.21).

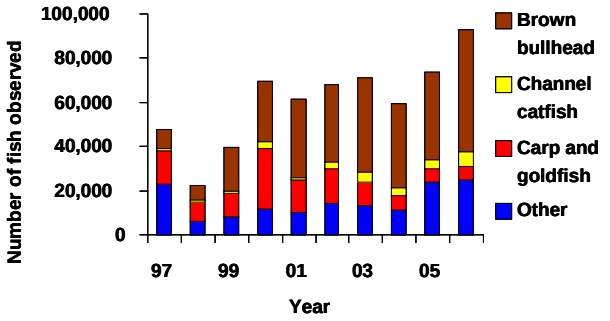


Figure 4.20. Number of fish observed, incidentally and in trap, at the carp barrier at Cootes Paradise from 1997 – 2006 (Data from Theysmeyer 2005 and RBG).

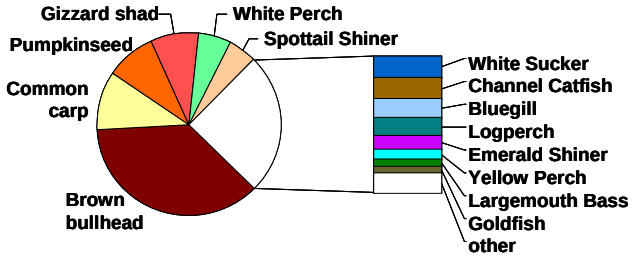


Figure 4.21. Relative abundance of fish species in Cootes Paradise (Based on equal weighting of electrofishing, carp barrier trap and incidental data from Theysmeyer 2005 and RBG).

4.5 Red Hill Creek

4.5.1 Key Characteristics

Red Hill Creek is located south of Hamilton Harbour, and covers an area of approximately 52 square kilometres (Figure 4.22). It enters Hamilton Harbour in the highly industrialized Windermere Basin along the southwest shore of the Beach Strip. The Niagara Escarpment cuts across the Red Hill Creek watershed in the City of Hamilton, and contributes significantly to the character and flow of the creek. This watershed has the lowest basin yield of the major Hamilton harbour watersheds indicating relatively low groundwater contribution to base flow and poorer quality for spawning salmonids (Table 1). However, the summer low flow index measured at Albion Falls (Table 1) was the highest among the Hamilton Harbour tributaries, indicating potential salmonid habitat, and so this watershed may have been a significant Atlantic salmon stream. Now this watershed is highly urbanized with residential, commercial, and industrial development. All of the streams and creeks have significantly been altered, particularly by channelization, increased surface flows in the form of stormwater, and reduced base flows. These alterations have degraded the temperature and flow regimes of the creek.

In 2007, a restoration plan using a natural channel design was completed along with the construction of the Red Hill Valley Expressway. This plan included a realignment of seven kilometres of Red Hill Creek. Four kilometres of concrete channel were replaced with natural materials to stabilize the creek banks. The naturalized channel runs from the top of the Niagara Escarpment to Windermere Basin.

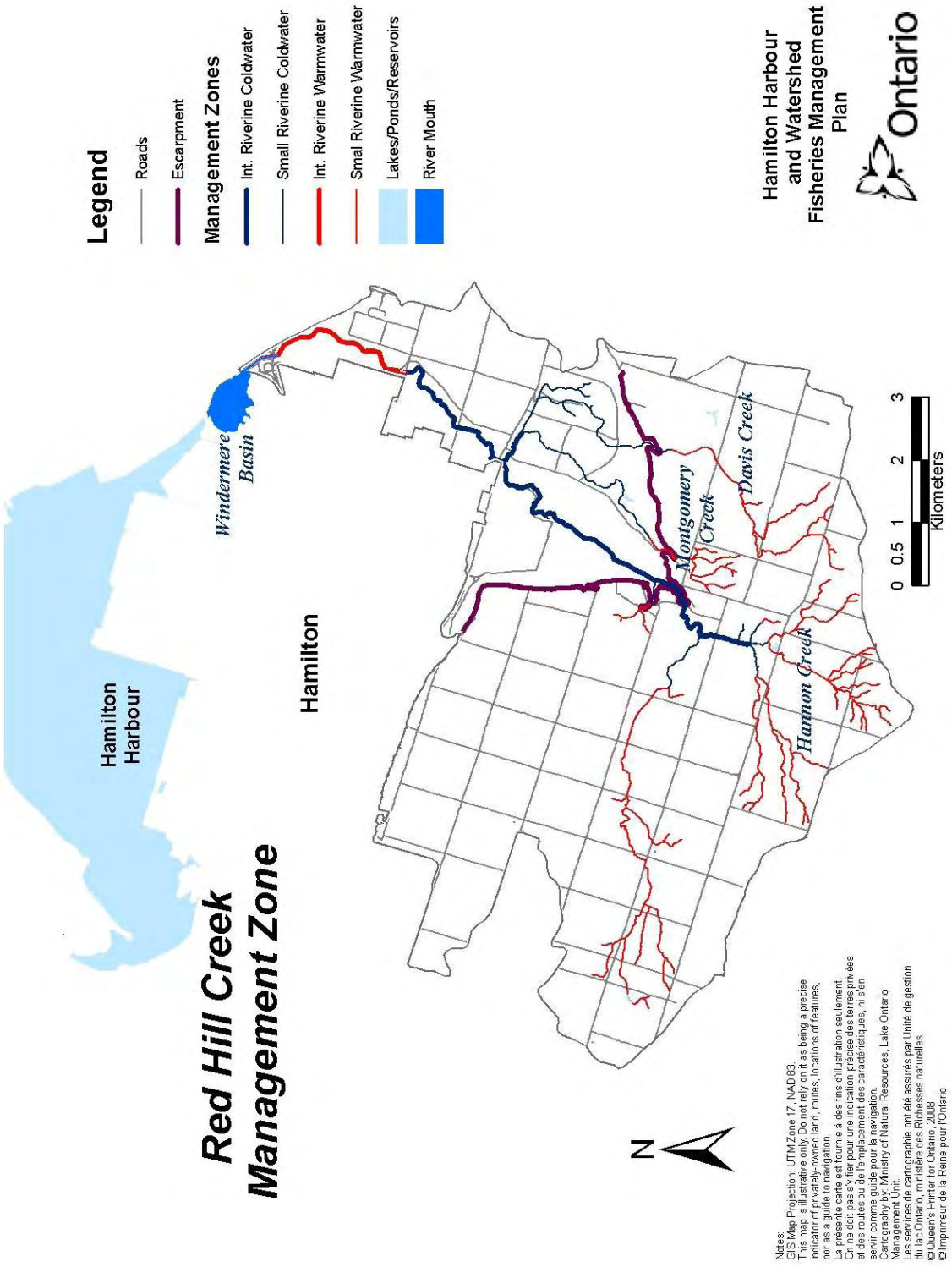


Figure 4.22. Map of Management Zones in the Red Hill Creek watershed.

4.5.2 Description of Management Zones in the Red Hill Creek Watershed

4.5.2.1 Small Riverine

Nearly 83% of stream reaches in the Red Hill Creek watershed are designated within the small riverine zone. Most of the small coldwater riverine zone is found in association with the Niagara Escarpment, in Davis Creek and Montgomery Creek below the escarpment. The gradient of these streams is high at the escarpment, and then declines farther downstream. Most of the small warmwater riverine zones are relatively low gradient streams found above the Niagara Escarpment.

4.5.2.2 Intermediate Riverine

Red Hill Creek is designated as intermediate coldwater riverine zone from Hannon Creek to Barton Street. This zone is associated with the Niagara Escarpment in a similar manner to the small coldwater riverine zone. Red Hill Creek becomes warmer as it moves farther downstream from the Niagara Escarpment and is designated as intermediate warmwater riverine zone from Barton Street to its mouth.

4.5.3 Fish Community

The Niagara Escarpment had a greater impact on the fish community than stream size, and so fish communities have been summarized according to temperature zones relative to the Niagara Escarpment. Coldwater zones above the escarpment were dominated by brook stickleback, a coldwater species, and northern redbelly dace (Figure 4.23), a warmwater species that is often found in cooler streams. In the coldwater zone below the Niagara Escarpment, the fish community is dominated by blacknose dace and other coolwater species (Figure 4.23). However, no salmonid populations reproduce in Red Hill Creek, due to marginal temperatures for salmonids.

The intermediate warmwater riverine zone is dominated by fathead minnows (Figure 4.23). The fish community of the Red Hill Creek watershed is not well sampled in the small warmwater zone.

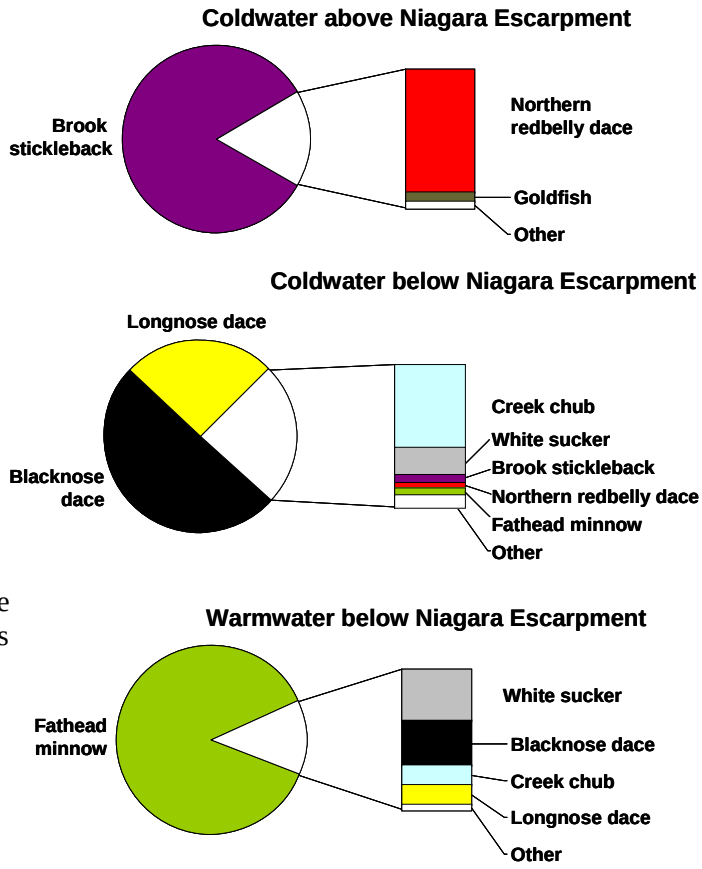


Figure 4.23. Relative abundance of fish species in Red Hill Creek.

4.6 Hamilton Harbour

4.6.1 Key Characteristics

Hamilton Harbour links Lake Ontario and the Hamilton Harbour tributary watersheds (Figure 4.24). Both inflow from the watershed and cold water from Lake Ontario through the Burlington Canal modify Hamilton Harbour. A cold water zone, or hypolimnion, is maintained in Hamilton Harbour throughout the summer creating the potential for a vibrant mixture of both coldwater and warmwater fish communities in the harbour.

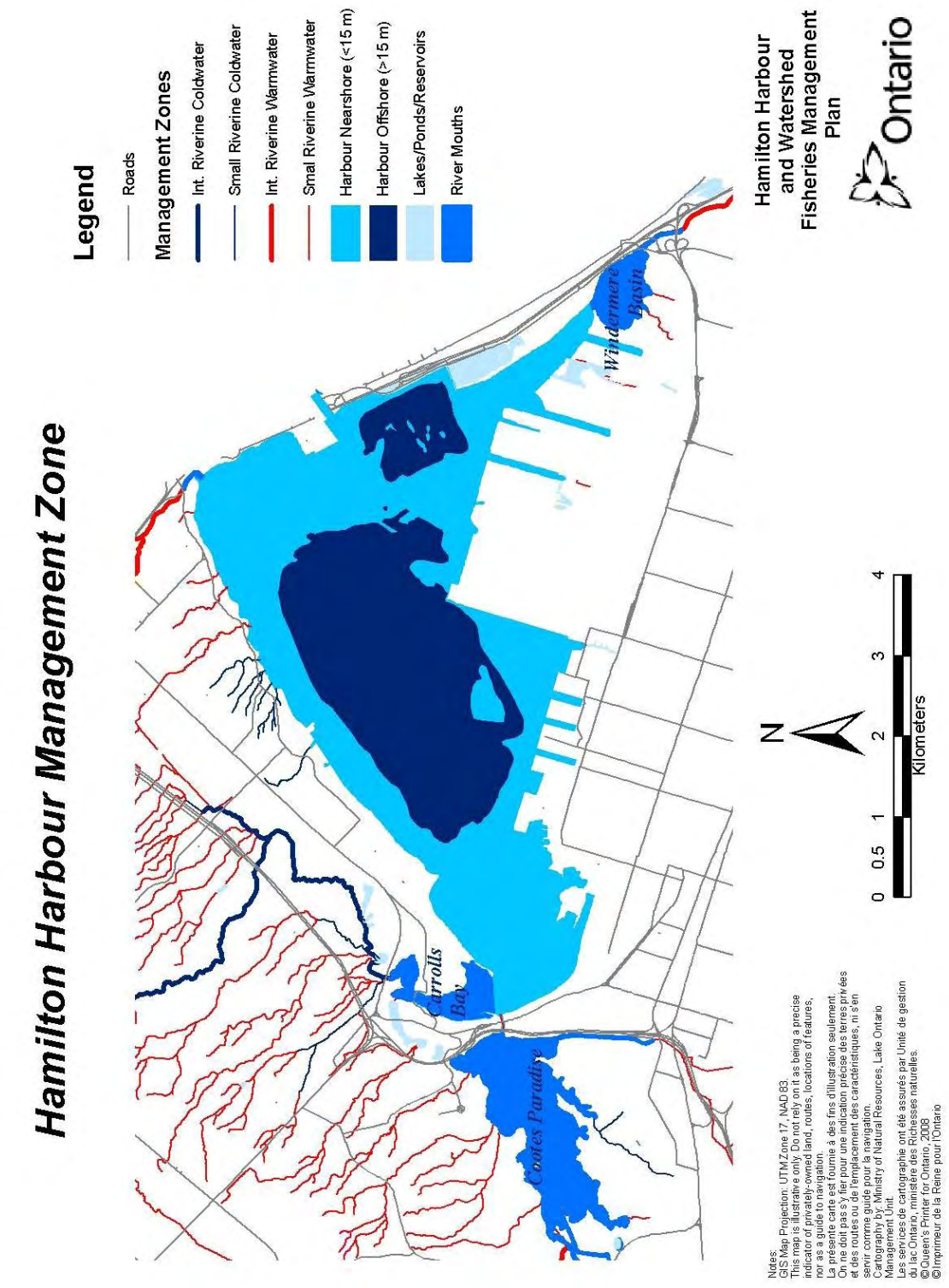


Figure 4.24. Map of Management Zones in the Hamilton Harbour.

A large glacial river carved through Dundas Valley and created Hamilton Harbour between two large exposed sandbars, one at the Beach Strip on the Lake Ontario side and another at Burlington Heights, separating it from Cootes Paradise. These and other glacial deposits formed critical spawning habitat for fish from Hamilton Harbour and Lake Ontario. The Burlington Canal connects Hamilton Harbour with Lake Ontario through the Beach Strip. Cootes Paradise connects to the harbour through the Desjardins Canal through the Burlington Heights. These canals were created by digging new channels, and the original connections have been partially or completely filled.

In the late 19th century and early 20th century, significant development occurred in the Hamilton Harbour area. In the past, the harbour was characterized by protected embayments and marsh along the southern shoreline, and by open bluffs with sandy sediments along the northern shoreline. Infilling, has reduced Hamilton Harbour from about 2,770 Ha in 1926 to 2,150 Ha, currently. Most of the infilling was along the south shore marsh lands, currently occupied by the Hamilton waterfront. From 1845 to 1977 over 74% of the marsh lands of Hamilton Harbour and Cootes Paradise were lost (Whillans 1982). Similarly, most of the 3.5 km^2 of historic shoal habitat in Hamilton Harbour (Figure 4.25) has been lost. Shoals along the south and west shorelines have been filled in. Development along the northern shore led to erosion of the bluffs and increased sedimentation. Shoals along the northern shoreline have disappeared, and it is unclear if the shoals are covered with fine sediment, or if the shoal material was removed, as was common along the Lake Ontario shoreline.

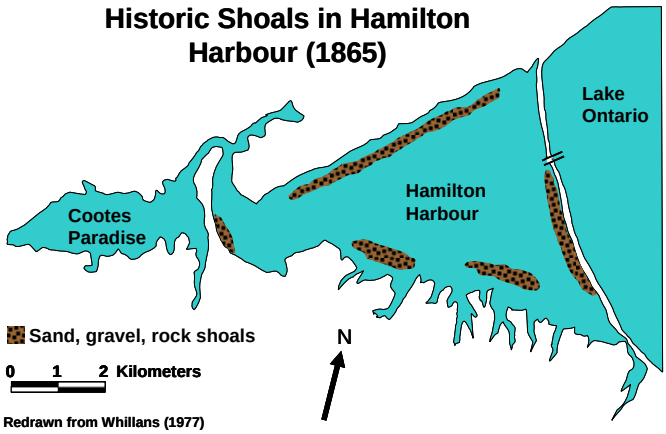


Figure 4.25. Location of historic shoals in Hamilton Harbour in 1865.

4.6.2 Description of Management Zones in Hamilton Harbour

Hamilton Harbour has two management zones that are defined as Nearshore (<15 m) and Offshore (>15 m) based on depths according to the Lake Ontario Fish Community Objectives (Stewart et al. 1999).

4.6.2.1 Nearshore

The nearshore zone occupies 65% of the area of Hamilton Harbour. Marshes and protected embayments along the south shore of the present Hamilton waterfront, and shoreline along the Beach Strip were filled in over the past 150 years, accounting for most of the habitat loss in Hamilton Harbour. Spawning and nursery habitats for a variety of warmwater and coldwater species were lost. Extensive original shoreline has been lost, and much of the harbour shoreline has been hardened with docks, sheet piling, and armourstone, Very little shoreline is left in original condition, as even natural areas along the north shore have been altered due to removal of trees in the riparian zone. Shoals along the north shore have been lost, and a windswept shallow sandbar remains. As a result spawning habitat for walleye, smallmouth bass, lake trout, lake whitefish, and lake herring has been lost in Hamilton Harbour. Deeper portions of this zone contain sediments contaminated with PCBs and heavy metals, and along the Hamilton waterfront Randle Reef has been contaminated with coal tar.

4.6.2.2 Offshore

The offshore zone makes up the remaining 35% of Hamilton Harbour. Incursions of cold water from Lake Ontario into the harbour are critical to maintain a cold hypolimnion layer below a thermocline during summer. Despite the high oxygen content of water from Lake Ontario, oxygen becomes too low

for the survival of fish in the hypolimnion of Hamilton Harbour (Figure 3.4) due to high production of algae in the harbour and to excessive inputs of organic pollutants. In addition, toxic sediments have accumulated in parts of this management zone. Under these conditions parts of the harbour bottom have become unsuitable for such species as sturgeon, whitefish, and sculpins, and their invertebrate food. Lake herring (or ciscoes) have the potential to occupy the midwater above or below the thermocline. Recent improvements in water quality may have restored a small portion of the "cisco layer" in Hamilton Harbour. A cisco layer has water with a temperature below 20^{o} C and oxygen above 3 mg/l, and forms a summer refuge for lake herring (Frey 1955).

4.6.3 Fish Community

4.6.3.1 Historical Fish Community

Hamilton Harbour originally contained a mixture of coldwater, coolwater, and warmwater fishes owing to its diversity of habitats (Holmes and Whillans 1984). The harbour was once considered one of the best lake herring and lake whitefish habitats in the Great Lakes (Whillans 1977). At the end of the 19th Century lake herring dominated the commercial fishery in the harbour (Figure 4.26). Hamilton Harbour was an important habitat for other coldwater species, including lake trout and Atlantic salmon. Substantial spawning migrations of Atlantic salmon were documented in Red Hill Creek and Spencer Creek, and likely occurred in Grindstone Creek, but in the 1830s their numbers had began to decline. Atlantic salmon were last observed in Hamilton Harbour tributaries in 1885 (Whillans 1977). Except for wanderers from Lake Ontario, lake herring, lake whitefish, and lake trout were eliminated from the harbour by the 1930s. Once, lake sturgeon was so plentiful in the harbour that they were considered a nuisance to commercial fishermen because they would tangle in fishing nets. By the turn of the 20th century lake sturgeon was no longer part of the fish community. The harbour also supported a thriving nearshore fish community that included populations of northern pike, muskellunge, largemouth and smallmouth bass, yellow perch and white suckers.

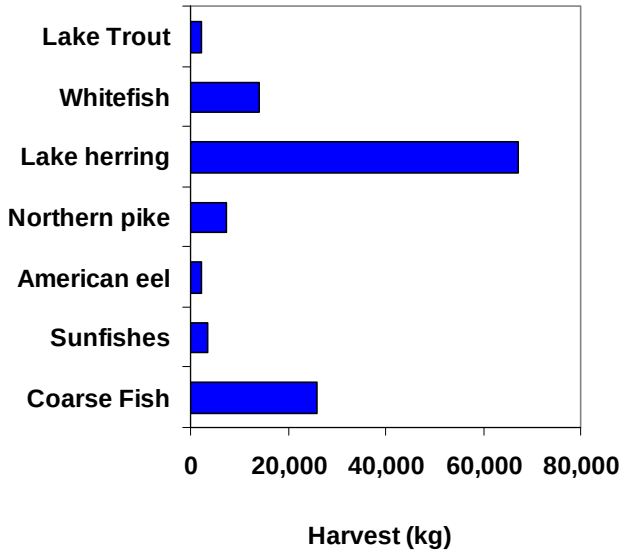


Figure 4.26. Average yearly commercial harvest of fish from Hamilton Harbour, 1871-1901 (Data from Holmes and Whillans 1984).

4.6.3.2 Present Fish Community

Sixty-four fish species have been reported from Hamilton Harbour (Appendix 7.4). Currently, the fish community is dominated by brown bullheads and white perch (Figure 4.27) which are tolerant of the high turbidity found in Hamilton Harbour. Centrarchid species such as bluegill and pumpkinseed sunfish, largemouth and smallmouth bass, and black crappie play a less prominent role in the fish community of Hamilton Harbour than many similar water

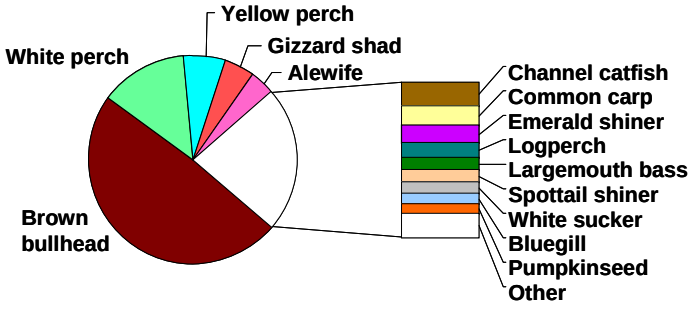


Figure 4.27. Relative abundance of fish species in Hamilton Harbour in 2006 (based on equal weighting of electrofishing and trapnet data from DFO and OMNR).

bodies in Ontario, such as the Bay of Quinte (Figure 4.27) and Kawartha Lakes. Northern pike and walleye numbers in Hamilton Harbour are more encouraging (Figure 4.28) with pike numbers exceeding the Bay of Quinte.

Walleye have been reproducing in Hamilton Harbour in recent years. Their age distribution indicates good natural reproduction in 1998 and 2003 (Figure 4.29).

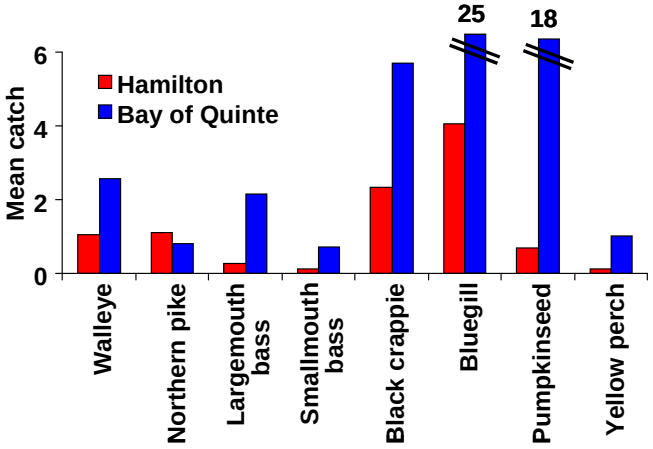


Figure 4.28. Catch per net of selected fish species in Hamilton Harbour in 2006 in trapnets (OMNR 2007) compared with the Bay of Quinte (OMNR 2006).

Abundance of several fish species in Hamilton Harbour from 1988 to 2006 is consistent with improvements in water quality (Figure 4.30). In particular, largemouth bass, rock bass, bluegill, pumpkinseed, yellow perch, logperch, have increased while brown bullheads have declined. Some of these species peaked in the 1990s and have since declined, and this may be consistent with predation by double-crested cormorants as has been documented in eastern Lake Ontario (Lantry et al. 2002; Casselman et al. 2002, McCullough and Wesloh 2007). Cormorant nests increased in Hamilton Harbour from 1990 to 2006 (Figure 4.31).

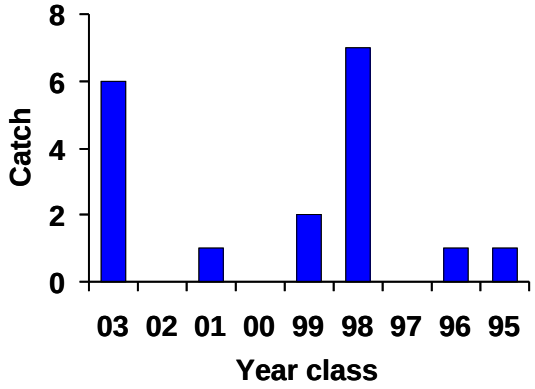


Figure 4.29. Total catch of walleye by year class in Hamilton Harbour in 2006 in trapnets (OMNR 2007). Year class refers to the year of hatching.

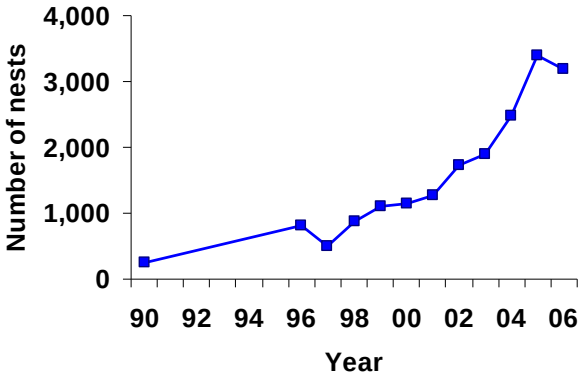


Figure 4.31. Number of double crested cormorant nests observed in Hamilton Harbour during 1990 to 2006 (data from Weseloh et al. 2002, and CWS unpublished.)

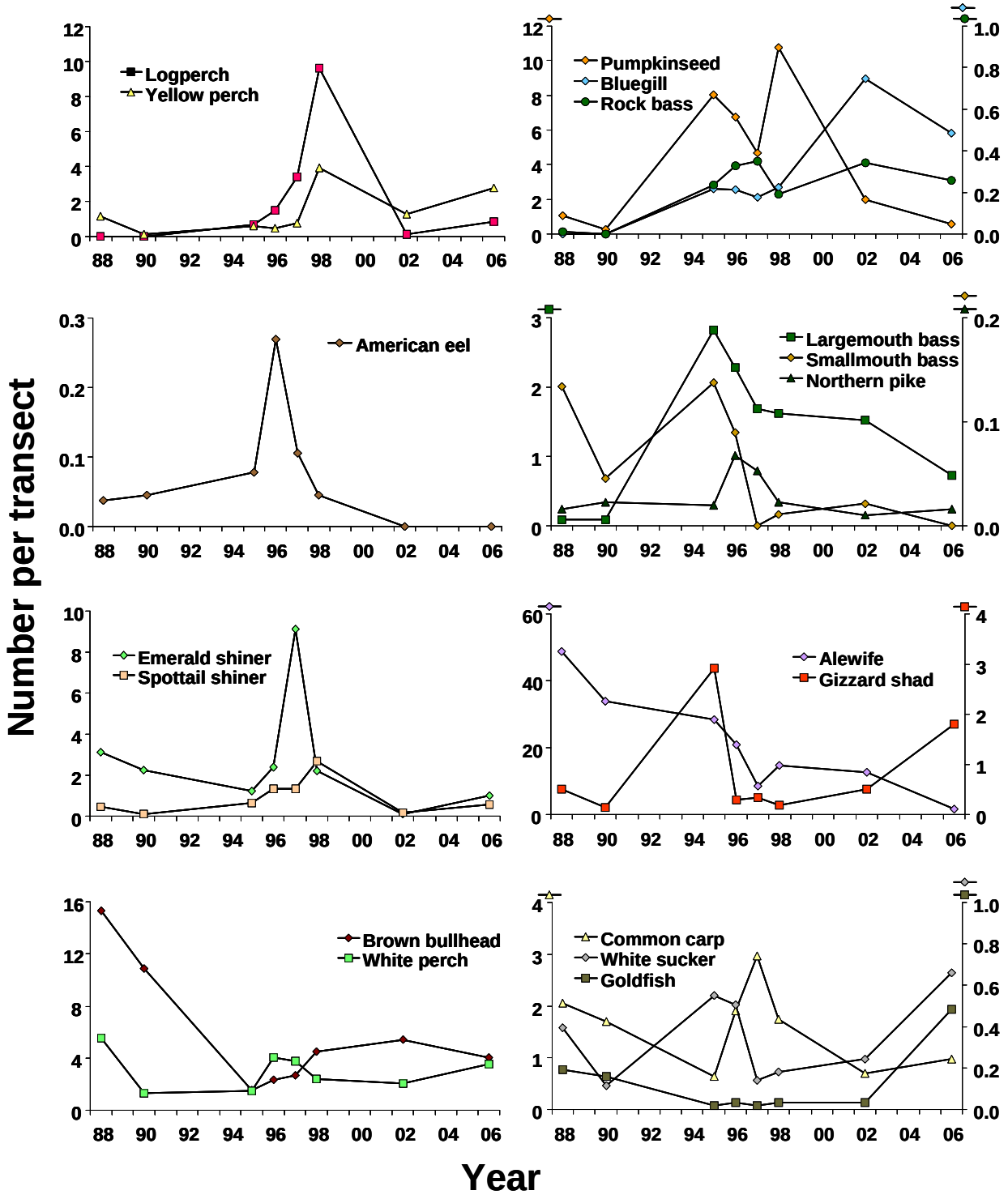


Figure 4.30. Catch of selected fish species in Hamilton Harbour from 1988 to 2006 by electrofishing (Brousseau and Randall 2008).

4.6.3.3 Fish Stocking

Chinook salmon and brown trout have been stocked at the Burlington Canal in Hamilton Harbour for over 20 years (Table 4.1). These fish were intended to provide fishing opportunities for anglers in boats, along the shoreline, and in tributaries in an area more widespread than Hamilton Harbour throughout western Lake Ontario. Nevertheless, spawning runs of these stocked fish concentrate in the tributaries of Hamilton Harbour. Since 1992, about 50,000 Chinook salmon and 15,000 brown trout have been stocked in most years.

Walleye were transferred from the Bay of Quinte or stocked into Hamilton Harbour from 1992 to 1999 to restore populations to the Harbour. Recent DNA analyses suggest that the current population of walleye in Hamilton Harbour were established from these stocked fish (C. Wilson, personal communication). As well, close to 400 adult northern pike were transferred into Hamilton Harbour in 1988.

Table 4.1. The number of fish stocked in Hamilton Harbour. 1983 - 2007.

Year	Brown trout	Brown trout	Chinook salmon	Lake trout	Walleye	
	Yearling	Fingerling	Fingerling	Yearling	Adult	Fingerling
1983	23,500	-	-	-	-	-
1984	20,368	-	65,584	-	-	-
1985	45,000	-	49,998	-	-	-
1986	34,660	-	95,819	-	-	-
1987	22,774	-	46,101	-	-	-
1988	-	-	64,842	-	-	-
1989	21,191	-	65,069	-	-	-
1990	-	-	57,571	-	-	-
1991	28,465	-	44,942	-	-	-
1992	15,128	-	69,761	41,882	-	-
1993	15,181	-	50,087	-	185	-
1994	15,477	-	49,624	-	129	-
1995	14,702	-	50,186	-	-	-
1996	15,252	-	49,874	-	-	-
1997	16,536	-	50,560	-	130	-
1998	14,313	-	51,079	-	120	-
1999	15,000	-	-	-	-	6,000
2000	15,521	-	51,707	-	-	-
2001	15,011	-	50,748	-	-	-
2002	15,040	-	-	-	-	-
2003	22,562	-	46,069	-	-	-
2004	11,879	-	49,998	-	-	-
2005	17,369	-	50,000	-	-	-
2006	15,019	-	37,000	-	-	-
2007	14,813	10,080	55,008	-	-	-

5 Key Issues and Proposed Management Objectives

5.1 Introduction

Key issues concerning fish communities in the Hamilton Harbour watershed were identified by the public during open houses, a public survey, and through meetings and ongoing discussions with the Steering Committee and the Angler's Working Group. These issues have been prioritized by the planning team in order to identify implementation options that will link to specific performance measures and the FMP goals and objectives in Chapter 1. The purpose of this section is to identify actions to effectively direct management efforts towards sustainable quality fisheries, an ecological diverse and healthy ecosystem, and community based partnerships. More information on the issues identified by the public is available in Appendix 7.3.

Addressing the fisheries issues in Hamilton Harbour and its watersheds with management strategies is simply providing solutions to the problems of aquatic community and habitat. Appropriate management strategies require objectives or a vision of the future fish communities. To a large extent the objectives are driven by the public's desire for healthy fish communities and aquatic environments which has also driven MNR's associated policies. For each watershed and Hamilton Harbour, we have used public input, current policies, historical conditions, and the constraints of invasive species and the modern ecosystem to develop a vision of the possible future fish community. These objectives have been described below. Management strategies to meet these objectives are provided in Appendix 7.5.

5.2 Key Issues

Key issues were developed under three themes: Aquatic Community, Aquatic Habitat, and Planning. Many of these themes were interconnected, both between and within the themes. For instance, many problems with fish communities are related to degradation of habitat, and so in some cases it may be difficult to peg an issue into a single theme or issue. Nevertheless, the separation of the issues may help with understanding the problems and solutions. In addition issues were ranked in importance by the public, the Steering Committee, and the Angler's Working Group.

Primary issues are those that are both within the scope of the management plan and have been identified by the public as a high priority concern. The primary issues are:

Aquatic Community

- Dams and barriers to fish passage
- Contaminants in fish
- Declines in native species abundance
- Invasive species
- Species at risk

Aquatic Habitat

- Loss or degradation of aquatic habitat
- Water Quality
- Sediment erosion into water bodies
- Maintaining stream flow

Planning
- Coordination of activities

Secondary issues are within the scope of the HHWFMP, but are identified by the public as having a relatively low priority. The secondary issues are:

Aquatic Community
- Unbalanced fish community
- Angling opportunities
- Nuisance Species

Aquatic Habitat
- Public Awareness
- Protection of riparian lands

Tertiary issues are those that have been identified by the public, but are not a primary focus of the HHWFMP, and may be dealt with indirectly through addressing primary and secondary issues as well as through other programs and initiatives. The tertiary issues are:

Aquatic Community
- Stocking

Aquatic Habitat
- Funding
- Contaminants

Planning
- Knowledge

The following provides a general description of each issue. Potential strategies and actions to address the issues are in Appendix 7.5.

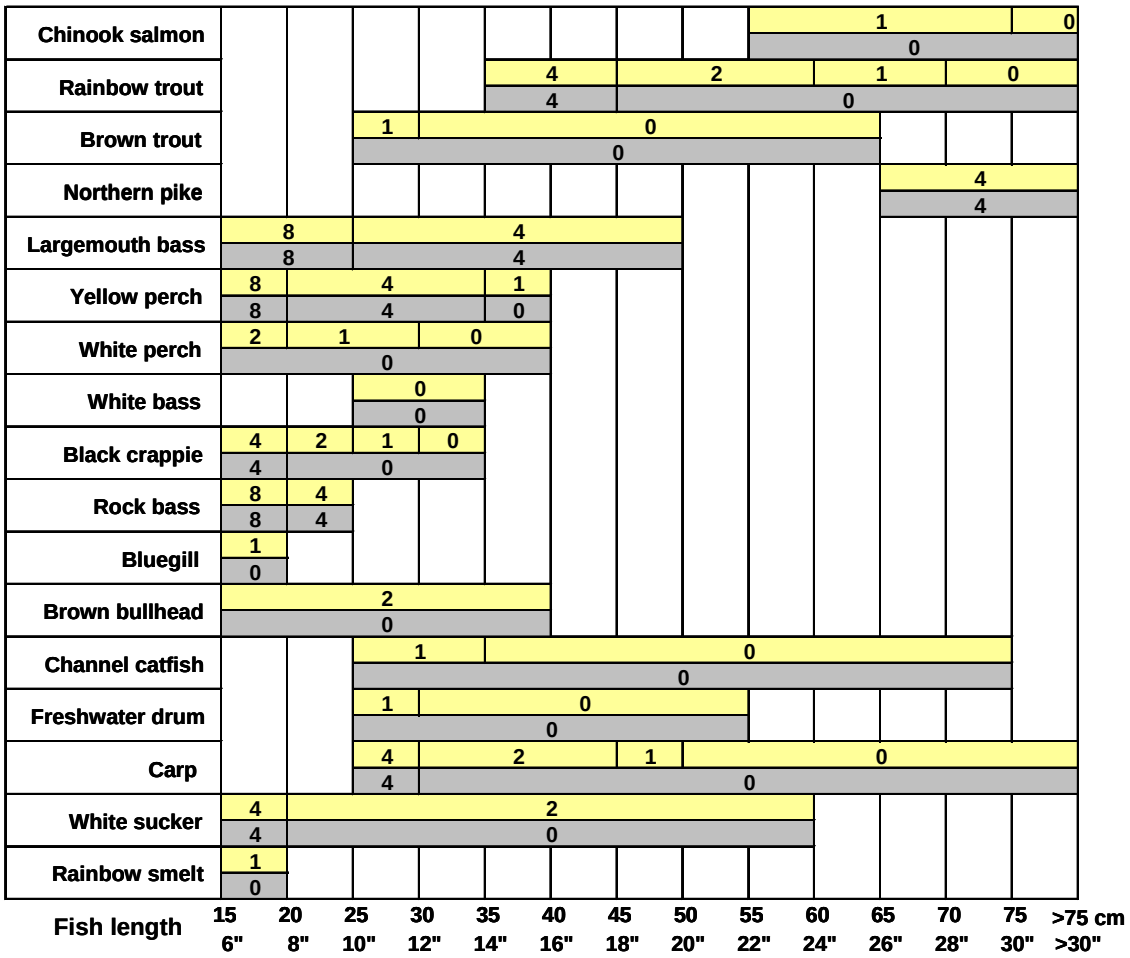
5.2.1 Aquatic Community

5.2.1.1 Primary issues

Dams and barriers to fish passage – Dams and barriers affect both aquatic communities and habitats, in similar amounts and in similar ways. Clearly, dams and barriers are issues for both aquatic communities and aquatic habitat. They restrict fish passage and alter habitat, causing positive and negative effects on aquatic communities. Restricting passage may prevent fish from reaching key habitat for spawning, or may hamper gene flow between small separated populations. For example, brook trout in upper Spencer Creek have lost the gene flow from other populations in Spencer Creek. In contrast, barriers to fish passage may prevent invasion of detrimental species, such as sea lamprey and round gobies, or diseases such as viral haemorrhagic septicaemia into the upper watersheds. As well, dams alter the habitat, and in turn, those habitats may benefit some species while harming others. The fish community of the large reservoirs in Spencer include largemouth bass and sunfishes and are much different than the communities upstream or downstream. Unfortunately, the reservoirs also result in warmer water downstream. In some cases small dams or man-made barriers have replaced the function of beaver dams, which are now reappearing with the recovery of beaver populations. Without many of these small man-made structures, several amphibian populations in the Hamilton Harbour watershed may have been severely depleted. Some dams and weirs within the watershed no longer serve a purpose or have become structurally unsafe, and should be investigated for removal or impact mitigation.

Contaminants in fish – Contaminants in fish are a health concern for people and the aquatic community of Hamilton Harbour. Fish from Hamilton Harbour have higher contaminant burdens that most other locations in Lake Ontario. Contaminants found in fish from Hamilton Harbour include mercury, other metals, PCBs, mirex/photomirex, pesticides, chlorinated phenols, chlorinated, benzenes, polycyclic aromatic hydrocarbons (PAHs), dioxins, furans, dioxin-like PCBs, and PCB congeners (OMOE 2007). Some of these chemicals such as PAHs and metals come from contaminated sediment in Hamilton Harbour, but some chemicals, such as mirex and photomirex and PCBs are lakewide problems. OMOE has recommended restricting consumption of all species of fish that have been tested from Hamilton (Table 5.1).

Table 5.1. Recommended acceptable number of meals/month of fish from Hamilton Harbour by length for the more common species caught by anglers. The upper number (highlighted in yellow) indicates meals/month for the general adult population, and the lower number (highlighted in grey indicates the meals/month for women of child-bearing age, children under 15. (from OMOE 2007)



Declines in native species abundance – In Hamilton Harbour and its watersheds, virtually all native species of importance, to fishing or structuring the fish community have declined. Some of these declines have been discussed above. The decline of brook trout is the most significant decline in the watersheds. In Hamilton Harbour whole fish communities have declined and been replaced by other native and non-native species. In most cases the declines of native fish species was due to changes in habitat, and often exacerbated by introductions and invasions of other species, both native and non-native.

Invasive species – Invasive species such as rainbow smelt and alewife have greatly harmed the native fish communities of Lake Ontario and Hamilton Harbour. Together these two species have contributed to the decline, extirpation or extinction of a number of coldwater and coolwater fishes in Lake Ontario and beyond. Other more recent invaders, such as quagga mussels have been implicated in the decline of lake whitefish through harming populations of opossum shrimp, a major food of whitefish. Most of the recent invaders, including round gobies, likely came to the Great Lakes in the ballast water of ocean-going ships or by intentional and unintentional introductions. At issue are the many other invaders with potential to flourish if transported to the Great Lakes.

Species at risk – These species are a special case of the issue "Declines in native species abundance", and are protected through the Endangered Species Act, 2007 (Ontario) or the Species At Risk Act (Canada). Species from Hamilton Harbour or its watersheds that have been listed in these Acts or are being considered are in Table 5.2. Local recovery action plans should be designed and implemented for species at risk within the study area consistent with broader species recovery strategies developed by MNR. For instance, redside dace will require restoration within Spencer Creek (Figure 5.1). Restoration of American eels and Atlantic salmon currently is concentrating elsewhere in the Lake Ontario watershed.

Table 5.2. Species with special status as listed in or being considered for the Endangered Species Act, 2007 (Ontario) or the Species At Risk Act (Canada). Codes: SC – Special Concern; THR – Threatened; END – Endangered; EXP – Extirpated; EXT – Extinct; "Pending" refers to public consultation; COSSARO is the Committee on the Status of Species at Risk in Ontario, and COSEWIC is the Committee on the Status of Endangered Wildlife in Canada.

Common Name	COSSARO	Endangered Species Act, 2007 (Ontario)	Species at Risk Act (Canada)	COSEWIC
Lake Ontario Kiyi			EXT	EXT
Kiyi	SC			
Blue pike	EXT		EXT	EXT
Atlantic salmon	EXP	EXP	Pending	EXP
Shortnose cisco	EXP	EXP	THR	END
Northern brook lamprey	SC	SC	Pending	SC
Bigmouth buffalo	SC	SC		Not at Risk [1]
Redside dace	END	END[2]	SC3 - Pending	END
American eel		END	Pending	SC
Blackfin cisco	EXT		THR	DD
Lake sturgeon		SC	Pending	THR
Spotted gar	THR	THR	THR	THR
Lake chubsucker	THR	THR	THR	THR
Black redhorse	THR	THR		THR

1. Great Lakes – Upper St. Lawrence populations were delisted by COSEWIC in April 2008.
2. Expected February 2009.

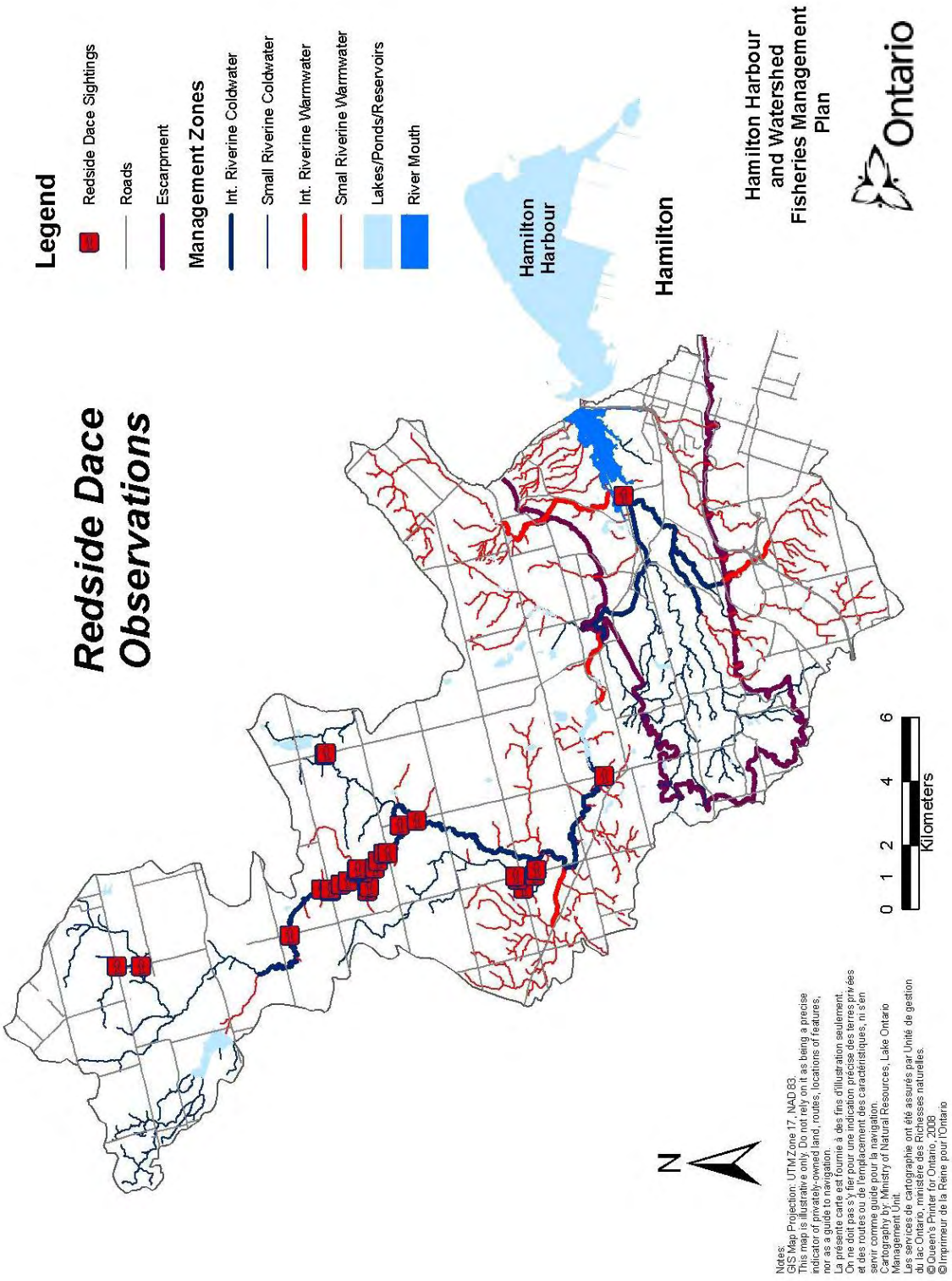


Figure 5.1. Distribution of redside dace in Spencer Creek watershed.

5.2.1.2 Secondary issues

Unbalanced fish community – The current fish community in Hamilton Harbour is seriously out of balance due to pollution of the aquatic habitats and habitat loss. For example, excessive nutrients in Cootes Paradise and Hamilton Harbour have contributed high turbidity and low dissolved oxygen, which favoured a high abundance of carp. Together the turbidity and carp have contributed to the loss of aquatic vegetation that formerly supported a diverse fish community. The situation has been exasperated by regulation of water levels in Lake Ontario. As a result, largemouth bass, northern pike, and walleye populations declined, and the role of dominant piscivore in Hamilton Harbour has been assumed by channel catfish, which is better adapted to the polluted habitats. Although the resulting fish communities may be in balance with the polluted habitat, they are still considered out of order from the norm, or unbalanced. To some extent the carp barrier in Cootes Paradise has reduced the impacts of carp, but only by reducing the excessive nutrients can this issue be totally solved.

Angling opportunities – Angling opportunities require access to the fishery, consumable fish, and sufficient numbers of desirable fish species. Interest in catch and release fishing for carp, freshwater drum and channel catfish is growing in Hamilton Harbour, but the fish are contaminated and unsuitable for unrestricted consumption. Numbers of pike, bass, walleye, perch, crappies and sunfish are insufficient to support a desirable recreational fishery. Most of the creeks in the watershed have abundant minnow populations that provide bait, but these fish have little value for consumption or as sport fish because of their small size. As the fish communities improve, access becomes a greater issue, particularly along the shorelines.

Nuisance Species – Nuisance species such as carp and cormorants disturb habitats and alter the structure of fish communities in Hamilton Harbour. Usually, species become classified as a nuisance after they become overly abundant.

5.2.1.3 Tertiary issues

Stocking – Stocking is a useful tool for restoring native fish species and for providing angling opportunities. For example, stocked walleye and northern pike may have been instrumental in restoring populations in Hamilton Harbour. Stocking issues center on the impact of stocked fish on native species, and on the impacts of the stocked fish on prey populations and fish community stability, particularly in Lake Ontario. The number of salmon and trout stocked into Lake Ontario is limited by agreement between New York State and the Province of Ontario through the Lake Ontario Committee of the Great Lakes Fishery Commission. Accordingly, any additional salmon and trout stocked in the Hamilton Harbour watershed, destined for Lake Ontario must by balanced with stocking reductions elsewhere. Restoration of prey fish is critical for the restoration of some predator fish species, particularly muskellunge, before considering reintroduction.

5.2.2 Aquatic Habitat

5.2.2.1 Primary issues

Loss or degradation of aquatic habitat – The loss and degradation of aquatic vegetation, and physical habitat in the streams and Hamilton Harbour was the most important issue for both the public and guiding committees. Particular problems include the loss of aquatic vegetation in Cootes Paradise and Hamilton Harbour, loss of shoreline and shoal habitat in Hamilton Harbour, channelization throughout the watershed, and piped streams in urban areas.

Water Quality – The water quality issue is another aspect of aquatic habitat degradation, but it has been treated separately due to its importance. In Hamilton Harbour and Cootes Paradise water quality degradation was one of the principal reasons for the designation of the Harbour as an AOC, and for the creation of the RAP. The main water quality issues in Hamilton Harbour are related to nutrient enrichment from waste water treatment plants and to toxic chemicals released from toxic sediments

originating from historic industrial deposits. In the watershed the main issue is elevated summer water temperature due to impoundments, reduced shading along stream banks, or reduced ground water inputs.

Sediment erosion into water bodies – Sediment erosion into the streams and other water bodies of the Hamilton Harbour watershed occurs primarily from soils which are bared by construction and agriculture. Increased stormwater flows caused by deforestation erode stream banks and flood plains. Prolonged exposure to high concentrations of suspended sediments in the water column can kill fish and invertebrates. The deposition of eroded material can cover gravel spawning habitats and invertebrate habitat, and can fill pools or other habitat used by fish.

Maintaining stream flow – The discharge or volume of stream flow during base flow conditions limits the volume of fish habitat in streams, and also affects the temperature of a stream through the cooling effects of ground water and through the resistance of higher volumes of water to temperature change. For coldwater streams maintaining the stream flow is critical. Reduced infiltration of precipitation to become ground water (i.e. increased run off), increased evaporation due to ponding, or water taking from either the ground or the stream may reduce base flow.

5.2.2.2 Secondary issues

Public Awareness – Public awareness is essential to solving all of the big problems in Hamilton Harbour. It is the necessary ingredient that mobilizes the public constituency to take action. The solution for many issues often lies with the public gaining an understanding of associated problems. With understanding the public may gain appreciation of aquatic resources and find an enjoyment in them, and moreover, may contribute to restoration projects. For example, restoration of Cootes Paradise will happen only when the public understands the issues and demands changes to nutrient loading. BARC as the public arm of the RAP is an effective agency for ensuring the public is aware of important issues.

Protection of riparian lands – Riparian lands border lakes and rivers. Impacts on riparian lands often contribute directly to impacts on lakes and streams due to the ecological linkage between. Encroachment of development and agriculture into riparian lands reduces the ability of these lands to buffer impacts of these activities on lakes and streams.

5.2.2.3 Tertiary issues

Funding – Many of the issues have been costly to address, and funding for some types of projects is limited.

Contaminants – Contaminants in the aquatic habitats of Hamilton Harbour, particularly Randle Reef is another reason for the designation of the Harbour as an AOC, and for the creation of the RAP. These sediments are contributors to poor water quality and contaminants in fish, both higher priority issues, above. We feel the lower ranking of this issue merely reflects that people considered the sediment issue already addressed through water quality and fish contaminants.

5.2.3 Planning

5.2.3.1 Primary issues

Coordination of activities – Hamilton Harbour and its watershed is covered by four separate MNR offices, two conservation authorities, and two cities and several other smaller municipalities. Fisheries and Oceans Canada and Environment Canada have taken a great interest in the harbour, in part due to the location of CCIW and in part due the problems it presents for restoration. Several professors at McMaster University have made studies in the watershed. RBG holds significant portions of Cootes Paradise and lower Grindstone Creek, and has significant science programs, as well. In addition, several other NGOs make significant contributions to restoration and management of Hamilton Harbour and its watershed. The RAP Office does an excellent job coordinating many of the activities relating to restoration of the

Harbour. However, some agencies and organizations make less use of it or the relationships that might be made through it, and so there is still some duplication of effort, and other opportunities for joint activities may be missed.

5.2.3.2 Tertiary issues

Knowledge – Knowledge issues relate to lack of knowledge and lack of synthesis. For instance, the temperature regime of Spencer Creek has not been determined comprehensively. However, collecting the temperatures is not enough. Once the temperatures have been collected, stream temperatures will need to be modeled to optimize the approach to improving temperatures for the aquatic community.

5.3 Fish Management Objectives

Fish Management Objectives provide a vision for fish communities in each Fisheries Management Zone within each watershed (North Shore: Tables 5.3, Grindstone Creek: Tables 5.4, Spencer Creek: Tables 5.5, Red Hill Creek: Tables 5.6) and Hamilton Harbour (Tables 5.7). To a large extent these visions are driven by Public's desire for healthy fish communities and aquatic environments which has also driven OMNR's associated policies. These Fish Management Objectives are based on key species representative of their fish communities. These species have stringent habitat needs and satisfying there requirements will benefit the ecosystem. For each watershed and Hamilton Harbour, we have used public input, current policies, historical conditions, and the constraints of invasive species and the modern ecosystem to develop a vision of the potential fish community. The Niagara Escarpment is a dominating force in determining fish community and habitat, and so the Fish Management Objectives for riverine zones have been separated above and below the escarpment. By addressing the Key Issues and Proposed Management Strategies (Appendix 7.5) we hope to meet the Fish Management Objectives.

In the following sections we have listed the general Fish Management Objectives across all watersheds. The objectives may differ in some watersheds, in which case the specific objectives for each watershed (Table 5.3 – 5.7) should take priority.

5.3.1 Riverine and Lake Zones – above Niagara Escarpment

The low gradient of the streams above the Niagara Escarpment are more suited to brook trout, and a variety of other coldwater and coolwater species, including redside dace. Temperature, flow regime, and silt still hinder restoration of these species. Because water flows down a river, any impacts to the river are carried downstream. Accordingly, the dependence of downstream reaches on the activities within the whole upstream watershed contributes to conflicting objectives in upstream and downstream parts of the watershed. For example, reservoirs increase water temperature, making reaches downstream unsuitable for coldwater species. These conflicts cannot be resolved here, but should be considered in future reviews of this FMP.

5.3.1.1 Small Coldwater Riverine Objectives

The capacity for brook trout should increase, and they should play a prominent role in most of these streams, and in Spencer Creek, redside dace populations should increase in accordance with the redside dace recovery plan. Priority to brook trout should be given to those streams with greater potential for lower water temperature, and priority to redside dace should be giver to those coldwater streams with less potential to lower the water temperature.

5.3.1.2 Intermediate Coldwater Riverine Objectives

The capacity for brook trout should increase, and they should play a prominent role in most of these streams. In Spencer Creek, redside dace populations should increase in accordance with the redside dace recovery plan. Where habitat cannot be restored adequately for brook trout, brown trout may be considered in their place.

5.3.1.3 Small and Intermediate Warmwater Riverine Objectives

Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters). If the temperature can be lowered enough to convert a warmwater stream to a coldwater stream, then priority should be given to redside dace and brook trout, as the physical habitat determines.

5.3.1.4 Inland Lakes and Reservoirs Objectives

Northern pike, largemouth bass, and sunfishes can provide angling opportunities in the larger inland lakes and reservoirs. The objectives for smaller in-line ponds are the same as the stream that flows through them.

5.3.2 Riverine Zones – below Niagara Escarpment

The high gradient and large substrate below the Niagara Escarpment is especially suited to Atlantic salmon and trout species. Temperature, flow regime, and silt still hinder restoration of these species. Because water flows down a river, any impacts to the river are carried downstream. The dependence of downstream reaches on the activities within the whole upstream watershed contributes to conflicting objectives in upstream and downstream parts of the watershed. These conflicts cannot be resolved here, but should be considered in future reviews of this FMP. The river mouth zones (especially Cootes Paradise) play a critical role in meeting the objectives for Hamilton Harbour, by acting as migratory corridors, and spawning and nursery habitat for fish species that reside elsewhere much of their lives.

5.3.2.1 Small Coldwater Riverine Objectives

The capacity for brook trout should increase, and they should play a prominent role in reaches of these streams that are not greatly impacted by rainbow trout and brown trout.

5.3.2.2 Intermediate Coldwater Riverine Objectives

The capacity for rainbow trout and brown trout should increase, and they should play a prominent role in most of these streams. Atlantic salmon reintroduction can be considered where brown trout prove that the quality of spawning habitat is suitable, as determined by the Atlantic salmon recovery plan.

5.3.2.3 Small Warmwater Riverine Objectives

Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters). If the temperature can be lowered enough to convert a warmwater zone to a coldwater zone, then priority should be given to brook trout, rainbow trout, or brown trout as the physical habitat determines.

5.3.2.4 Intermediate Warmwater Riverine Objectives

Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters). Increase the spawning capacity for migrants from Hamilton Harbour, such as walleye, white sucker, and smallmouth bass. If the temperature can be lowered enough to convert a warmwater zone to a coldwater zone, then priority should be given to rainbow trout, or brown trout as the physical habitat determines.

5.3.2.5 River Mouth (including Cootes Paradise) Objectives

Increase the spawning capacity for migrants from Hamilton Harbour, such as northern pike and largemouth bass. Reduce carp and goldfish populations.

5.3.3 Hamilton Harbour

Hamilton Harbour may be a key area for restoration of the lake herring population, and consequently, the fish community in western Lake Ontario. Lake herring can provide an alternative to alewife, as a food source for walleye, salmon and trout in Lake Ontario or Hamilton Harbour. Unlike alewife, lake herring are not susceptible to the winterkills, and they do not contain thiaminase which causes a thiamine

deficiency and reduced natural reproduction among salmon and trout in Lake Ontario. Remnant lake herring populations in Lake Ontario spawn in large embayments, such as the Bay of Quinte, Weller's Bay, and West Lake. In western Lake Ontario, Hamilton Harbour is the only embayment of similar size and potential for lake herring spawning. Among all embayments in Lake Ontario, only the Bay of Quinte has more coldwater habitat than Hamilton Harbour. Restoration of Hamilton Harbour may be a necessary condition for the restoration of a native fish community in western Lake Ontario. For instance, large muskellunge require large prey. Muskellunge may benefit from restoration of lake herring, white suckers, walleye, and lake whitefish.

5.3.3.1 Nearshore Objectives

Increase the capacity for largemouth bass, smallmouth bass, northern pike, walleye, yellow perch, and sunfishes. Increase the spawning capacity for lake herring and lake whitefish.

The Index of Biological Integrity (IBI) summarizes the state of the fish community (Minns et al. 1994, Smokorowski et al. 1998), and shows that the state quality is well below the RAP target for delisting Hamilton Harbour as an AOC (Figure 5.2). In contrast the IBI for the Bay of Quinte meets the Hamilton Harbour RAP target, as Quinte has a more balanced fish community with fewer bullheads, more fish predators such as walleye, and a greater proportion of native species. Accordingly, individual species targets will be developed using standard trapnet catch, based on the Bay of Quinte fish community.

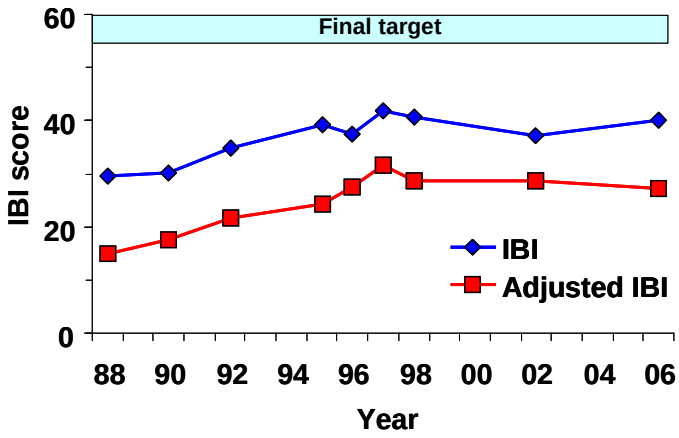


Figure 5.2. Index of Biotic Integrity (IBI) and adjusted IBI scores for Hamilton Harbour from 1988 to 2002 (Smokorowski et al. 1998, DFO unpublished data). Final target is for delisting Hamilton Harbour as an Area of Concern.

5.3.3.2 Offshore Objectives

Increase the capacity for lake herring and walleye. Maintain stocking of brown trout and Chinook salmon for Lake Ontario.

Table 5.3. Fish Management Objectives for the North Shore Watershed.

Fisheries Management Zone	Objective	Indicator
Small coldwater riverine	Increased capacity for white sucker spawning	Catch of white suckers in fisheries surveys of Hamilton Harbour
	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Small warmwater riverine	Increased capacity for white sucker spawning	Catch of white suckers in fisheries surveys of Hamilton Harbour
	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Intermediate warmwater riverine	Increased capacity for white sucker spawning	Catch of white suckers in fisheries surveys of Hamilton Harbour
	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
River mouth	Increased capacity for northern pike spawning	Catch of northern pike by anglers and in fisheries surveys of Hamilton Harbour

Table 5.4. Fish Management Objectives for Grindstone Creek.

Fisheries Management Zone	Objective	Indicator
Small coldwater riverine	Maintain capacity for native coldwater and coolwater fishes (e.g. minnows and darters)	Catch of native coldwater and coolwater fishes in fisheries surveys at current levels
Small coldwater riverine (above Niagara Escarpment)	Increase capacity for brook trout	Catch of brook trout by anglers and in fisheries surveys
Small coldwater (below Niagara Escarpment)	Increase production of rainbow trout	Catch of rainbow trout by anglers and in fisheries surveys
Intermediate coldwater	Maintain capacity for native coldwater and coolwater fishes (e.g. minnows and darters)	Catch of native coldwater and coolwater fishes in fisheries surveys at current levels
Intermediate coldwater (below Niagara Escarpment)	Increase production of rainbow trout	Catch of rainbow trout by anglers and in fisheries surveys
	Create brown trout angling opportunities	Catch of brown trout by anglers
	Use brown trout to test for the quality of spawning habitat for Atlantic salmon	Observations of naturally produced brown trout
	If feasible (based on brown trout reproduction) introduce Atlantic salmon	Observations of returning adult Atlantic salmon
	Increased capacity for white sucker spawning	Catch of white suckers in fisheries surveys of northwest shoreline of Hamilton Harbour
Small warmwater riverine	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Intermediate warmwater riverine	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Reservoirs and Inland Lakes (e.g. Lake Medad)	Maintain capacity for largemouth bass and sunfishes	Catch of largemouth bass and sunfishes in fisheries surveys at current levels
River mouth	Increased capacity for northern pike largemouth bass spawning	Catch of northern pike by anglers and in fisheries surveys of Hamilton Harbour

Table 5.5. Fish Management Objectives for Spencer Creek.

Fisheries Management Zone	Objective	Indicator
Small coldwater riverine (above Niagara Escarpment)	Increase capacity for redside dace	Catch of redside dace in fisheries surveys
	Increase capacity for brook trout	Catch of brook trout by anglers and in fisheries surveys
Intermediate coldwater riverine (above Niagara Escarpment)	Increase capacity for redside dace	Catch of redside dace in fisheries surveys
	Increase capacity for brook trout	Catch of brook trout by anglers and in fisheries surveys
	Where habitat cannot be restored adequately for brook trout, create brown trout angling opportunities	Catch of brown trout by anglers
Small coldwater riverine (below Niagara Escarpment)	Increase capacity for brook trout	Catch of brook trout by anglers and in fisheries surveys
	Increase production of rainbow trout	Catch of rainbow trout in fisheries surveys
	If feasible (based on brown trout reproduction) introduce Atlantic salmon	Observations of returning adult Atlantic salmon
Intermediate coldwater riverine (below Niagara Escarpment)	Increase production of rainbow trout	Catch of rainbow trout by anglers and in fisheries surveys
	Create rainbow trout and brown trout angling opportunities	Catch of rainbow trout and brown trout by anglers
	Use brown trout to test for the quality of spawning habitat for Atlantic salmon	Observations of naturally produced brown trout
	If feasible (based on brown trout reproduction) introduce Atlantic salmon	Observations of returning adult Atlantic salmon
Small warmwater riverine	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Intermediate warmwater riverine (above Niagara Escarpment)	Increase capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Intermediate warmwater riverine (below Niagara Escarpment)	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
	Increased capacity for walleye and smallmouth bass spawning	Catch of walleye and smallmouth bass by anglers and at carp barrier
	Increased capacity for white sucker spawning	Catch of white suckers and at carp barrier
	Create rainbow trout and brown trout to angling opportunities on a seasonal basis	Catch of rainbow trout and brown trout by anglers
Reservoirs and Inland Lakes (Valens, Christie, Crook's Hollow)	Maintain capacity for northern pike, largemouth bass and sunfishes	Catch of northern pike, largemouth bass, and sunfishes by anglers and in fisheries surveys at current levels
River mouth (Cootes Paradise)	Reduce carp and goldfish populations	Decreased catch of carp and goldfish in fisheries surveys and at carp barrier
	Increased capacity for northern pike and largemouth bass spawning	Catch of northern pike and largemouth bass by anglers and in fisheries surveys of Hamilton Harbour

Table 5.6. Fish Management Objectives for Red Hill Creek.

Fisheries Management Zone	Objective	Indicator
Small coldwater riverine	Maintain capacity for native coldwater and coolwater fishes (e.g. minnows and darters)	Catch of native coldwater and coolwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
	Create rainbow trout and brown trout angling opportunities	Catch of rainbow trout and brown trout by anglers
Intermediate coldwater riverine	Maintain capacity for native coldwater and coolwater fishes (e.g. minnows and darters)	Catch of native coldwater and coolwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
	Create rainbow trout and brown trout angling opportunities	Catch of rainbow trout and brown trout by anglers
	Increased capacity for white sucker spawning	Catch of white suckers in fisheries surveys of Hamilton Harbour
Small warmwater riverine	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Conduct fisheries surveys to determine fish populations
		Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
Intermediate warmwater riverine (below Niagara Escarpment)	Maintain capacity for native coolwater and warmwater fishes (e.g. minnows and darters)	Catch of native coolwater and warmwater fishes (e.g. minnows and darters) in fisheries surveys at current levels
	Increased capacity for walleye and smallmouth bass spawning	Catch of walleye and smallmouth bass by anglers and at carp barrier
	Increased capacity for white sucker spawning	Catch of white suckers and at carp barrier
	Create rainbow trout and brown trout angling opportunities on a seasonal basis	Catch of rainbow trout and brown trout by anglers
River mouth (Windermere basin)	Increased capacity for northern pike and largemouth bass spawning	Catch of northern pike by anglers and in fisheries surveys of Hamilton Harbour

Table 5.7. Fish Management Objectives for Hamilton Harbour.

Fisheries Management Zone	Objective	Indicator
Nearshore	Increased capacity for largemouth bass, smallmouth bass, northern pike, walleye, yellow perch, and sunfishes for spawning and production	Catch of largemouth bass, smallmouth bass, northern pike, walleye, yellow perch, and sunfishes by anglers and in fisheries surveys of Hamilton Harbour
	Increased capacity for lake herring and lake whitefish spawning	Catch of lake herring and lake whitefish in fisheries surveys of Hamilton Harbour and western Lake Ontario
Offshore	Increased capacity for walleye	Catch of walleye by anglers and in fisheries surveys of Hamilton Harbour
	Increased capacity for lake herring	Catch of lake herring in fisheries surveys of Hamilton Harbour and western Lake Ontario
	Maintain stocking of brown trout and Chinook salmon for Lake Ontario	Catch of brown trout and Chinook salmon by anglers western Lake Ontario

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7 Appendices

7.1 Appendix: Key Concepts and Guiding Principles

7.1.1 Ontario's Biodiversity Strategy (OMNR 2005a)

Ontario's Biodiversity Strategy sets out a plan for protecting and conserving Ontario's biodiversity. Biodiversity is the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes diversity within species, between species and of ecosystems. The Strategy provides Ontarian's with a vision for sharing responsibility for conserving the Province's biodiversity. It accounts for the significant growth that is forecasted for Ontario and acknowledges that sensitive areas need to be planned in a responsible manner, so that biodiversity is retained as populations increase. The Strategy describes Ontario's four major ecological regions, presents a vision for the future, outlines goals and principles, highlights the threats and opportunities facing Ontario, and provides a series of strategic directions and recommended actions. Strategic Plan for Ontario Fisheries (SPOF II)

7.1.2 Strategic Plan for Ontario Fisheries (SPOF II)

In 1992, OMNR updated the Strategic Plan for Ontario Fisheries (SPOF II) as policy to guide fisheries management in the Province. SPOF II adopted an ecosystem approach to managing fisheries resources and supports ecological sustainability. The goal statement of this policy is that there be "Healthy aquatic ecosystems that provide sustainable benefits, contributing to society's present and future requirements for a high-quality environment, wholesome food, employment and income, recreational activity, and cultural heritage." Furthermore, the objectives of this document are to:

- to protect healthy aquatic ecosystems,
- to rehabilitate degraded aquatic ecosystems, and
- to improve cultural, social and economic benefits from Ontario's fisheries resource.

7.1.3 OMNR Watershed-based Fisheries Management Plan Guideline.

The following guiding principles provide focus and a philosophy for the Hamilton Harbour Fisheries Management Plan. The following principles are derived from the above policies and OMNR's Watershed-based Fisheries Management Plan (WBFiMP) Guideline.

ECOSYSTEM APPROACH: An ecological approach to fisheries management is central to conservation and use of the resource in a sustainable manner. Resource management strategies and actions should consider the economic, social and cultural benefits and costs to society, both present and future.

SUSTAINABLE DEVELOPMENT: The finite capacity of the resource needs to be recognized in planning strategies and actions of the HHWFMP. Only natural resources over and above those essential for long-term sustainability requirements are available for use, enjoyment and development. There is a limit to the natural productive capacity of aquatic ecosystems and, hence, a limit to the amount of fish that can be harvested from them.

BIODIVERSITY: The plan should ensure the conservation of biodiversity by committing to healthy ecosystems, protecting our native species, and sustaining genetic diversity of fish in the watershed. All species in the watershed including non-sport fish and species at risk must be considered.

CONTROLLING INTRODUCED SPECIES: The plan should promote control and prevention of invasive or nuisance species.

NATURAL REPRODUCTION: Naturally reproducing fish communities based on native fish populations provide predictable and sustainable benefits with minimal long-term cost to society.

HABITAT PROTECTION: The objective is to increase the natural productive capacity of habitats for Canada's fisheries resources, to benefit present and future generations of Canadians. This can be attained through fish habitat conservation (by maintaining the current productive capacity of and ensuring no net loss of the productive capacity of habitats), fish habitat restoration (by rehabilitating the productive capacity of fish habitats) and fish habitat development (by improving and creating fish habitat).

REHABILITATION: Rehabilitation of degraded habitat and populations is an important management aspect of the HHWFMP.

VALUING THE RESOURCE: Stakeholders and landowners that rely on the watershed should be encouraged to understand and appreciate the value of fisheries resources, and to participate in decisions that may directly or indirectly affect aquatic ecosystem health.

RESPONSIBILITY: Fisheries management at a watershed level requires local, regional, provincial and federal cooperation and sharing of knowledge, costs and benefits. Jurisdictions directly involved in fisheries management are ultimately responsible for HHWFMP development and implementation.

KEY ROLE OF TEAMS: A HHWFMP management team has been established to lead the development of the plan and an implementation team should be developed to guide the implementation of strategies and actions.

MULTI-PARTY INVOLVEMENT: Participation in fisheries management plan development must include all those who share an interest. Plan preparation and implementation should involve a wide range of stakeholders, Aboriginal peoples, and interested parties to ensure an open and transparent process that acknowledges their valuable role in the process.

ABORIGINAL INTERESTS: The planning process has regard for the rights and interests of Aboriginal communities and provides for meaningful consultation with Aboriginal communities in cases in which their Aboriginal or treaty rights may be affected.

DIRECT ACTION: All reasonable options must be considered and evolve to implementation actions that are feasible.

KNOWLEDGE: The HHWFMP and its implementation should be based on the best available information.

ADAPTIVE MANAGEMENT: The HHWFMP should provide for the long-term monitoring, assessment and reporting of the effectiveness of management actions. Strategies and actions should be regularly reviewed, revised and acted upon in a timely fashion, as necessary, in response to new information gained and progress made.

7.1.4 Policy for the Management of Fish Habitat in Canada (DFO 1986)

The Policy for the Management of Fish Habitat outlines the Department of Fisheries and Oceans Canada (DFO) objectives, goals, and strategies for the management of fish habitat. The policy objectives of this document are to achieve a "net gain of habitat for Canada's fisheries resources" and to "increase the natural productive capacity of habitats for the nation's fisheries resources, to benefit present and future generations of Canadians." The goals of this policy include:

- Fish Habitat Conservation: "Maintain the current productive capacity of fish habitats supporting Canada's fisheries resources, such that fish suitable for human consumption may be produced."
- The guiding principle behind this goal is that "the no net loss principle is fundamental to the habitat conservation goal. Under this principle, the Department will strive to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that

further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented."

- Fish Habitat Restoration: "Rehabilitate the productive capacity of fish habitats in selected areas where economic or social benefits can be achieved through the fisheries resource."
- Fish Habitat Development: "Improve and create fish habitats in selected areas where the production of fisheries resources can be increased for the social or economic benefit of Canadians."

7.1.5 A Joint Strategic Plan for Management of Great Lakes Fisheries (GLFC 2007)

The Joint Strategic Plan for Management of Great Lakes Fisheries is a commitment through the Great Lakes Fishery Commission to inter-jurisdictional coordinated fishery management based upon an ecosystem approach. Fish-Community Objectives for Lake Ontario result from this plan.
The common goal statement for Great Lakes fishery agencies (including OMNR) is:

"To secure fish communities, based on foundations of stable self-sustaining stocks, supplemented by judicious plantings of hatchery-reared fish, and provide from these communities an optimum contribution of fish, fishing opportunities and associated benefits to meet needs identified by society for:

- wholesome food,
- recreation,
- cultural heritage,
- employment and income, and
- a healthy aquatic ecosystem."

7.1.6 Fish-Community Objectives for Lake Ontario (Stewart et al. 1999)

This document outlines binational, whole-lake fish-community objectives for Lake Ontario.' This document will be used by the New York State Department of Environmental Conservation and OMNR to guide the delivery of their mandates for managing the fish community and fisheries of Lake Ontario. These objectives are also a starting point for discussions with management agencies, interest groups, and the general public for developing more-specific fisheries, habitat, and watershed management plans. In addition, the objectives will contribute to other management planning initiatives, for example, Remedial Action Plans and the Lakewide Management Plan for Lake Ontario

7.2 Appendix: Relevant Institutional Arrangements and Watershed Stakeholders

Table 7.1. Key agencies and organizations operating in the Hamilton Harbour watershed.

Agency/Organization	Fisheries-related Mandate
Environment Canada	▪ Implements Section 36 of the Fisheries Act, which deals with the deposition of deleterious substances in streams
Fisheries and Oceans Canada	▪ Responsible for the administration of the fisheries habitat provisions of the Fisheries Act ▪ The lead agency responsible for the enforcement of the Fisheries Act
Ontario Ministry of Natural Resources	▪ Responsible for fisheries management in Ontario ▪ Responsible for collecting fisheries data and maintaining fisheries databases ▪ Responsible for identifying, evaluating and classifying wetlands ▪ Deals with fishery regulations, enforcement of regulations pursuant to the Fish and Wildlife Conservation Act and Fisheries Act, the Lakes and Rivers Improvement Act and the Public Lands Act ▪ Administration and enforcement of Ontario's Endangered Species Act
Ontario Ministry of the Environment	▪ Responsible for the administration of the Environmental Protection Act and the Ontario Water Resources Act ▪ Regulates water takings and the impacts that activities may have on surface water, groundwater, and the natural environment ▪ Responsible for regulating wastewater treatment plants and private sewage facilities ▪ Plays a role in implementing Section 36 of the Fisheries Act, which relates to the deposition of deleterious substances in streams
Hamilton Conservation Authority and Conservation Halton	▪ Encourage municipalities to identify and protect environmentally sensitive areas through land-use planning and projects under the Environmental Assessment Act ▪ Involved in a broad environmental management activities, stewardship actions, watershed planning, fisheries and water quality monitoring ▪ Hamilton-Halton Watershed Stewardship Program ▪ Protection of watercourses and wetlands under the authority of the Conservation Authorities Act ▪ Have agreements with DFO related to the administration of Section 35 of the Fisheries Act for the screening and mitigation of proposed habitat alterations and for negotiating compensation agreements
Royal Botanical Gardens	▪ Promotes the protection, conservation, enhancement, and of natural resources (including fish) ▪ Operates a carp barrier and undertakes aquatic habitat restoration works in the Cootes Paradise and Grindstone Creek marshlands
Municipalities (City of Hamilton/City of Burlington)	▪ Identifies and protects environmentally sensitive areas through land-use planning through the implementation of land use planning strategies that will protect water quality ▪ Responsible for implementing the Planning Act and the Provincial Policy Statement ▪ Responsible for operation and maintenance of several Wastewater Treatment Plants ▪ the “planning authority” (makes decisions on the development of land in the watershed)
Bay Area Implementation Team (Hamilton Harbour RAP)	▪ To coordinate key stakeholder groups to implement recommendations of the Hamilton Harbour Remedial Action Plan
Niagara Escarpment Commission	▪ Responsible for the protection and maintenance of the natural environment of the Niagara Escarpment
Hamilton Port Authority	▪ To promote and develop the movement of cargo through Hamilton Harbour and to develop marine-related businesses on the lands that it owns or manages, while advancing the economic interests of the Hamilton region. ▪ To manage marine navigation and safety issues within port boundaries in a modern, secure and environmentally responsible manner ▪ To provide facilities and recreational marina services that are competitive, safe and commercially viable
Bay Area Restoration Council (BARC)	▪ To increase awareness about Hamilton Harbour watershed issues among residents
Hamilton-Wentworth Stewardship Council	▪ To be involved at the implementation stage and help coordinate key stakeholders and private landowners through workshops and demonstration projects, especially where Species at Risk are identified
Non-governmental Organizations (i.e., local environmental organizations and angling groups)	▪ Involved in the implementation of many of the strategies of the plan, such as restoration and education efforts ▪ Examples of groups operating in the Hamilton Harbour area include Trout Unlimited, Hamilton Fly Fishers and Tyers, Dofasco Fishing Club, and Hamilton Naturalists Club

Table 7.2. Summary of relevant international agreements/legislation relevant for fisheries management.

Policy/ Legislation	Responsible Agency	Relevance for fish and habitat	Important websites
Great Lakes Water Quality Agreement	International Joint Commission	The Hamilton Harbour Remedial Action Plan works toward restoring Hamilton Harbour through cleanup of pollutants and toxic sediments.	www.ijc.org/rel/agree/quality.html www.ijc.org/rel/news/hh20121999e.html www.hamiltonharbour.ca/rap/ www.on.ec.gc.ca/water/raps/hamilton/intro_e.html
Boundary Waters Treaty; International Boundary Waters Treaty Act (Canada)	International Joint Commission	Water level control at Moses Saunders Dam affects the water levels in Hamilton Harbour and Cootes Paradise	www.ijc.org/rel/agree/water.html laws.justice.gc.ca/en/i-17/77063.html
Convention on Great Lakes Fisheries	Lake Ontario Committee of the Great Lakes Fishery Commission	Coordinate the management of fish populations and fish habitat in Hamilton Harbour	www.glfc.org/

Table 7.3. Summary of key federal level legislation relevant for fisheries management.

Legislation	Responsible Agency	Relevance for fish and habitat	Important websites
Fisheries Act	Department of Fisheries and Oceans; Ontario Ministry of Natural Resources	Requires the protection of fish and fish habitat from destructive activities; any work that occurs in the or near water must demonstrate that the works will not harmfully alter, disrupt or destroy fish habitat. Regulates fishing.	laws.justice.gc.ca/en/showtdm/cs/F-14 www.dfo-mpo.gc.ca/canwaters-eauxcan.
Canadian Environmental Assessment Act	Environment Canada	Requires that all federal government-related projects undergo an environmental assessment to ensure that the project will not cause ill effects on the environment	www.ceaa-acee.gc.ca.
Navigable Waters Protection Act	Department of Fisheries and Oceans	Regulates the construction or placement of work, in, on, over, under, through or across navigable water	laws.justice.gc.ca/en/N-22/index.html
Species At Risk Act	Environment Canada	Ensures that species at risk (listed under Schedule 1, Parts 1-3 of the Act), residences, or their habitat are protected	laws.justice.gc.ca/en/s-15.3/103526.html

Table 7.4. Summary of key provincial-level legislation relevant for fisheries management.

Legislation	Responsible Agency	Relevance for fish and fish habitat	Important websites
Ontario Fisheries Regulations	OMNR	Regulates fishing activities including angling seasons, harvest limits, and fish size limits.	www.mnr.gov.on.ca/MNR/pubs/pubmenu.html#fish laws.justice.gc.ca/en/showtdm/cr/SOR-89-93
Lakes and Rivers Improvement Act	OMNR	Regulates structures in and alterations to lakes, rivers and streams	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90l03_e.htm
Fish and Wildlife Conservation Act	OMNR	Centres on the management, perpetuation and rehabilitation of fish and wildlife resources in Ontario; provides for hunting, trapping, fishing and related activities	www.e-laws.gov.on.ca/DBLaws/Statutes/English/97f41_e.htm
Public Lands Act	OMNR	provides for the management, sale and disposition of public lands; easements in or over public lands may also be granted for environmental purposes	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90p43_e.htm
Planning Act	OMAH	Guides land use development through a provincial policy-led planning system	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90p13_e.htm
Drainage Act	OMAF	Ensures that landowners living along streams with the rights of property owners (who do not have access to a stream or creek) in order to drain their lands; it ensures the construction and maintenance of sufficient outlets to drain surface and subsurface water	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90d17_e.htm
Ontario Water Resources Act	OMOE	Provides for the protection of surface and ground water related to adverse discharges. The Act regulates the taking of water from wells or surface water sources and the treatment and disposal of sewage	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90o40_e.htm
Environmental Assessment Act	OMOE	Provides for the protection, conservation and wise management of the environment	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90e18_e.htm
Conservation Authorities Act	Conservation Authorities	Regulates construction in a floodplain, alteration of a waterway and the placement of fill in regulated areas; CAs are responsible for the conservation and management of natural aquatic and terrestrial resources	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90c27_e.htm
Endangered Species Act	OMNR	Ensures the conservation, protection, restoration or propagation of species of flora and fauna that are threatened with extinction in Ontario	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90e15_e.htm
Municipal Act	Municipalities	Regulates approvals for construction over public shores and waters	www.e-laws.gov.on.ca/DBLaws/Statutes/English/01m25_e.htm
Environmental Bill of Rights	OMOE	provides a mechanism for the people of Ontario to become involved in environmental decision making	www.e-laws.gov.on.ca/DBLaws/Statutes/English/93e28_e.htm
Niagara Escarpment Planning and Development Act	Niagara Escarpment Commission	Provides for the protection and maintenance of the natural environment of the Niagara Escarpment.	www.e-laws.gov.on.ca/DBLaws/Statutes/English/90n02_e.htm
Greenbelt Act	Municipal Affairs and Housing	Enables the creation of a Greenbelt Plan to protect about 1.8 million acres of environmentally sensitive and agricultural land in the Golden Horseshoe from urban development and sprawl.	www.e-laws.gov.on.ca/DBLaws/Statutes/English/05g01_e.htm

7.3 Public Input

7.3.1 Public Open Houses

The first round of Public Open Houses was held to help determine ideas of the public regarding the key issues and management of the fish communities in Hamilton Harbour and its watershed. These Public Open Houses were held on July 12, 2005 at Royal Botanical Gardens (RBG) and on July 14, 2005 at the Beverley Community Centre in the Town of Flamborough. At these meetings, members of the Steering Committee and the Science and Technical Committee of the HHWFMP made presentations of background information on state of the resources in Hamilton Harbour and its watershed, and on the Fisheries Management Planning process. Following the presentations, members of the public participated in smaller discussion groups to:

1. Identify an issue facing the fish community of the watershed
2. Identify at least one suggestion for how this issue could be resolved.
3. Identify one or two innovative suggestions for making the Fisheries Management Plan process a success.

In addition, questionnaires were given out participants in these open houses.

The second round of Public Open Houses was held to distribute the results of the first round of public consultations and the proposed goals, objectives, and management zones for the HHWFMP. One Public Open House was held on December 6, 2005 at RBG.

7.3.1.1 First Round Open House Questionnaire

This questionnaire has been modified from the original only by removing lines and spaces to save paper.

Hamilton Harbour Fisheries Management Plan
Public Consultation – First Round Questionnaire

Date:

The following questionnaire is designed to help quantify and assess what the priorities of the public are with respect to the management of fish communities in the watershed. You do not have to include your name or contact information. In addition, there is space for further comments or questions at the end of the questionnaire.

A summary of the results for this questionnaire will be posted on the Hamilton Harbour Fisheries Management Plan Webpage, located on Royal Botanical Gardens Science and Conservation Website (http://www.rbg.ca/pages_sci_conserv/sci_fmp.html).

1) Your interest in Lake Ontario fisheries comes from which perspectives? Circle/underline all that apply.
    a. Angler
    b. Charterboat Operator or Fishing Guide
    c. Environmentalist / Naturalist
    d. Fishing-related business owner (e.g. tackle shop)
    e. Home owner
    f. Pleasure boater
    g. Service industry business owner (e.g. marina, campground)
    h. Other(s) (specify): _____

2) I am interested in the health and state of the fish communities in Hamilton Harbour and it's tributaries because (circle/underline more than more if necessary):
    a. I like having good fishing spots near my home.
    b. I have noticed declines in certain fish species and am concerned.
    c. I have noticed increases in certain fish species (names of species).
    d. I am generally concerned about the health and quality of freshwater in the watershed.
    e. I am concerned about the loss of aquatic habitat in the watershed.
    f. Other: _____
    g. All of the above

3) I fish in the watershed of Hamilton Harbour:
    a. Once a day
    b. Once a week
    c. Once a month
    d. Occasionally
    e. Only during certain seasons (season:)
    f. Never

4) How many meals of sport fish from Hamilton Harbour or its tributaries did you eat last year? *You can indicate the specific location in comments section.*

	None	1 – 5	6 – 10	>10	Comments
From the creeks in the watershed					
From the reservoirs (e.g. Valens or Christie)					
From the Harbour proper					

5) If you eat Hamilton Harbour sport fish, which species do you eat most often? *List up to 5 species.*

_____

_____

_____

_____

_____

6) My favourite place to fish in the watershed is:
   a. The Harbour (location_____)
   b. Spencer Creek (location_____)
   c. Valens reservoir
   d. Christie reservoir
   e. Grindstone Creek (location_____)
   f. Other:_____
   g. I do not fish in the watershed

7) How would you rank the following in terms of importance to you:

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree	Comments
Fish are only important for angling						
Fish are important parts of our natural heritage.						
Fish are important indicators of the overall health of the water.						
Fish provide interesting and fun educational opportunities						

8) How would you rank the following issues in terms of impacts on the health of fish communities in the watershed?

	Not important	Somewhat Important	Important	Very Important	Comments
Species at Risk					
Water Quality					
Habitat Loss (in streams, marshes, Harbour)					
Contaminants					
Effects of urbanization / land use practices					
Exotic species					
Inadequate enforcement of fishing regulations					
Loss of native aquatic species					
Loss of wetlands					
Over-harvest of fish					
Sea lamprey predation					
Water level fluctuations					
Water-taking					
Others *(specify)*					

9) How would you rank the following in terms of importance

	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree	Comments
Restoring & protecting native fish species should be a priority in this watershed						
Increasing &/or improving sport fishing opportunities should be a priority for this watershed						
Removal of barriers (small dams, culverts, etc) to fish movement is necessary in this watershed (indicate any barriers in particular that you think are a problem in the comments section)						
Incompatible land use is a problem in this watershed and should be managed with better controls (indicate which land uses you think are a particular problem in the comments section.)						
My overall enjoyment of the watershed and its fish communities would be improved by increasing public awareness of the ecosystem (ex: interpretative signs near creeks &/or harbour)						

10) What, if any, observations have you noticed about the fish communities in the watershed?

11) The restoration/preservation of local fish communities is important to me because:

12) What fish species do you feel is in most need of management action and why?

13) What parts of the watershed do you feel are in need of restoration or special management action and why?

14) Are there other aspects of the fish community that you wish to have more information on?

15) Did you find this evening's presentation/discussion groups helpful/informative? Why or why not?

16) How did you hear about this evening's open house (circle more than one if necessary)?
    a. Newspaper advertisement
    b. Newspaper article
    c. Poster (location)
    d. Website (specify: _____)
    e. Chatboard
    f. Other (specify:_____)

Area of Residence:

If you have additional comments/suggestions/concerns that you wish to contribute, feel free to fill in the space below:

7.3.1.2 Results from Questionnaire

The respondents to the questionnaire showed a high degree of awareness and concern for environmental and fishery issues in Hamilton Harbour and its watershed. Degradation of the environment and loss of habitat and wetlands in Hamilton Harbour and its watershed were considered the greatest issues of the respondents (Table 7.5). Most respondents identified themselves as anglers or as environmentalists/naturalists. Although fewer respondents occasionally fished in Hamilton Harbour and its watershed, and none ate the fish, good fishing opportunities near home may be an important consideration in their interest in the health of the fish community. All respondents indicated that they were interested in the water quality, and the majority of them were concerned about the loss of aquatic habitat. Fish were perceived as important indicators of water quality. Declines of local fish species were a concern for 65% of the respondents.

Table 7.5. The percent of respondents favouring Very Important in the question: "How would you rank the following issues in terms of impacts on the health of fish communities in the watershed?"

How would you rank the following issues?	% Very Important
Water Quality	94
Contaminants	88
Habitat Loss (in streams, marshes, Harbour)	82
Loss of wetlands	82
Effects of urbanization / land use practices	71
Loss of native aquatic species	71
Species at Risk	65
Water-taking	59
Exotic species	47
Over-harvest of fish	35
Inadequate enforcement of fishing regulations	24
Water level fluctuations	24
Sea lamprey predation	18

Bass and walleye were thought to need the greatest management action (Table 7.6). Most of such species identified by respondents are residents of nearshore zone of Hamilton harbour, Cootes Paradise and some of the reservoirs. Respondents considered that Gobies need to be controlled. Carp were considered to need management for sport fishing and for control to reduce their environmental impacts.

7.3.1.3

Table 7.6. The number of respondents identifying a fish species for the question: "What fish species do you feel is in most need of management action?"

Species	Number of respondents
Smallmouth/largemouth bass	6
Walleye	5
Northern pike	3
Yellow perch	3
Common carp	3
Round goby	3
Brook trout	2
Sunfish, pan fish, crappies	2
Rainbow trout/salmonids	2
Muskellunge	1
Native minnows	1
Game fish	1

7.3.1.4 Specific Answers to Questionnaire

The following tables give the number of responses in each category. A total of 17 questionnaires were received.

1) Your interest in Lake Ontario fisheries comes from which perspectives?

Angler	Charterboat / fishing guide	Environmentalist / naturalist	Fishing-related business owner	Home owner	Pleasure boater	Service industry business owner
15	0	10	0	5	3	0

2) I am interested in the health and state of the fish communities in Hamilton Harbour and it's tributaries because:

I like having good fishing spots near my home.	I have noticed declines in certain fish species and am concerned.	I have noticed increases in certain fish species.	I am generally concerned about the health and quality of freshwater in the watershed.	I am concerned about the loss of aquatic habitat in the watershed.
13	11	7	17	14

3) I fish in the watershed of Hamilton Harbour:

Once a day	Once a week	Once a month	Occasionally	Only during certain seasons	Never
1	1	2	8	0	5

4) How many meals of sport fish from Hamilton Harbour or its tributaries did you eat last year?

Location	None	1 – 5	6 – 10	>10
From the creeks in the watershed	17	0	0	0
From the reservoirs (e.g. Valens or Christie)	17	0	0	0
From the Harbour proper	17	0	0	0

6) My favourite place to fish in the watershed is:

The Harbour	Spencer Creek	Valens Reservoir	Christie Reservoir	Grindstone Creek	Other	I do not fish in the watershed
7	0	5	3	1	2	4

7) How would you rank the following in terms of importance to you:

	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
Fish are only important for angling	1	3	0	3	10
Fish are important parts of our natural heritage.	9	8	0	0	0
Fish are important indicators of the overall health of the water.	15	2	0	0	0
Fish provide interesting and fun educational opportunities	10	5	1	0	0

8) How would you rank the following issues in terms of impacts on the health of fish communities in the watershed?

	Not important	Somewhat important	Important	Very important
Species at Risk	0	0	3	11
Water Quality	1	0	0	16
Habitat Loss (in streams, marshes, Harbour)	0	0	3	14
Contaminants	0	1	1	15
Effects of urbanization / land use practices	0	1	4	12
Exotic species	0	1	7	8
Inadequate enforcement of fishing regulations	3	2	4	5
Loss of native aquatic species	0	2	3	12
Loss of wetlands	0	1	2	14
Over-harvest of fish	1	2	5	6
Sea lamprey predation	1	3	6	3
Water level fluctuations	2	1	8	4
Water-taking	0	2	4	11

9) How would you rank the following in terms of importance

	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
Restoring & protecting native fish species should be a priority in this watershed.	11	4	1	1	0
Increasing &/or improving sport fishing opportunities should be a priority for this watershed.	6	6	2	3	0
Removal of barriers (small dams, culverts, etc) to fish movement is necessary in this watershed.	9	5	2	0	0
Incompatible land use is a problem in this watershed and should be managed with better controls.	8	7	2	0	0
My overall enjoyment of the watershed and its fish communities would be improved by increasing public awareness of the ecosystem.	10	6	1	0	0

7.3.2 Guiding Committees

Three committees were established for the development of this plan, and they were invaluable in its evolution: Anglers Working Group, Steering Committee, and Science and Technical Committee. These committee reviewed earlier drafts of this document.

Table 7.7. Angler's Working Group.

Name	Affiliation
Felix Barbetti	Ontario Federation of Anglers and Hunters
Chris Chilcott	Muskies Canada
George Cooke	Stelco Fishing Club
Bill Jeffries	Dofasco Angling Club
Alfred Marinelli	Ontario Federation of Anglers and Hunters
John Neil	Hamilton Angling and Hunting Club
Andy Pappas	Muskies Canada
Rip Pearce	Hamilton Association of Sportsmen
Gord Peterson	Dofasco Angling Club
Charles Ross	Concerned angler and member of BARC
Dave Steeves	Stelco Fishing Club
Harvey Velix	Golden Horseshoe Outdoors Club
Bruce Wainman	Hamilton and Area Fly Fishers and Tyers

Table 7.8. HHWFMP Steering Committee.

Name	Affiliation
Jason Borwick (Co-chair, 2004)	Ontario Ministry of Natural Resources - Lake Ontario Management Unit
Jim Bowlby (Co-chair, 2006-2008)	Ontario Ministry of Natural Resources - Lake Ontario Management Unit
Stephen Casselman (Co-chair,2005)	Ontario Ministry of Natural Resources - Lake Ontario Management Unit
Mark Heaton (Co-chair)	Ontario Ministry of Natural Resources - Aurora District
Brenda Axon	Conservation Halton
Mark Bainbridge	City of Hamilton
Felix Barbetti	Ontario Federation of Anglers and Hunters
Christine Brousseau	Fisheries & Oceans Canada
Vic Cairns	Fisheries & Oceans Canada (emeritus)
Kevin Considine	Stelco Inc. (renamed U. S. Steel Canada)
Shari Faulkenham	Hamilton Conservation Authority
Paul General	Six Nations of the Grand River
Teresa Giangregorio	City of Burlington
John Hall	Hamiton Harbour Remedial Action Plan
Harold Harvey	Bait Association of Ontario
Sherry Houston	Bay Area Restoration Council
Rick Kiriluk	Fisheries & Oceans Canada
Tom McGuire	AcelorMittal Dofasco
Lorraine Normington	Ontario Ministry of Natural Resources - Hamilton Wentworth Stewardship Council
Sheila O'Neal	Hamilton Halton Watershed Stewardship Program
Bob Randall	Fisheries & Oceans Canada
Farhad Salehi	Hamilton Port Authority
MaryEllen Scanlon	Ontario Ministry of the Environment
Dave Steeves	Stelco Fishing Club
Art Timmerman	Ontario Ministry of Natural Resources - Guelph District
Tys Tysmeyer	Royal Botanical Gardens
Sherwin Watson-Leung	Conservation Halton

Table 7.9. HHWFMP Science and Technical Committee.

Name	Affiliation
Jim Bowlby	Ontario Ministry of Natural Resources Lake Ontario Management Unit
Christine Brousseau	Fisheries & Oceans Canada
Stephen Casselman	Ontario Ministry of Natural Resources-Lake Ontario Management Unit
Shari Faulkenham	Hamilton Conservation Authority
Mark Heaton	Ontario Ministry of Natural Resources - Aurora District
Bob Randall	Fisheries & Oceans Canada
Tys Tysmeyer	Royal Botanical Gardens
Sherwin Watson-Leung	Conservation Halton

7.4 Fish Community

7.4.1 Temperature Guilds

Temperature guilds of fish species observed in Hamilton Harbour and watersheds (Tables 7.10, 7.11, 7.12) were based on thermal preference and optimum temperature for growth - "coldwater": <19°C, "coolwater": 19-25°C, and "warmwater": > 25°C (Coker et al 2001). Preferred and optimum temperatures were calculated with data from Stewart and Robertson (1991), Wismer and Christie (1987), and OMNR (unpublished data). When preferred and optimum temperature data were not available the classification of Coker et al. 2001 was used.

Table 7.10. Coldwater fish species (prefer <19°C) observed in Hamilton Harbour and Watersheds.

Common Name	Scientific Name	Preferred Temperature (°C)
American brook lamprey	*Lampetra appendix*	
Chestnut lamprey	*Ichthyomyzon castaneus*	
Sea lamprey	*Petromyzon marinus*	14.3
Alewife	*Alosa psedoharengus*	16.8
Coho salmon	*Oncorhynchus kisutch*	15.3
Chinook salmon	*Oncorhynchus tshawytscha*	14.1
Rainbow trout	*Oncorhynchus mykiss*	16.7
Atlantic salmon	*Salmo salar*	16.0
Brown trout	*Salmo trutta*	15.8
Brook trout	*Salvelinus fontinalis*	16.9
Lake trout	*Salvelinus namaycush*	11.6
Lake whitefish	*Coregonus clupeaformis*	13.0
Lake herring	*Coregonus artedii*	11.5
Bloater	*Coregonus hoyi*	10.5
Shortnose cisco	*Coregonus reighardi*	
Kiyi	*Coregonus kiyi*	4.2
Blackfin cisco	*Coregonus nigripinnis*	
Burbot	*Lota lota*	14.9
Round whitefish	*Prosopium cylindraceum*	
Rainbow smelt	*Osmerus mordax*	11.2
Longnose sucker	*Catostomus catostomus*	11.1
Brook stickleback	*Culaea inconstans*	
Three-spine stickleback	*Gasterosteus aculeatus*	11.8
Trout-perch	*Percopsis omiscomaycus*	13.4
Mottled sculpin	*Cottus bairdi*	16.6

Table 7.11. Coolwater fish species (prefer 19-25°C) observed in Hamilton Harbour and Watersheds.

Common Name	Scientific Name	Preferred Temperature (°C)
Northern brook lamprey	*Ichthyomyzon fossor*	
Silver lamprey	*Ichthyomyzon unicuspis*	
Lake sturgeon	*Acipenser fulvescens*	
American shad	*Alosa sapidissima*	21.4
Gizzard shad	*Dorosoma cepedianum*	19.5
Northern pike	*Esox lucius*	
Central mudminnow	*Umbra limi*	24.5
Mooneye	*Hiodon tergisus*	20.8
Common white sucker	*Catostomus commersoni*	22.3
Bigmouth buffalo	*Ictiobus cyprinellus*	
Silver redhorse	*Moxostoma anisurum*	
Finescale dace	*Phoxinus neogaeus*	
Redside dace	*Clinostomus elongatus*	
Brassy minnow	*Hybognathus hankinsoni*	
Golden shiner	*Notemigonus crysoleucas*	24.0
Emerald shiner	*Notropis athernoides*	22.6
Common shiner	*Luxilus cornutus*	
Blackchin shiner	*Notropis heterodon*	
Blacknose shiner	*Notropis heterolepis*	
Spottail shiner	*Notropis hudsonius*	19.1
Blacknose dace	*Rhinichthys atratulus*	
Longnose dace	*Rhinichthys cataractae*	
Creek chub	*Semotilus atromaculatus*	
Pearl dace	*Margariscus margarita*	
Silver shiner	*Notropis photogenis*	
Striped shiner	*Luxilus chrysocephalus*	
Rudd	*Scardinius erythrophthalmus*	
American eel	*Anguilla rostrata*	18.6
Banded killifish	*Fundulus diaphanus*	19.3
Striped bass	*Morone saxatilis*	19.5
Yellow perch	*Perca flavescens*	21.1
Sauger	*Sander canadense*	22.5
Blue pike	*Sander vitreum glaucum*	
Walleye	*Sander vitreum*	21.7
Rainbow darter	*Etheostoma caeruleum*	
Fantail darter	*Etheostoma flabellare*	
Least darter	*Etheostoma microperca*	
Johnny darter	*Etheostoma nigrum*	19.2
Logperch	*Percina caprodes*	
Blackside darter	*Percina maculata*	
Round goby	*Neogobius melanostomus*	

Table 7.12. Warmwater fish species (prefer >25°C) observed in Hamilton Harbour and Watersheds.

Common Name	Scientific Name	Preferred Temperature (°C)
Longnose gar	*Lepisosteus osseus*	31.5
Spotted gar	*Lepisosteus oculatus*	
Bowfin	*Amia calva*	30.5
Muskellunge	*Esox masquinongy*	25.0
Quillback	*Carpiodes cyprinus*	29.0
Lake chubsucker	*Erimyzon sucetta*	
Northern hog sucker	*Hypentelium nigricans*	26.6
Black redhorse	*Moxostoma duquesnei*	
Golden redhorse	*Moxostoma erythrurum*	
Shorthead redhorse	*Moxostoma macrolepidotum*	26.8
Goldfish	*Carassius auratus*	26.6
Northern redbelly dace	*Phoxinos eos*	25.3
Common carp	*Cyprinus carpio*	28.4
Hornyhead chub	*Nocomis biguttatus*	
River chub	*Nocomis micropogon*	
Rosyface shiner	*Notropis rubellus*	25.5
Spotfin shiner	*Cyprinella spiloptera*	27.8
Sand shiner	*Notropis stramineus*	
Mimic shiner	*Notropis volucellus*	
Bluntnose minnow	*Pimephales notatus*	26.5
Fathead minnow	*Pimephales promelas*	26.0
Black bullhead	*Ameiurus meleas*	
Yellow bullhead	*Ameiurus natalis*	28.2
Brown bullhead	*Ameiurus nebulosus*	27.3
Channel catfish	*Ictalurus punctatus*	27.5
Stonecat	*Noturus flavus*	25.1
Tadpole madtom	*Noturus gyrinus*	
White perch	*Morone americana*	30.1
White bass	*Morone chrysops*	30.1
Rock bass	*Ambloplites rubestris*	25.9
Green sunfish	*Lepomis cyanellus*	28.7
Pumpkinseed	*Lepomis gibbosus*	29.0
Bluegill	*Lepomis macrochirus*	30.5
Longear sunfish	*Lepomis megalotis*	
Smallmouth bass	*Micropterus dolomieu*	28.5
Largemouth bass	*Micropterus salmoides*	29.1
White crappie	*Pomoxis annularis*	
Black crappie	*Pomoxis nigromaculatus*	26.0
Brook silverside	*Labidesthes sicculus*	
Freshwater drum	*Aplodinotus grunniens*	26.6

7.4.2 Temperature Guild, Origin, and Abundance of Fish

The following tables (Table 7.13 to 7.XX) record the fish community observed in seining and electrofishing fish surveys since 1970. Data from the watersheds were obtained from over 600 unpublished studies and were compiled into databases by the Hamilton Conservation Authority and Conservation Halton. Data from Cootes Paradise and Hamilton Harbour were from electrofishing, and entrapment surveys by DFO, RBG, and OMNR. "SPC" refers to OMNR species code. Abundance levels are based on quartiles with "1" as the lowest, and "4" as the highest relative abundance.

Table 7.13. Fish community in streams in the riverine zones of the North Shore Watershed.

SPC	Common Name	Temperature guild	Origin	Abundance
163	White sucker	Cool	Native	4
180	Minnows (unidentified)	-	-	1
182	Northern redbelly dace	Warm	Native	3
185	Lake chub[1]	Cold	Native	1
186	Common carp	Warm	Introduced	3
189	Brassy minnow	Cool	Native	2
198	Common shiner	Cool	Native	2
201	Spottail shiner	Cool	Native	2
206	Mimic shiner	Warm	Native	1
208	Bluntnose minnow	Warm	Native	4
209	Fathead minnow	Warm	Native	4
210	Blacknose dace	Cool	Native	3
211	Longnose dace	Cool	Native	3
212	Creek chub	Cool	Native	4
312	Green sunfish	Warm	Native	2
313	Pumpkinseed	Warm	Native	1
366	Round goby	Cool	Invader	1

1 - Identification not verified.

Table 7.14. Fish community in riverine zones of Grindstone Creek, above (Upper) and below (Lower) the Niagara escarpment.

SPC	Common Name	Temperature guild	Origin	Abundance			
				Upper Grindstone coldwater	Upper Grindstone warmwater	Lower Grindstone small coldwater	Lower Grindstone intermediate coldwater
076	Rainbow trout	Cold	Introduced	-	-	3	4
078	Brown trout	Cold	Introduced	-	-	-	1
131	Northern pike	Cool	Native	2	2	-	-
141	Central mudminnow	Cool	Native	4	3	-	-
163	White sucker	Cool	Native	3	3	4	4
180	Minnows (unidentified)	-	-	4	-	3	4
181	Goldfish	Warm	Invader	1	-	-	-
182	Northern redbelly dace	Warm	Native	3	-	-	1
183	Finescale dace	Cool	Native	2	-	-	-
186	Common carp	Warm	Invader	1	4	-	1
189	Brassy minnow	Cool	Native	2	2	-	1
193	River chub	Warm	Native	-	2	-	-
194	Golden shiner	Cool	Native	2	1	-	-
196	Emerald shiner	Cool	Native	-	-	-	1
198	Common shiner	Cool	Native	2	1	-	-
200	Blacknose shiner	Cool	Native	2	-	-	-
201	Spottail shiner	Cool	Native	-	-	-	3
208	Bluntnose minnow	Warm	Native	3	3	-	3
209	Fathead minnow	Warm	Native	4	2	2	-
210	Blacknose dace	Cool	Native	4	4	4	4
211	Longnose dace	Cool	Native	2	4	-	4
212	Creek chub	Cool	Native	4	3	4	3
214	Pearl dace	Cool	Native	4	1	-	-
221	*Phoxinus sp.*	Cool/Warm	Native	3	-	-	-
233	Brown bullhead	Warm	Native	1	4	-	1
235	Stonecat	Warm	Native	-	-	-	3
281	Brook stickleback	Cold	Native	4	1	-	-
311	Rock bass	Warm	Native	-	1	-	3
312	Green sunfish	Warm	Native	1	-	-	-
313	Pumpkinseed	Warm	Native	3	4	1	2
314	Bluegill	Warm	Native	1	-	-	1
316	Smallmouth bass	Warm	Native	1	-	-	1
317	Largemouth bass	Warm	Native	2	4	-	2
320	Sunfishes	Warm	Native	-	-	-	1
331	Yellow perch	Cool	Native	-	2	-	-
337	Rainbow darter	Cool	Native	1	-	1	4
339	Fantail darter	Cool	Native	-	-	1	-
341	Johnny darter	Cool	Native	3	2	2	3
342	Logperch	Cool	Native	-	-	-	2
348	Darters	Cool	Native	-	-	-	1

Table 7.15. Fish community in small coldwater riverine zones of Spencer Creek.

SPC	Common Name	Temper-ature guild	Origin	Abundance				
				Anacas-ter, Sulphur, Spring Creek	Flambor-ough Creek	Fletch-er Creek	Upper Spencer Creek coldwater	West-over Creek
011	American brook lamprey	Cold	Native	2	-	-	-	-
014	Sea lamprey	Cold	Native	2	-	-	-	-
076	Rainbow trout	Cold	Introduced	4	-	-	-	-
078	Brown trout	Cold	Introduced	-	-	1	-	-
080	Brook trout	Cold	Native	2	4	4	4	-
131	Northern pike	Cool	Native	-	2	2	1	1
141	Central mudminnow	Cool	Native	-	4	4	3	4
163	White sucker	Cool	Native	4	4	4	1	3
165	Northern hog sucker	Warm	Native	-	1	1	-	-
181	Goldfish	Warm	Invader	2	-	-	-	-
182	Northern redbelly dace	Warm	Native	3	2	4	3	4
183	Finescale dace	Cool	Native	-	1	1	1	2
184	Redside Dace [2]	Cool	Native	-	2	2	-	-
186	Common carp	Warm	Introduced	1	1	-	-	-
189	Brassy minnow	Cool	Native	1	1	-	-	-
192	Horneyhead chub	Warm	Native	-	-	-	4	-
193	River chub	Warm	Native	1	-	1	-	-
196	Emerald shiner	Cool	Native	-	-	3	-	-
198	Common shiner	Cool	Native	3	2	2	-	-
200	Blacknose shiner	Cool	Native	1	-	1	-	-
201	Spottail shiner	Cool	Native	1	-	2	-	3
202	Rosyface shiner	Warm	Native	2	-	-	-	-
204	Sand shiner	Warm	Native	1	-	-	-	-
206	Mimic shiner	Warm	Native	-	-	2	-	-
208	Bluntnose minnow	Warm	Native	3	2	1	-	2
209	Fathead minnow	Warm	Native	4	2	2	-	2
210	Blacknose dace	Cool	Native	4	-	4	1	2
211	Longnose dace	Cool	Native	3	-	2	-	-
212	Creek chub	Cool	Native	4	4	4	1	4
214	Pearl dace	Cool	Native	-	3	3	-	1
233	Brown bullhead	Warm	Native	-	3	-	2	-
281	Brook stickleback	Cold	Native	4	3	3	1	4
313	Pumpkinseed	Warm	Native	2	4	3	4	2
317	Largemouth bass	Warm	Native	2	1	-	3	1
331	Yellow perch	Cool	Native	1	-	2	-	-
337	Rainbow darter	Cool	Native	4	-	-	-	-
339	Fantail darter	Cool	Native	3	-	-	-	-

2 – Species at risk. See Table 5.2.

Table 7.16. Fish community in small warmwater riverine zones of Spencer Creek.

SPC	Common Name	Temperature guild	Origin	Abundance				
				Borers Creek	Chedoke Creek	Logie's Creek	Upper Spencer Creek warm	West Spencer Creek
076	Rainbow trout	Cold	Introduced	1	-	-	-	-
131	Northern pike	Cool	Native	1	-	-	1	2
141	Central mudminnow	Cool	Native	3	-	1	4	4
163	White sucker	Cool	Native	3	-	2	-	4
165	Northern hog sucker	Warm	Native	-	-	-	-	2
182	Northern redbelly dace	Warm	Native	-	-	1	1	-
183	Finescale dace	Cool	Native	-	-	2	1	-
184	Redside Dace [2]	Cool	Native	-	-	-	-	-
186	Common carp	Warm	Introduced	-	-	-	-	3
198	Common shiner	Cool	Native	1	-	1	2	1
200	Blacknose shiner	Cool	Native	-	-	-	1	-
201	Spottail shiner	Cool	Native	-	-	-	-	-
208	Bluntnose minnow	Warm	Native	2	-	-	-	-
209	Fathead minnow	Warm	Native	2	-	3	1	2
210	Blacknose dace	Cool	Native	4	-	3	-	-
211	Longnose dace	Cool	Native	2	-	1	-	-
212	Creek chub	Cool	Native	4	1	4	4	3
214	Pearl dace	Cool	Native	-	-	4	-	-
233	Brown bullhead	Warm	Native	-	-	-	2	-
281	Brook stickleback	Cold	Native	1	4	4	4	1
310	Sunfishes	Warm	Native	4	-	-	-	-
312	Green sunfish	Warm	Native	-	-	-	1	3
313	Pumpkinseed	Warm	Native	4	1	-	2	4
314	Bluegill sunfish	Warm	Native	-	-	-	1	-
317	Largemouth bass	Warm	Native	3	-	-	3	1
319	Black crappie	Warm	Native	-	-	-	1	-
337	Rainbow darter	Cool	Native	2	-	-	-	-

2 – Species at risk. See Table 5.2.

Table 7.17. Fish community in intermediate riverine zones of Spencer Creek.

SPC	Common Name	Temperature guild	Origin	Abundance		
				Mid Spencer Creek cold	Mid Spencer Creek warm	Lower Spencer Creek
076	Rainbow trout	Cold	Introduced	-	1	-
131	Northern pike	Cool	Native	3	-	-
141	Central mudminnow	Cool	Native	4	-	-
163	White sucker	Cool	Native	4	3	2
165	Northern hog sucker	Warm	Native	2	-	-
180	Carps and minnows	-	-	3	-	-
182	Northern redbelly dace	Warm	Native	2	3	1
183	Finescale dace	Cool	Native	1	1	1
184	Redside dace [2]	Cool	Native	3	-	-
186	Common carp	Warm	Introduced	3	4	3
189	Brassy minnow	Cool	Native	2	-	-
192	Horneyhead chub	Warm	Native	4	-	2
193	River chub	Warm	Native	4	4	4
194	Golden shiner	Cool	Native	3	-	1
196	Emerald shiner	Cool	Native	1	-	-
198	Common shiner	Cool	Native	4	3	2
200	Blacknose shiner	Cool	Native	4	-	-
201	Spottail shiner	Cool	Native	2	-	-
202	Rosyface shiner	Warm	Native	3	-	2
203	Spotfin shiner	Warm	Native	1	-	-
206	Mimic shiner	Warm	Native	-	2	-
208	Bluntnose minnow	Warm	Native	4	3	4
209	Fathead minnow	Warm	Native	4	3	3
210	Blacknose dace	Cool	Native	4	2	4
211	Longnose dace	Cool	Native	3	4	4
212	Creek chub	Cool	Native	4	4	3
214	Pearl dace	Cool	Native	2	1	-
217	Striped shiner	Cool	Native	2	-	-
223	*Nocomis sp.*	Warm	Native	1	1	-
224	*Notropis sp.*	Cool /Warm	Native	1	-	-
233	Brown bullhead	Warm	Native	2	2	1
281	Brook stickleback	Cold	Native	3	1	-
311	Rock bass	Warm	Native	2	-	-
312	Green sunfish	Warm	Native	2	-	-
313	Pumpkinseed	Warm	Native	3	2	1
314	Bluegill sunfish	Warm	Native	1	1	-
317	Largemouth bass	Warm	Native	1	4	-
320	Sunfishes	Warm	Native	1	-	-
331	Yellow perch	Cool	Native	2	-	2
337	Rainbow darter	Cool	Native	1	-	3
339	Fantail darter	Cool	Native	1	-	4

2 – Species at risk. See Table 5.2.

Table 7.18. Fish community in the reservoirs of Spencer Creek.

SPC	Common Name	Temperature guild	Origin	Abundance		
				Valens Reservoir	Christie Reservoir	Crooks Hollow Reservoir
131	Northern pike	Cool	Native	1	2	-
141	Central mudminnow	Cool	Native	1	-	-
163	White sucker	Cool	Native	1	4	3
165	Northern hog sucker	Warm	Native	-	1	-
169	Black redhorse [2]	Warm	Native	-	1	-
186	Common carp	Warm	Introduced	2	3	4
192	Horneyhead chub	Warm	Native	-	-	1
198	Common shiner	Cool	Native	-	2	2
202	Rosyface shiner	Warm	Native	-	1	-
208	Bluntnose minnow	Warm	Native	-	4	4
209	Fathead minnow	Warm	Native	-	3	-
212	Creek chub	Cool	Native	-	-	1
233	Brown bullhead	Warm	Native	2	3	1
291	Trout-perch	Cold	Native	-	1	-
313	Pumpkinseed	Warm	Native	4	3	3
314	Bluegill sunfish	Warm	Native	3	-	-
317	Largemouth bass	Warm	Native	3	4	2
319	Black crappie	Warm	Native	4	-	-

2 – Species at risk. See Table 5.2.

Table 7.19. Fish community in Red Hill Creek.

SPC	Common Name	Temperature guild	Origin	Abundance		
				Coldwater above escarpment	Coldwater below escarpment	Warmwater below escarpment
163	White sucker	Cool	Native	-	3	4
181	Goldfish	Warm	Invader	2	1	-
182	Northern redbelly dace	Warm	Native	3	1	-
186	Common carp	Warm	Introduced	-	-	2
196	Emerald shiner	Cool	Native	-	-	1
201	Spottail shiner	Cool	Native	-	1	1
209	Fathead minnow	Warm	Native	1	2	4
210	Blacknose dace	Cool	Native	1	4	4
211	Longnose dace	Cool	Native	-	4	3
212	Creek chub	Cool	Native	-	3	3
233	Brown bullhead	Warm	Native	-	-	-
281	Brook stickleback	Cold	Native	4	2	-
282	Threespine stickleback	Cold	Native	-	-	2
313	Pumpkinseed	Warm	Native	-	-	1

Table 7.20. Fish community in Cootes Paradise, Hamilton Harbour, and Grindstone Creek rivermouth.

SPC	Common Name	Temperature guild	Origin	Abundance		
				Cootes Paradise (Spencer Creek)	Hamilton Harbour	Grindstone Creek rivermouth
012	Northern brook lamprey [2]	Cold	Native	1	-	-
013	Silver lamprey	Cold	Native	1	-	-
014	Sea lamprey	Cold	Native	-	1	-
041	Longnose gar	Warm	Native	2	1	-
042	Spotted gar [2]	Warm	Native	1	-	-
051	Bowfin	Warm	Native	3	2	1
061	Alewife	Cold	Invader	3	4	2
063	Gizzard shad	Cool	Native	4	4	4
075	Chinook salmon	Cold	Introduced	2	-	-
076	Rainbow trout	Cold	Introduced	3	1	2
078	Brown trout	Cold	Introduced	2	-	-
081	Lake trout	Cold	Native	2	1	-
121	Rainbow smelt	Cold	Invader	2	-	-
131	Northern pike	Cool	Native	3	2	2
141	Central mudminnow	Cool	Native	-	-	2
163	White sucker	Cool	Native	4	3	3
166	Bigmouth buffalo [2]	Cool	Native	2	1	1
168	Silver redhorse	Cool	Native	1	-	-
170	Golden redhorse	Warm	Native	1	-	-
171	Shorthead redhorse	Warm	Native	2	1	1
172	Greater redhorse	Warm	Native	1	-	-
181	Goldfish	Warm	Invader	4	3	1
186	Common carp	Warm	Invader	4	4	4
192	Hornyhead chub	Warm	Native	-	-	1
193	River chub	Warm	Native	1	-	-
194	Golden shiner	Cool	Native	2	2	2
196	Emerald shiner	Cool	Native	4	4	3
198	Common shiner	Cool	Native	2	-	2
201	Spottail shiner	Cool	Native	4	3	4
204	Sand shiner	Warm	Native	1	-	-
206	Mimic shiner	Warm	Native	-	-	1
208	Bluntnose minnow	Warm	Native	3	-	4
209	Fathead minnow	Warm	Native	3	-	3
211	Longnose dace	Cool	Native	1	-	-
212	Creek chub	Cool	Native	1	-	2
220	Rudd	Cool	Invader	1	-	-
231	Black bullhead	Warm	Native	2	1	-
233	Brown bullhead	Warm	Native	4	4	3
234	Channel catfish	Warm	Native	4	4	-
236	Tadpole madtom	Warm	Native	2	-	3

2 – Species at risk. See Table 5.2.

Table 7.20. Fish community in Cootes Paradise, Hamilton Harbour, and Grindstone Creek rivermouth (cont'd).

SPC	Common Name	Temperature guild	Origin	Abundance		
				Cootes Paradise (Spencer Creek)	Hamilton Harbour	Grindstone Creek rivermouth
281	Brook stickleback	Cold	Native	-	-	1
282	Three-spine stickleback	Cold	Native	3	-	2
291	Trout-perch	Cold	Native	2	-	2
301	White perch	Warm	Invader	4	4	4
302	White bass	Warm	Native	2	2	-
304	Striped bass	-	-	1	-	-
311	Rock bass	Warm	Native	3	3	3
312	Green sunfish	Warm	Native	3	1	3
313	Pumpkinseed	Warm	Native	4	3	4
314	Bluegill	Warm	Native	4	3	4
315	longear sunfish	Warm	Native	2	-	-
316	Smallmouth bass	Warm	Native	2	1	1
317	Largemouth bass	Warm	Native	4	3	4
318	White crappie	Warm	Native	1	-	1
319	Black crappie	Warm	Native	3	2	3
320	Lepomis sp.	Warm	Native	1	-	-
331	Yellow perch	Cool	Native	4	4	3
334	Walleye	Cool	Native	2	2	-
341	Johnny darter	Cool	Native	3	-	3
342	Logperch	Cool	Native	4	3	4
361	Brook silverside	Warm	Native	3	-	2
366	Round goby	Cool	Invader	3	2	4
371	Freshwater drum	Warm	Native	4	2	1
601	Carp x goldfish	Warm	Invader	3	-	1
650	Black bullhead x brown bullhead	-	-	1	-	-

2 – Species at risk. See Table 5.2.

7.5 Key Issues and Proposed Management Strategies

The first of the following tables of contains the Key Issues and Proposed Management Strategies that are common to Hamilton Harbour and all watersheds. Later tables contain those issues and strategies that are specific to each watershed, Cootes Paradise, and Hamilton Harbour.

Table 7.21. All Watersheds Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Dams and barriers to fish passage	Modify barriers to fish passage	Identify barriers to fish passage and mitigate and/or remove barriers, where feasible to reconnect fragmented populations and habitat	
Aquatic Community	Contaminants in fish	Monitor contaminant levels in fish	Implement a trend monitoring program for indicator species	
Aquatic Community	Contaminants in fish	Support RAP initiative to reduce contaminants in Hamilton Harbour	Support RAP initiative to reduce contaminants in Hamilton Harbour	
Aquatic Community	Declines in native species abundance	Improve overall species diversity	Focus habitat management on improving whole fish community over single species	
Aquatic Community	Declines in native species abundance	Protect species during sensitive periods (e.g., spawning and migration)	Consider strategic fish sanctuaries and angling regulations to address protection needs	FW-11
Aquatic Community	Declines in native species abundance	Protect species during sensitive periods (e.g., spawning and migration)	The timing windows for in-water construction are: ▪ Warmwater riverine, lake and harbour[1] zones - July 1 to March 15 ▪ Coldwater riverine zones (see Redside dace exception) - June 15 to September 15 ▪ Redside dace habitat - July 1 to September 15	
Aquatic Community	Declines in native species abundance	Reintroduce native species or introduce naturalized species when stream health conditions are reclaimed	Monitor fish community response to environmental changes in the management area	
Aquatic Community	Invasive species	Control spread of invasive species	Ballast water from ocean-going ships is the source of most of the recent species introductions in the Great Lakes, (e.g. zebra mussel, round goby)	
Aquatic Community	Invasive species	Control spread of invasive species	Maintain selected existing barriers to prevent spread of invasive species	FW- 5.8
Aquatic Community	Invasive species	Control spread of invasive species	Publicize invasive species hotline	FW- 5.8
Aquatic Community	Invasive species	Control spread of invasive species	Restore habitat and improve water quality for native species to impede invasive species	
Aquatic Community	Invasive species	Control spread of invasive species	Use existing barriers to prevent spread of invasive species	
Aquatic Community	Invasive species	Detect invasive species	Support ongoing fish community monitoring and develop protocols for responding to invasive species	FW- 5.8

1 - Hamilton Harbour: if coldwater species are restored, adjust timing window to: July 1 to October 15

Table 7.21. All Watersheds Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Invasive species	Increase and improve signage, public education, and stewardship in the watershed	Invasive species outreach program (OFAH)	
Aquatic Community	Invasive species	Increase and improve signage, public education, and stewardship in the watershed	Undertake activities to educate the public regarding the effects of invasive aquatic species	
Aquatic Community	Nuisance Species	Reduce the negative effects of overpopulations of some nuisance species	Develop a management strategy with species targets for nuisance species (e.g. round gobies)	FW- 5.1
Aquatic Community	Stocking	Identify desirable and feasible species for reintroduction	High priority species include: Atlantic salmon, lake sturgeon, American eel, redside dace, lake herring, lake whitefish, and muskellunge	
Aquatic Community	Stocking	Identify desirable and feasible species for stocking	Use naturalized species such as rainbow and brown trout for restoring sportfishing opportunities	
Aquatic Habitat	Coordination of activities	Encourage coordination among stakeholders and agencies	Maintain a Fish and Wildlife Habitat Restoration Project Steering Committee of BAIT	FW- 2 FW-3
Aquatic Habitat	Loss or degradation of aquatic habitat	Cooperate with corporate and local landowners to improve fish habitat	Support stewardship groups and NGOs to undertake fish habitat rehabilitation through CFWIP program	
Aquatic Habitat	Water Quality	Enhance the collection of water quality monitoring information	Conduct surveillance monitoring, performance monitoring, and special studies on creeks within the tributary watershed, as determined by BAIT.	RM-4
Aquatic Habitat	Water quality	Enhance the collection of water quality monitoring information	Develop a stream flow and water quality monitoring system for urban watersheds including stormwater management ponds	RM-4.5
Aquatic Habitat	Water quality	Enhance the collection of water quality monitoring information	Explore harmonized watershed monitoring program between Hamilton and Halton Conservation Authorities and the RBG	RM-4.4
Aquatic Habitat	Water quality	Enhance the collection of water quality monitoring information	Periodically undertake special studies:	RM-4.3
Aquatic Habitat	Water Quality	Enhance the collection of water quality monitoring information	Surveillance Monitoring: Maintain a minimum of six sampling sites on the Grindstone, Spencer and Red Hill Creeks (to total a minimum of two per creek) as part of the Provincial Water Quality Monitoring Network to improve the ability to determine long term water quality trends	RM-4.1
Aquatic Habitat	Water Quality	Enhance the collection of water quality monitoring information	Undertake specific performance monitoring when needed to evaluate the effectiveness of stewardship programs, pollution source identification, etc.	RM-4.2
Aquatic Habitat	Water Quality	Ensure that the tributaries meet provincial water quality guidelines	Support RAP initiative to improve water quality.	

Table 7.21. All Watersheds Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Water Quality	Improve overall water quality	Reduce levels of toxic substances in the water, sediment, and food chain to allow for the presence and natural reproduction of the most sensitive native aquatic species	FW-6
Aquatic Habitat	Water Quality	Improve the quality of water of North Shore tributaries	Improve water quality by removing stresses resulting from discharges from WWTPs, CSOs, and watersheds	FW-4
Aquatic Habitat	Water quality	Remediate sources of sediment from inappropriate land management practices	Storm runoff is a source of bacterial contamination to the Harbour. Illegal or bad practices or malfunctioning infrastructure should be corrected to minimize bacterial discharge.	ULM-6
Aquatic Habitat	Water quality	Collect stream temperature data	Use in situ data recorders	
Aquatic Habitat	Sediment erosion into water bodies	Implement appropriate stormwater management measures	Encourage landowners to undertake stormwater management plans on their existing developed sites	ULM-11.2
Aquatic Habitat	Sediment erosion into water bodies	Implement appropriate stormwater management measures	Implement stormwater management plans for all greenfield and brownfield development sites in accordance with "Stormwater Management Practices Planning and Design Manual" (OMOE 2000)	ULM-11.1
Aquatic Habitat	Sediment erosion into water bodies	Minimize erosion and sedimentation during land clearing and construction activities	Follow "Erosion and Sediment Control Guideline for Urban Construction. (December 2006)", prepared by the Greater Golden Horseshoe Area Conservation Authorities	
Aquatic Habitat	Sediment erosion into water bodies	Minimize erosion and sedimentation during land clearing and construction activities	Determine who will control and regularly inspect sediment control plans on development sites	ULM – 3.3 ULM – 3.4
Aquatic Habitat	Sediment erosion into water bodies	Minimize erosion and sedimentation during land clearing and construction activities	Implement enhanced enforcement and reporting of erosion and sediment control for development sites	ULM – 3.5
Aquatic Habitat	Sediment erosion into water bodies	Minimize erosion and sedimentation during land clearing and construction activities	Management practices must continue to be developed, adopted and enforced by municipalities and conservation authorities; need training programs for inspectors and construction site supervisors	ULM 3.0
Aquatic Habitat	Sediment erosion into water bodies	Minimize erosion and sedimentation during land clearing and construction activities	Undertake workshops to promote best management practices for sediment and erosion control on construction sites	ULM – 3.6
Aquatic Habitat	Sediment erosion into water bodies	Minimize erosion and sedimentation from agricultural lands	Encourage landowners to implement Agricultural Best Management Practices(e.g. conservation tillage, buffer strips, cover crops, crop rotation and structural controls)	ULM-2
Aquatic Habitat	Sediment erosion into water bodies	Minimize sedimentation from roads and runoff	Encourage wastes from street cleaning processes on major highways, in industrial areas, and on all parking lots and alleys, be disposed of in landfills	ULM 5.5

Table 7.21. All Watersheds Issues and Strategies (Cont'd)

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Sediment erosion into water bodies	Remediate sources of sediment from inappropriate land management practices	Urban storm runoff be controlled by municipalities to prevent deleterious discharges in sensitive areas	ULM 6.1
Aquatic Habitat	Sediment erosion into water bodies	Remediate sources of sediment from inappropriate land management practices	Identify sites in need of remediation	ULM 5.4
Aquatic Habitat	Maintaining stream flow	Conserve water	Municipalities (or other water service providers in the watershed) undertake strategies to achieve water conservation	ULM-9
Aquatic Habitat	Maintaining stream flow	Protect groundwater	Undertake groundwater studies and ongoing monitoring to identify significant groundwater sites and develop policies for their protection.	ULM-12
Aquatic Habitat	Public Awareness	Develop education programs to inform public about the impacts that everyday activities have on water and fish	Continue Yellow Fish Road program	EPI – 1.5
Aquatic Habitat	Public Awareness	Develop education programs to inform public about the impacts that everyday activities have on water and fish	Establish centres for disseminating information	
Aquatic Habitat	Public Awareness	Encourage stewardship	Actively promote the various MNR conservation programs, including Community Fisheries and Wildlife Involvement Program	
Aquatic Habitat	Public Awareness	Encourage stewardship	Continue and expand adopt-a-creek programs	EPI – 5.2
Aquatic Habitat	Public Awareness	Encourage stewardship	Incorporate volunteers into fisheries projects when opportunities present themselves (i.e. stream spawning surveys, signage).	
Aquatic Habitat	Public Awareness	Encourage stewardship	Incorporate volunteers into fisheries works when opportunities present themselves (i.e. stream spawning surveys, signage).	
Aquatic Habitat	Public Awareness	Encourage stewardship	Inform landowners adjacent to wetlands, creeks, streams, and other natural areas about the importance of the natural environment	EPI – 6.1 & 6.2
Aquatic Habitat	Public Awareness	Encourage stewardship	Provide displays on the fish community at various public events	
Aquatic Habitat	Public Awareness	Encourage stewardship	Provide landowners with land management recommendations that can help to improve water quality and fish habitat	EPI – 6.8 & 6.9
Aquatic Habitat	Public Awareness	Increase and improve signage, public education, and stewardship in the watershed	Signs re: fish habitat/community, water quality-related issues, fish consumption-related issues, pool discharge into creeks, natural area encroachment, golfcourses, stormwater management, quarries	

Table 7.21. All Watersheds Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems in Hmailton Harbour and its watershed	Continue annual Hamilton Harbour Family Fishing Festival	EPI – 2.5
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems in Hmailton Harbour and its watershed	Develop outreach programs and to pursue partnerships with non-profit community organizations	PAA – 2.1
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems in Hmailton Harbour and its watershed	Develop partnerships with community non-profit organizations to assist in the implementation of the objectives	PAA – 2
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems in Hmailton Harbour and its watershed	Construct boardwalks, trails and viewing platforms with appropriate signage	PAA – 2
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems in Hmailton Harbour and its watershed	For example, Marine Discovery Centre – fish-related initiatives	PAA – 2; EPI – 1, 2, 3, & 4
Aquatic Habitat	Protection of riparian lands	Encourage sustainable development of lands near watercourses or waterbodies	Municipalities and other authorities continue to acquire and develop lands for public use, to develop existing lands under their control and to identify new sites that provide more physical access to the shores of the Hamilton Harbour, its tributaries and significant related ecosystems. Such acquisitions should be consistent with Shoreline Management Strategies where these exist. The development of shoreline management strategies by the responsible authorities is encouraged.	
Aquatic Habitat	Protection of riparian lands	Encourage sustainable development of lands near watercourses or waterbodies	The development of shoreline/riparian management strategies by the responsible authorities is encouraged.	
Aquatic Habitat	Protection of riparian lands	Encourage sustainable use of shorelines and wetland areas	Protect habitat sites from public overuse	FW – 8.1 & 8.3
Aquatic Habitat	Protection of riparian lands	Establish appropriate riparian buffers.	All watercourses within the Hamilton Harbour watershed should have a vegetative riparian buffer with a minimum of (measured from the limit of the meander belt): ▪ 15 m adjacent to warmwater zones ▪ 30 m adjacent to coldwater zones ▪ 30 m adjacent to redside dace habitat	ULM – 2.7 & 2.8
Aquatic Habitat	Protection of riparian lands	Establish appropriate riparian buffers.	Ensure that riparian buffers are vegetated.	ULM – 2
Aquatic Habitat	Protection of riparian lands	Establish appropriate riparian buffers.	Update the 2003 "Watershed Riparian Buffer Mapping and Analysis Using GIS" report, including highlighting of rural and urban boundaries	ULM – 2.11

Table 7.21. All Watersheds Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Protection of riparian lands	Promote sustainable development of shorelines	Promote the development of the Hamilton Harbour in line with the recommendations of "Protecting Your Shoreline Naturally: Shoreline Protection Ideas for Fish and Wildlife Enhancement"	ULM – 8
Aquatic Habitat	Protection of riparian lands	Promote sustainable development of shorelines	Support CAs to implement Generic Regulations (*Development, Interference of Wetlands and Alterations to Shorelines and Watercourses Ontario Regulation*) and complete mapping of regulated areas for the shoreline of Hamilton Harbour	ULM – 8.1
Aquatic Habitat	Protection of riparian lands	Promote the sustainable development and growth of urban areas	Practice smart growth management and establish firm urban boundaries, to encourage more compact urban growth and to discourage urban sprawl; this would help to preserve natural spaces and rural areas	ULM – 1
Aquatic Habitat	Protection of riparian lands	Protect fish habitat	Apply the Fisheries Act to ensure the policy of "no net loss" of all fish habitats	FW – 12
Aquatic Habitat	Protection of riparian lands	Restore flood plain habitat	Restore flood plain habitat and providing access for fish and wildlife	FW – 4
Aquatic Habitat	Funding	Continued support for HCA aquatic resource monitoring program	Financial assistance for staff and equipment needed	
Aquatic Habitat	Funding	Develop a list of Funding sources	Develop a list of Funding sources including government grant programs, endowments, and foundations	
Aquatic Habitat	Funding	Develop a list of Funding sources	Incorporate corporate sponsorship into restoration activities	
Aquatic Habitat	Funding	Encourage partner funding of rehabilitation projects through corporate sources	Seek 1/3rd match funding support for major fisheries management plan implementation projects through federal and provincial sources (e.g. Canada-Ontario Agreement program and the Great Lakes Sustainability Fund)	
Aquatic Habitat	Funding	Encourage stewardship	Obtain financial assistance for stewardship activities	
Planning	Coordination of activities	Encourage development industry to accept and adopt the RAP goals and principle	HIEA to continue to improve environmental practices in the areas of water quality related to Hamilton Harbour	ULM – 14.4
Planning	Coordination of activities	Promote consistency in the field of watershed planning	Support the Watershed Planning Network (WPN) to provide a forum for open discussion on issues related to watershed planning.	ULM – 6.1
Planning	Coordination of activities	Undertake a regional natural areas management plan with local stakeholders	Stakeholders include the City of Hamilton, the City of Burlington, local Conservation Authorities, the Royal Botanical Gardens, the Hamilton Naturalist Club, and interested local residents and public groups.	

Table 7.21. All Watersheds Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Planning	Knowledge	Develop habitat targets for riparian areas	% riparian zone; % wetlands; etc.	FW – 4.6
Planning	Knowledge	Synthesize watershed information and determine course of action	Complete a comprehensive "Watershed Report Card" summarizing the 5-year Conservation Halton Long Term Environmental Monitoring	ULM – 10.5
Planning	Knowledge	Synthesize watershed information and determine course of action	Complete watershed plans for areas where studies have yet to be undertaken.	ULM – 10
Planning	Knowledge	Synthesize watershed information and determine course of action	Investigate the potential to develop and utilize an integrated GIS water budget/quality model for the Hamilton Harbour Watershed	ULM – 10.6
Planning	Knowledge	Synthesize watershed information and determine course of action	Undertake a regional natural areas management plan with local stakeholders.	
Planning	Knowledge	Synthesize watershed information and determine course of action	Update the "Headwaters to the Bay" report	ULM – 10.7

Table 7.22. North Shore Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Loss or degradation of aquatic habitat	Daylight sections of Indian Creek.	Determine feasibility piped of daylighting piped sections of Indian Creek	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on lower reaches of Indian Creek	Continue with current efforts on Indian Creek Rehabilitation project to restore lower reaches of Indian Creek; Re-vegetate river mouth; Restore flood plain habitat and providing access for fish and wildlife; Improve stream morphology and hydrology	FW – 1.11
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on North Shore tributaries	Develop habitat targets (riparian and stream morphology) for lower reaches of the North Shore tributaries.	FW – 4.5
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on North Shore tributaries	Implement site-specific recommendations of the North Shore Watershed Study (CH 2006) to restore aquatic habitat.	
Aquatic Habitat	Protection of riparian lands	Establish appropriate riparian buffers.	Complete "How Much Habitat is Enough" analysis and recommendations for North Shore watershed	ULM – 2.9

Table 7.23. Grindstone Creek Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Dams and barriers to fish passage	Modify barriers to allow fish passage	Identify barriers (42 known) to fish passage and mitigate and/or remove barriers, where feasible to reconnect fragmented populations	
Aquatic Community	Declines in native species abundance	Consider reintroduction of native species, where feasible, in order to restore populations	A high priority species for this watershed would be Atlantic Salmon if feasible	
Aquatic Community	Declines in native species abundance	Restore Brook trout in upper reaches of Grindstone	Determine suitable areas for restorion of remnant population or re-introduction	
Aquatic Community	Angling opportunities	Improve public access for fishing	Provide public dock facilities at Valley Inn Road in partnership with the waterfront trail project (Hendrie Valley and Carroll's Bay)	
Aquatic Community	Angling opportunities	Manage lower Grindstone as a migratory rainbow and resident brown trout fishery until such time as the watershed is capable of supporting Atlantic salmon	Restore existing rainbow trout population through habitat restorion. Stock brown trout to encourage a resident recreational fishery.	
Aquatic Habitat	Loss or degradation of aquatic habitat	Maintain natural water cycles within the floodplains of RBG	Investigate water level manipulation techniques and implement if feasible	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on lower reaches of Grindstone Creek	Maintain the existing projects and continue to advance projects at the mouth of Grindstone Creek	FW – 1.1
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on lower reaches of Grindstone Creek	Encourage development of 40 ha of emergent and submergent aquatic vegetation in Grindstone Creek delta and Grindstone Creek marshes.	FW – 1.2 & 4.2
Aquatic Habitat	Maintaining stream flow	Protect pre-development hydrograph through active management of basin imperviousness	Manage for maximum 10% impervious area within watershed area that is currently undeveloped	
Aquatic Habitat	Public Awareness	Encourage stewardship	Increase support for stewardship within Hidden Valley Park	
Aquatic Habitat	Public Awareness	Encourage stewardship	Increase support for Centre Road to Hwy 6 (Chart 1 Grindstone Study)	
Aquatic Habitat	Public Awareness	Encourage stewardship	Increase support for Hamilton Halton Stewardship projects -- 5th Concession to Parkside Drive (Chart 2 Grindstone Study)	
Aquatic Habitat	Public Awareness	Encourage stewardship	Increase support for Hamilton Halton Stewardship projects -- 6th Concession to Hwy 6 (Chart 2 Grindstone Study)	
Aquatic Habitat	Public Awareness	Encourage stewardship	Provide support for Riis property monitoring	
Aquatic Habitat	Public Awareness	Encourage stewardship	Provide support for Vanderkruuk property	
Aquatic Habitat	Public Awareness	Encourage stewardship	Continue and expand adopt-a-creek programs	EPI – 5.2

Table 7.23. Grindstone Creek Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Public Awareness	Increase and improve signage, public education, and stewardship in the watershed	Provide specific signage on lower Grindstone and the associated marshes regarding their significance to the Lake Ontario fish community	
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems	Dependent on successful recovery of Grindstone Creek Estuary (Carroll's Bay), evaluate a potential waterfront pedestrian boardwalk along the shoreline of Carroll's Bay	PAA – 2
Planning	Knowledge	Monitor aquatic community	Continue benthos and fisheries monitoring in Hidden Valley Park, and assess the habitat quality of restored channel	
Planning	Knowledge	Monitor aquatic community	Provide support for 6th line project	
Planning	Knowledge	Monitor aquatic community	Continue monitoring fish passage through culvert at OPTA Minerals	
Planning	Knowledge	Monitor aquatic community	Continue migratory salmonid spawning surveys.	
Planning	Knowledge	Monitor aquatic community	Conduct fisheries inventory on Lake Medad	

Table 7.24. Spencer Creek Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Dams and barriers to fish passage	Modify barriers to allow fish passage in Fletcher Creek	Fix problem culverts (e.g. CP railway crossing, Puslinch Concession Road #7, Lennon Road.)	
Aquatic Community	Dams and barriers to fish passage	Modify barriers to allow fish passage in Spencer Creek	Remove low-head dams on lower Spencer Creek to allow passage of Lake Ontario fish (e.g. Atlantic salmon) farther upstream.	
Aquatic Community	Dams and barriers to fish passage	Modify barriers to allow fish passage in Sulphur Creek	Mitigate on-line ponds in Sulphur Creek watershed	
Aquatic Community	Contaminants in fish	Monitor contaminants in sportfish in Valens and Christie Reservoirs	Continue monitoring of contaminants in sportfish and publish in *Guide to Eating Ontario Sportfish*	FW- 6.8
Aquatic Community	Declines in native species abundance	Enhance and/or restore brook trout in upper Spencer Creek, Fletcher Creek, and Flamborough Creek	Protect and improve base flow, ground water, temperature, and sedimentation	
Aquatic Community	Declines in native species abundance	Enhance fish communities in Valens, Christie, and Crook Hollow Reservoirs	Control carp through habitat and fish species management.	

Table 7.24. Spencer Creek Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Declines in native species abundance	Enhance fish communities in Valens, Christie, and Crook Hollow Reservoirs	Develop plans to manage reservoir water levels to benefit native fish species.	
Aquatic Community	Species at risk	Enhance and/or restore redside dace in Spencer Creek	Design and implement local recovery action plans.	
Aquatic Community	Species at risk	Enhance and/or restore redside dace in Spencer Creek	Protect and improve base flow, ground water, temperature, and sedimentation	
Aquatic Community	Angling opportunities	Manage coldwater zones of Spencer Creek below escarpment as a migratory rainbow and resident brown trout fishery until the watershed is capable of supporting Atlantic salmon	Restore existing rainbow trout population through habitat restorion. Stock brown trout to encourage a resident recreational fishery.	
Aquatic Community	Public Awareness	Encourage stewardship	Provide specific signage on lower Spencer Creek regarding its significance to the Cootes Paradise and Lake Ontario fish communities	
Aquatic Habitat	Loss or degradation of aquatic habitat	Reduce livestock erosion of stream banks	Use fencing and cattle crossings (e.g. Flamborough Creek / Spencer Creek confluence at Middleton Road)	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on Chedoke Creek between Main St. West and Cootes Paradise	Incorporate natural channel design into mproving stream morphology and hydrology between Main St. West and Cootes Paradise	FW – 4
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on Flamborough Creek	Investigate locations near Safari Road and Brock Road, Fenton property	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on lower reaches of Spencer Creek	Reconstruct the ditched sections of Spencer Creek channel through Dundas incorporating natural channel design	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on lower reaches of Spencer Creek	Introducing large woody debris for instream cover	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat on lower reaches of Spencer Creek	Restore spawning habitat for walleye	
Aquatic Habitat	Water quality	Evaluate impact of Christie and Crook Hollow Reservoirs on downstream stream temperatures	Christie and Crook Hollow Reservoirs raise the temperature of Spencer Creek and may reduce the potential fro Atlantic salmon restoration. Determine mitigation strategy (e.g. bottom draw from reservoir)	
Aquatic Habitat	Water quality	Evaluate impact of Reservoirs on downstream stream temperatures	Valens Reservoir raises the temperature of upper Spencer Creek and impacts brook trout and perhaps, redside dace. Determine mitigation strategy	

Table 7.24. Spencer Creek Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Maintaining stream flow	Maintain appropriate flows from reservoirs	Evaluate water levels in Christie Reservoir to determine if flow/levels maintained appropriately for fish (e.g Chinook or Atlantic salmon in fall)	
Aquatic Habitat	Maintaining stream flow	Maintain appropriate flows from reservoirs	Important to have low level flooding during the spring for spawning pike	
Planning	Coordination of activities	Synthesize watershed information and determine course of action	Update the Spencer Creek Watershed plan by completing subwatershed and tributary plans	ULM – 10.2
Planning	Knowledge	Determine angling impacts on fish community	Assess seasonal fishing pressure in Christie Reservoir	
Planning	Knowledge	Determine the cold/warm thermal habitat volumes of Christie reservoir and potential for getting cold water downstream	Undertake temperature/oxygen profile assessment in Christie Reservoir	
Planning	Knowledge	Improve temperatures of coldwater management zones	Measure stream temperature throughout Spencer Creek and its tributaries during summer with recording thermometers to verify temperature classification (e.g. Logies Creek) and determine potential temperature improvements	
Planning	Knowledge	Improve temperatures of coldwater management zones	Use simple mass-temperature balance models to optimize coldwater zone temperatures	
Planning	Knowledge	Monitor aquatic community	Survey fish community Valens, Christie, and Crook Hollow Reservoirs	
Planning	Knowledge	Monitor fish community	Continue RBG fish monitoring programs	

Table 7.25. Cootes Paradise Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Declines in native species abundance	Protect species during spawning or migration	Promote conservation of species through enforcement of existing angling regulations	
Aquatic Community	Declines in native species abundance	Protect species during spawning or migration	Consider restriction of access to prohibit angling during sensitive spawning and migration periods	
Aquatic Community	Unbalanced fish community	Actively manage for increasing presence of piscivores	Promote conservation of species through enforcement of existing angling regulations	FW-11

Table 7.25. Cootes Paradise Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Angling opportunities	Improve public access for fishing	Provide public dock facilities at Princess Point and in the old Desjardin Canal at Olympic Drive	
Aquatic Habitat	Loss or degradation of aquatic habitat	Protect fish habitat	Extend the riverbank of Chedoke Creek into Cootes Paradise to bypass poor quality water past Princess Point Bay	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore aquatic habitat in Cootes Paradise	Investigate removal of carp passing through carp barrier	FW- 5.2
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore aquatic habitat in Cootes Paradise	Use carp barrier to reduce access for carp and maintain carp in Cootes Paradise at less than 40 kg/ha	FW – 9.1
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore aquatic habitat in Cootes Paradise	Reduce phosphorus to RAP recommendation	FW – 9.2
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat in Cootes Paradise	Remove ditch berms along the north side of Spencer Creek (Cootes Paradise)	
Aquatic Habitat	Loss or degradation of aquatic habitat	Re-vegetation of Cootes Paradise with native plants	Conitinue wetland restoration projects in Cootes Paradise.	FW-1.6
Aquatic Habitat	Loss or degradation of aquatic habitat	Re-vegetation of Cootes Paradise with native plants	Provide 240 ha emergent and submergent aquatic plants in Cootes Paradise in accordance with the Fish and Wildlife Habitat Restoration Project	FW-9.3
Aquatic Habitat	Loss or degradation of aquatic habitat	Re-vegetation of Cootes Paradise with native plants	Promote appropriate management of Lake Ontario water levels	FW-9
Aquatic Habitat	Loss or degradation of aquatic habitat	Secure properties in the smaller subwatersheds to protect the long term future of the marsh	Areas in need of protection include the undeveloped north side of Cootes Paradise to the escarpment	
Aquatic Habitat	Water Quality	Decrease loadings from WWTPs	Support the RAP targets of CSO and STP loadings into Cootes Paradise	WQ – 2
Aquatic Habitat	Water Quality	Determine contaminant levels in sediments	Determine contaminant levels in sediments	
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems	Continue with public open houses at the Cootes Paradise Carp barrier	
Aquatic Habitat	Public Awareness	Promote appreciation of wetlands and other natural ecosystems	Improve signage and viewing platforms around Cootes Paradise	
Aquatic Habitat	Contaminants	Address contaminated sediments where they effect aquatic community health and human health	At remnant canal section at the back of Cootes Paradise	

Table 7.26. Red Hill Creek Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Declines in native species abundance	Enhance white sucker in Redhill Creek	Protect migration corridor from Lake Ontario	
Aquatic Community	Angling opportunities	Manage coldwater zones of Red Hill Creek below escarpment as a migratory rainbow and resident brown trout fishery until such time as the watershed is capable of supporting Atlantic salmon	Stock rainbow trout population to encourage migratory trout fishery. Stock brown trout to encourage a resident recreational fishery.	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore habitat at Windermere Basin	Identify options for wetland construction analysis and enhancements in Windermere Basin	FW- 1.9
Aquatic Habitat	Protection of riparian lands	Restore habitat at Windermere Basin	Naturalize lands surrounding Windermere Basin	FW- 1.8
Planning	Knowledge	Improve temperatures of coldwater management zones	Measure stream temperature throughout Spencer Creek during summer with recording thermometers	
Planning	Knowledge	Improve temperatures of coldwater management zones	Use simple mass-temperature balance models to optimize coldwater zone temperatures	

Table 7.27. Hamilton Harbour Issues and Strategies.

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Contaminants in fish	Monitor contaminant levels in fish	Test fish from Hamilton Harbour for tainting of flavour	RM-2.4, 2.6
Aquatic Community	Contaminants in fish	Monitor contaminants in sportfish for human consumption	OMOE/OMNR program for the “Guide to Eating Ontario Sportfish”. There should be no restrictions on consumption of fish and wildlife from the Harbour attributable to local sources.	FW – 6.8 RM – 2.3
Aquatic Community	Contaminants in fish	Support programs that monitor the impacts of contaminants on fish health and natural reproduction	Support DFO and EC monitoring programs	FW – 6.1 to 6.7 TSSR – 3.9
Aquatic Community	Species at risk	Reintroduce lake sturgeon and American eel	Obtain appropriate source unless remnant populations are sufficient	
Aquatic Community	Unbalanced fish community	Reintroduce lake herring, lake whitefish, muskellunge	Adult transfer or stock with Lake Ontario source	
Aquatic Community	Unbalanced fish community	Restore the nearshore fish community	Restore 500 ha of aquatic vegetation Hamilton Harbour, Cootes Paradise, Windermere Basin, Grindstone Rivermouth Management Zones.	FW – 1.2
Aquatic Community	Unbalanced fish community	Restore the nearshore fish community	Restore shoal habitats in Hamilton Harbour for spawning or nursery habitat for muskellunge, smallmouth bass, and walleye.	
Aquatic Community	Unbalanced fish community	Obtain a better balance of predator and prey fish.	Use carp barrier to reduce carp populations in Hamilton Harbour by maintaining carp in Cootes Paradise at less than 40 kg/ha	FW – 9 FW – 11

Table 7.26. Hamilton Harbour Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Community	Unbalanced fish community	Restore the nearshore fish community (to species indicative of a mesotrophic environment, containing self-sustaining populations of northern pike, muskellunge, smallmouth and largemouth bass, walleye, yellow perch, and sunfish)	Restore water and sediment quality in Hamilton Harbour	WQ – 1a
Aquatic Community	Unbalanced fish community	Restore the offshore fish community	Restore shoal habitats in Hamilton Harbour for spawning by lake herring and lake whitefish	
Aquatic Community	Unbalanced fish community	Restore the offshore fish community (to include self-sustaining populations of native coldwater species such as lake herring, as well as stocked salmon and trout)	Restore water and sediment quality in Hamilton Harbour	WQ – 1a FW – 11.11
Aquatic Community	Angling opportunities	Increase access to Hamilton Harbour for shore anglers	Support efforts of Municipalities, CAs, RBG, and Hamilton Port Authority to create and maintain trails and waterfront parks to increase public access to 35% of the Hamilton Harbour shoreline (includes Cootes Paradise, Windermere Basin, and Grindstone Creek rivermouth)	PAA – 1.1 to 1.11
Aquatic Community	Angling opportunities	Increase access to Hamilton Harbour for shore anglers	Complete design and construction of fish access, windsurfing access, and trail at north shore of CCIW property.	PAA - 1.7
Aquatic Community	Nuisance Species	Reduce the negative effects of over populations of some nuisance species	Reduce double-crested cormorants numbers to 200 pairs.	FW- 5.4
Aquatic Community	Stocking	Continue stocking Chinook salmon and brown trout at Burlington Canal to support fishery in Lake Ontario	Improve water quality in Hamilton Harbour to allow more stocked salmonids to use the harbour	
Aquatic Habitat	Loss or degradation of aquatic habitat	Identify fish habitat compensation projects for Randle Reef	Follow DFO guidelines	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore littoral zone	Restore 15 km of littoral habitat in Hamilton Harbour and Rivermouth Management Zones for benefit of nearshore species such as spottail shiners, trout-perch, sunfish, largemouth bass, and northern pike	FW – 1.2, 1.3, 1.7,1.9 to 1.12, 1.14, 1.15
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore littoral zone	Reduce carp and improvements in water quality will allow light penetration and growth of submergent and emergent aquatic vegetation	ULM – 8
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore littoral zone	Naturalize shorelines with a diversity of habitats (e.g. open coastal beaches)	
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore or recreate shoals, especially along northern (1,500 Ha) and eastern shoreline (800 Ha) for spawning of lake herring, lake whitefish, walleye, and smallmouth bass and for summer habitat of yellow perch, and others species	Expand shoals that have been created at LaSalle Park and, the N.E. Shoreline and islands (e.g. Farr Island); future work scheduled at these locations, north side of CCIW, and Fisherman's Pier should expand the quantity of shoals and consider the spawning needs of these species	FW – 1.1,1.3, 1.7, 1.10,1.14, 1.17, 1.18
Aquatic Habitat	Loss or degradation of aquatic habitat	Restore the migratory route for Lake Ontario offshore fish community (native coldwater species such as lake herring, lake whitefish, and Atlantic salmon, as well as stocked salmon and trout)	Restore water and sediment quality in Hamilton Harbour	WQ – 1a

Table 7.26. Hamilton Harbour Issues and Strategies (Cont'd).

Theme	Key Issue	Strategy	Management tool	HHRAP/ BAIT Target
Aquatic Habitat	Water Quality	Determine quality of water in winter	Water quality impacts on the fish community during winter are unclear	WQ – 1e.5
Aquatic Habitat	Water Quality	Develop oxygen goals for spawning shoals of Hamilton Harbour during winter based on the needs of lake herring and lake whitefish	Monitor oxygen levels at potential shoal locations	
Aquatic Habitat	Water Quality	Develop oxygen goals for the hypolimnion of Hamilton Harbour during summer based on the needs of pelagic coldwater species, especially lake herring	Define the "cisco layer" for lake herring	
Aquatic Habitat	Water Quality	Support all RAP targets for improvement of sediment quality and RAP goal of zero discharge of trace metals and organics	Support RAP Toxic Substances And Sediment Remediation Recommendations	TSSR – 1 to TSSR - 7
Aquatic Habitat	Water Quality	Support all RAP targets for improvement of water quality and goals in RAP Recommendations: Table WQ – 1a Water Quality Goals for Hamilton Harbour	Support RAP Water Quality And Bacterial Contamination Recommendations	WQ – 1 to WQ – 4
Aquatic Habitat	Public Awareness	Incorporate volunteers into fisheries works when opportunities present themselves	Involvement in culture or stocking of Chinook salmon or brown trout at Burlington Canal	
Planning	Knowledge	Monitor fish community	Continue MNR trapnetting, and DFO and RBG fish monitoring programs	