


FISHERIES
MANAGEMENT PLAN

FOR DUFFINS CREEK AND CARRUTHERS CREEK

JUNE, 2004

Toronto and Region Conservation for The Living City

Member of Conservation Ontario Natural Champions

Ontario Ministry of Natural Resources

Duffins and Carruthers Watersheds

Fisheries and Oceans Canada Pêches et Océans Canada

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EXECUTIVE SUMMARY

Unlike many of the other watersheds in the Greater Toronto Area, the Duffins and Carruthers Creek watersheds remain largely undeveloped. However, as development pressures increase, the need to prepare a watershed plan becomes more critical. This process was initiated in 2000, with the initiation of the Duffins and Carruthers Creeks Watershed Plan process. Concurrent with this project was the development of a fisheries management plan (FMP), which will be used to guide future management of the aquatic ecosystem and provide direction for implementation.

The objectives of the FMP are:

- to protect and enhance the biological integrity of the aquatic ecosystem;
- to achieve "no net loss" of fisheries habitat;
- to promote the sustainable utilization of fisheries resources;
- to develop a greater knowledge of fish populations, fish habitat and aquatic ecosystems;
- to describe the existing conditions of the fish community to establish a benchmark of ecosystem health;
- to provide a framework for fisheries management at subwatershed, reach and site scales;
- to rehabilitate degraded fish communities and fish habitat, for self-sustaining, native stocks;
- to promote public awareness, appreciation and understanding of fisheries resources and the aquatic habitats on which they depend; and
- to involve organized angling associations, environmental interest groups and the general public in fisheries management activities.

The Duffins Creek watershed remains the healthiest watershed in TRCA's jurisdiction and contains a high proportion of cold-water streams which support populations of resident brook trout, sculpin, American brook lamprey and darter species, as well as migratory rainbow trout, chinook salmon and warm-water species such as largemouth and smallmouth bass and northern pike. Stressors on the aquatic ecosystem are primarily instream barriers, lack of riparian vegetation and in more urbanized areas, alterations to the flow regime. Carruthers Creek maintains a diversity of cool and warm-water fish species including rainbow trout, northern redbelly dace, large and smallmouth bass, black crappie, logperch and mottled sculpin. However, the apparent absence of brook trout, redside dace and rainbow darter suggest signs of impacts from development, including altered flows and reduced riparian vegetation.

As the fisheries management plan was developed, the public was asked to provide input on issues they felt were important. The main issues raised included impacts from development, ponds and barriers, access for migratory species versus protection of resident species and water quality.

Based on the data analysis, current science and public input, target species for management were developed. The six zones are (a) brook trout, (b) brook trout and Atlantic salmon, (c) redside dace and darter species, (d) redside dace and rainbow trout, (e) smallmouth bass and (f) northern pike and large and smallmouth bass. Essential to maintaining these management zones is the need to preserve three barriers in the Duffins Creek watershed as fisheries management tools. The barrier north of Church Street in the Lower Duffins Creek is to continue to function in its role as a sea lamprey barrier while Whitevale dam on the West Duffins Creek and Newman's dam on the East Duffins Creek will be utilized to separate migratory salmon and trout and resident trout populations.

In order to address the issues raised by the public and to achieve the future management goals, a suite of management actions were developed. While many are applicable across both watersheds, it is at the subwatershed level where the management actions are the most specific and are summarized in the following tables.

East Duffins Creek Subwatershed

- Implement TRCA's Terrestrial Natural Heritage System Strategy.
- Investigate potential barriers to fish passage and mitigate known barriers. High Hills Pond is a priority.
- Maintain Newman's dam as a barrier to migratory trout and salmon. Structural assessment of the dam is required.
- Establish riparian vegetation along East Duffins Creek between Taunton and Rossland Roads, the headwaters of Mitchell, Spring and Brougham Creeks, and a small tributary that joins East Duffins Creek north of the 8th Concession Road.
- Work with private land-owners to implement best management practices.
- Work with Transport Canada to protect and enhance environmental features and functions.
- OMNR to investigate the habitat suitability for redside dace and Atlantic salmon in the appropriate management zones and if appropriate, consider stocking.
- Baitfish collection to be restricted at known redside dace locations.
- OMNR to change angling regulations to include artificial bait and single barbless hooks only upstream of Highway 7, catch and possession limits in both watersheds for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.
- OMOE should consult with other government agencies to determine acceptable flow alterations to protect aquatic communities.

West Duffins Creek Subwatershed

- Implement TRCA's Terrestrial Natural Heritage System Strategy.
- Investigate potential barriers to fish passage and mitigate known barriers. Former trout rearing pond at Secord Property is a priority.
- Maintain Whitevale dam as a barrier to migratory trout and salmon.
- Establish riparian vegetation along West Duffins Creek between 7th Concession Road north to Webb Road, Secord Property, upstream of Highway 7; Stouffville Creek in Stouffville, south of 19th Sideroad to confluence with Reesor Creek; Reesor Creek along the York/Durham Townline between Bethesda Road and north of the Uxbridge/Pickering Townline and between the 8th and 9th Concession Roads; Wixon Creek north and south of Webb Road and north of 9th Concession Road; Major Creek along most of it's length; Whitevale Creek south of Highway 7; Un-named Creek south of 7th and 9th Concession Roads and between 7th and 8th Concession Roads.

- Work with private land-owners to implement best management practices.
- Work with Transport Canada to protect and enhance environmental features and functions.
- OMNR to investigate the habitat suitability for redside dace and Atlantic salmon in the appropriate management zones and if appropriate, consider stocking.
- Baitfish collection to be restricted at known redside dace locations.
- OMNR to change angling regulations to include artificial bait and single barbless hooks only upstream of Highway 7, catch and possession limits in both watersheds for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.
- OMOE should consult with other government agencies to determine acceptable flow alterations to protect aquatic communities.

Ganatsekiagon Creek Subwatershed

- Work with the provincial government on the Seaton Lands and Transport Canada on the airport lands to protect and enhance environmental features and functions.
- Implement TRCA's Terrestrial Natural Heritage System Strategy.
- Protect and restore groundwater recharge and discharge locations and pathways.
- Investigate potential barriers to fish passage and mitigate known barriers.
- Establish riparian vegetation in headwater areas.
- Investigate and assess salmonid spawning and presence of redside dace.
- Baitfish collection to be restricted at known redside dace locations.

Urfe Creek Subwatershed

- Work with the provincial government on the Seaton Lands and Transport Canada on the airport lands to protect and enhance environmental features and functions.
- Implement TRCA's Terrestrial Natural Heritage System Strategy.
- Protect and restore groundwater recharge and discharge locations and pathways.
- Investigate potential barriers to fish passage and mitigate known barriers.
- Establish riparian vegetation in headwater areas.
- Investigate and assess salmonid spawning and presence of redside dace.
- Baitfish collection to be restricted at known redside dace locations.

Miller's Creek Subwatershed

- Implement TRCA's Terrestrial Natural Heritage System Strategy.
- Protect and restore groundwater recharge and discharge locations and pathways.
- Restore the water balance by improving infiltration and implementing stormwater management retrofits.
- Investigate potential barriers to fish passage.
- Establish riparian vegetation and create wetlands in headwater areas.
- Investigate opportunities to naturalize and restore Miller's Creek from Rossland Road downstream to the confluence with Duffins Creek.
- Investigate and assess use by migratory salmonids.
- Engage the community in stream clean-up and stewardship activities such as Yellow Fish Road, Adopt a Stream and other programs.

Lower Duffins Creek Subwatershed

- Maintain the water balance by improving infiltration and implementing stormwater management retrofits.
- Investigate potential barriers to fish passage.
- Establish riparian vegetation in the coastal marsh and along tributaries.
- Investigate opportunities to naturalize and restore Duffins Creek near Highway 401.
- Maintain the sea lamprey barrier north of Church Street.
- Conduct additional research to evaluate alternative sea lamprey barriers and fish passage technology to improve passage for non-jumping fish.
- Continue to investigate alternatives to the use of TFM in the control of sea lamprey.
- Conduct a creel census to better understand angler use and needs.
- Implement the Duffins Creek Marsh Restoration Project.
- Engage the community in stream clean-up and stewardship activities such as Yellow Fish Road, Adopt a Stream and other programs.

Carruthers Creek Subwatershed

- Implement TRCA's Terrestrial Natural Heritage System Strategy.
- Establish riparian vegetation in headwater areas north of Taunton Road.
- Investigate potential barriers to fish passage and mitigate known barriers.
- Baitfish collection to be restricted at known redside dace locations.
- Investigate the habitat suitability for a self-sustaining population of rainbow trout and if appropriate, consider stocking.
- Investigate the habitat suitability for brook trout and redside dace in the appropriate management zones and if appropriate, consider stocking.
- Prepare and implement a restoration action plan for the Carruthers Creek Marsh.
- Investigate opportunities for the securement of conservation easements, with emphasis on lands in the headwaters.
- Work with private land-owners to implement best management practices.
- Develop an improved understanding of ground and surface water flows.

Implementation of this Plan will require a concerted effort between federal, provincial and municipal governments, non-governmental organizations, rod and gun clubs, industry, agriculture, golf courses and private citizens. In fact, implementation has already started through riparian plantings and streambank stabilization at Paulynn Park, riparian plantings and spawning surveys on the Transport Canada Property, and the development of designs to bypass an existing on-line pond at the Deer Creek Golf Course. These initial projects represent the first steps on the road to protecting and restoring the aquatic systems in the Duffins and Carruthers Creek watersheds.

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1.0 INTRODUCTION

The Duffins and Carruthers Creeks Fisheries Management Plan is a resource document written for the citizens and stakeholders of the Duffins and Carruthers creeks watersheds. Watershed residents, government officials, land use planners, consultants, farmers, private land owners, land developers, anglers and nature enthusiasts will find current and historical information relevant to the aquatic ecosystem, as well as resource protection and restoration recommendations meant to provide direction for future fisheries management. It is hoped that this document will motivate stakeholders to follow the recommended management actions provided and subscribe to an "ecosystem first" approach regarding resource use and watershed development.

1.1 BACKGROUND

Watershed management is critical to fisheries management since many aspects of land and water use affect fish habitat and productivity. The long-term health of aquatic ecosystems is a critical consideration in any land use planning process; and Fisheries Management Plans (FMPs) are fundamental in incorporating fisheries concerns into the planning and permitting process. Fisheries Management Plans provide background information on the state of the aquatic ecosystem, as well as the management directions and targets necessary to manage the aquatic ecosystem in order to provide tangible benefits to society, while maintaining the resource.

The purpose of this Plan is to:

- present current and historical fisheries information;
- identify critical issues;
- outline management objectives;
- recommend rehabilitation activities.

1.2 PLAN OBJECTIVES

The objectives of the Plan are to:

- outline management objectives;
- protect and enhance the biological integrity of the aquatic ecosystem;
- outline management objectives;
- describe the existing conditions of the fish community to establish a benchmark of ecosystem health;
- outline management objectives;
- provide a framework for fisheries management at subwatershed, reach and site scales;
- outline management objectives;
- promote the sustainable utilization of fisheries resources;
- outline management objectives;
- achieve a "net gain" of productive capacity of fisheries resources;
- outline management objectives;
- outline management objectives;
- rehabilitate degraded fish communities and fish habitat, for self-sustaining, native stocks;
- develop a greater knowledge of fish populations, fish habitat and aquatic ecosystems;
- promote public awareness, appreciation and understanding of fisheries resources and the aquatic habitats on which they depend; and
- involve organized angling associations, environmental interest groups and the general public in fisheries management activities.

1.3 PLAN DEVELOPMENT

Background Information

A solid understanding of the watershed functions are required to manage fisheries resources. Background reports on the state of the Duffins and Carruthers creeks watersheds were prepared to support both the development of the Watershed Plan and the Fisheries Management Plan. Additional background information was collected from various sources, including published literature, consultant reports and GIS data. For example, historic and current fisheries data was collected from the Ontario Ministry of Natural Resources (OMNR) and Toronto and Region Conservation (TRCA) sampling records, as well as other agency documents and consultant reports. Information on the physical features and factors currently impacting the aquatic ecosystem, such as barriers, on-line ponds, extent of riparian vegetation, land-use etc., were analyzed and mapped.

Technical Team

Members of the Technical Advisory Committee (TAC) met regularly over the early planning stages of the document to provide input to the FMP. Members were selected to represent a cross-section of the government agencies involved in fisheries resource management and included staff from the Federal Department of Fisheries and Oceans (DFO), (OMNR and TRCA. A consultant, who is also a watershed resident and member of the Duffins and Carruthers Task Force was also retained to ensure consistency between the development of the Duffins and Carruthers Watershed Plan and the FMP. Many ideas incorporated into the FMP were developed through the TAC and from stakeholder consultation sessions.

Stakeholder Consultation

An initial public consultation session was held in the summer of 1999 to establish stakeholder perspectives on priorities for fisheries management. Midway through the study, six public open houses were held in May and June of 2002. Another meeting was held in May of 2002 and a final public meeting was held in November of 2003 to discuss the draft Plan.

During the public consultation process, issues that attracted the most interest and greatest response included maintenance of barriers to migratory species, riparian buffer widths, and the promotion of catch and release and barbless hooks at strategic locations on TRCA property. Some anglers voiced a preference for managing for rainbow trout rather than brook trout upstream of existing instream barriers. Strong concern was also voiced regarding groundwater and source protection. Anglers in particular identified a preference for managing the fishery that reflected their angling interest. As a result, this Plan strived to find a balance between introduced and native fish communities. There was, however, common support for managing the watershed functions to sustain the fish community.

1.4 CONTEXT OF THE PLAN

Fisheries management falls within the direct mandate of DFO and OMNR, however numerous other agencies are also indirectly involved (Table 1).

Table 1. Legislation relevant to fisheries resource management in Ontario*.

Legislation	Agency	Provisions Dealing with Fish and Fish Habitat
Federal Fisheries Act	DFO - Habitat Management	regulates activities affecting fish and fish habitat
NavigableWaters Protection Act	DFO - Coast Guard	regulates works built on, over, through or across any navigable water
Species at Risk Act	Environment Canada	protects Species at Risk and the habitat critical for their survival
Canadian Environmental Assessment Act	Environment Canada	regulates the process to predict the environmental effects of proposed initiatives before they are carried out
Beds of Navigable Waters Act	OMNR	the beds of most navigable waters are Crown Land
Ontario Fisheries Regulations	OMNR	fisheries management requirements pursuant to the Federal Fisheries Act
Lake and Rivers Improvement Act	OMNR	regulates activities affecting lakes and rivers
Game and Fish Act Beach Protection Act	OMNR	regulates the capture, sale and possession of fish
Public Lands Act	OMNR	regulates the removal of sand and gravel from beaches

Legislation	Agency	Provisions Dealing with Fish and Fish Habitat
Ontario Planning and Development Act	OMNR	provides for preparation and review of development plans
Drainage Act	Ontario Ministry of Municipal Affairs and Housing	permits individuals and municipalities to initiate and maintain drainage works
Ontario Water Resources Act	Ontario Ministry of Agriculture and Food	regulates discharge into waterbodies and withdrawal of water
Environmental Assessment Act	OMOE	provides for assessment of the effects on the environment of public and private projects
Conservation Authorities Act	OMOE	provides for regulation of floodplain activities
Municipal Act	Conservation Authorities Municipalities	regulates approvals for construction over public shores and waters

** – Primarily derived from Appendix 4 of Maple District Fisheries Management Plan 1989 - 2000.*

The FMP is a resource document and not a policy document. The information provided should be used in conjunction with policy documents such as TRCA's Valley and Stream Corridor Management Program, OMNR's Strategic Plan for Ontario Fisheries and the federal government's Policy for the Management of Fish Habitat.

These policy documents, however, are only one component of protecting the resource. Experience has shown that to successfully manage aquatic resources, it is necessary to impart a strong non-regulatory approach through education, outreach and an overall management philosophy of "net gain". Many of the actions outlined in this plan are, therefore, based on this approach.

1.4.1 FEDERAL LEVEL

At the federal level, the Fisheries Act defines legal obligations essential to the protection and management of fish habitat. The Policy for the Management of Fish Habitat sets out Fisheries and Oceans Canada's (DFO) objectives, goals and strategies for the management of fish habitat. The policy objectives for this document is a net gain of productive capacity for fisheries resources.

Section 2 of the Federal Fisheries Act defines fish to include "parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals". Section 34(1) of the Federal Fisheries Act defines fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes". The essential components of fish habitat include food, cover, spawning habitat and access for migration. Fish require all four components, in adequate amounts, to survive and reproduce, as well as good water quality (Stoneman et al., DFO, 1997).

Section 35 is the primary section pertaining to the protection of fish habitat and states that "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat." Subsection 35(2) qualifies that prohibition by stating that "no person contravenes Subsection 35(1) by causing the alteration, disruption or destruction of fish habitat by any means or under any condition unless authorized by the minister or under regulations made by the governor of council under this Act."

1.4.2 PROVINCIAL LEVEL

Guiding documents for fisheries management include the Strategic Plan for Ontario Fisheries (SPOF II) and the Maple District Fisheries Management Plan 1989-2000. SPOF II consists of four parts and provides a basis for actions involving the public and private sectors (Table 2).

Table 2. Outline of SPOF II.

Goal for Ontario Fisheries	To have "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"	
Objectives	To protect healthy aquatic ecosystems	
	To rehabilitate degraded aquatic ecosystems	
	To improve cultural, social and economic benefits from Ontario's fisheries resource	
Guiding Principles	Sustainable development	Knowledge
	Limit to resource	Societal benefits
	Natural reproduction	
Strategic Management Actions	Protect and rehabilitate aquatic ecosystems	Improve program management and co-ordination
	Involve the public in decision making	Acquire and communicate knowledge
	Ensure resources are appropriately valued	Enforce firmly and effectively

The Maple District Fisheries Management Plan 1989-2000 (MDFMP) covers a large area, encompassing many different watersheds, and is used to identify strategies and tactics to confront broad issues in the management of fisheries resources. Where possible, broad management objectives for individual watersheds are also identified. District fisheries management plans provide a framework to address broad issues in fisheries management, but generally lack the detail needed to direct management at a watershed, subwatershed or reach level.

Oak Ridges Moraine Conservation Plan

This Plan provides policies to govern specific land uses on the Oak Ridges Moraine and is intended to protect the moraine and its ecological functions and to ensure a continuous natural environment for future generations, while providing compatible social and economic opportunities. The Oak Ridges Moraine Conservation Act (2001) directs municipalities to bring their official plans into conformity with the Plan and to ensure that the decisions they make on development applications conform with the Plan. As such, the Plan will be implemented mainly at the municipal level, however, where municipal official plans or zoning bylaws conflict with the provincial policy, the provincial policy will prevail. Within the ORMCP, watercourses are included in the Hydrologically Sensitive Features category, and receive a minimum vegetation protection zone of 30 m from any part of the feature. Fish habitat is included in the Key Natural Heritage Features category, also receiving a minimum vegetation protection zone of 30 m from any part of the feature.

1.4.3 MUNICIPAL LEVEL

At the municipal level, fish habitat receives protection indirectly through Official Plan designation of Green Space or Open Space and through development setbacks. Municipalities also work closely with their local conservation authorities, through watershed planning, the development of watershed level fisheries management plans, the plan review process and through support of authority policies and programs.

Conservation authorities have indirect responsibility to participate in fisheries management through the conservation authorities Act, particularly Ontario Regulation 158. This regulation requires a permit from the conservation authority prior to various works taking place (e.g. altering a watercourse, constructing any building in the floodplain or placing fill in a regulated area).

TRCA's Valley and Stream Corridor Management Program (1994) contains another indirect component for fish habitat management by identifying valley and stream corridor boundaries so that they can be appropriately identified in municipal planning documents and zoned in Open Space categories. The program defines a valley and stream corridor as follows:

Stream Corridors

- 10 metres inland from the Regulatory Flood Plain; or
- if the watercourse has a drainage area of less than 125 hectares, 10 metres from the predicted meander belt of the watercourse, expanded as required to convey the major system flows and/or maintain riparian stream functions.

Valley Corridors

- a minimum of 10 metres inland from the stable top of the valley bank;
- if the valley slope is not stable, a minimum of 10 metres inland from the predicted long-term stable slope projected from the existing stable/stabilized toe (base) of the slope, or from the predicted location of the toe of slope as shifted as a result of stream erosion over a 100-year period.

For either feature, where a significant area as defined by the Valley and Stream Corridor Management Program is within and/or immediately adjacent to a valley or stream corridor, the corridor boundary is extended to include the significant area and a minimum 10 metre buffer inland.

TRCA's Terrestrial Natural Heritage System Strategy

The TNHS Strategy is a tool that can play a key role in identifying the lands that should be protected and restored to natural cover in order to enhance biodiversity and improve natural system functions. It uses a science-based analytical tool, based on sound ecological criteria, to identify an expanded and targeted land base for inclusion in a terrestrial natural heritage system.

The terrestrial natural system was designed for the entire TRCA jurisdiction because terrestrial systems and their interactions span watershed boundaries. The target system relates to the terrestrial component of the natural heritage system. Although increases in natural cover would benefit many other system components, such as promoting a more natural water budget, the target terrestrial natural heritage system was designed using terrestrial ecological criteria.

The watershed planning process will serve as the main vehicle for developing a more comprehensive approach to natural heritage system design and management. At the watershed or subwatershed level of detail, integration of other natural heritage elements, including aquatic and hydrologic components, can be addressed. The target terrestrial natural heritage system can best be refined at the watershed and subwatershed planning scale by identifying areas beyond the terrestrial focus where protection and restoration would benefit comprehensive and sustainable watershed management.

The modeling carried out in the integrated watershed planning process allows TRCA to develop alternative land use scenarios, and recommend a preferred scenario based on a range of environmental indicators. The models (such as the water budget models) can estimate the benefits of natural cover, in terms of providing hydrological functions, preventing erosion, improving water quality, and enhancing recreation and quality of life, as well as enhancing biodiversity. For example, predictions can be made on how increases in terrestrial natural cover change groundwater levels and stream base flow, which in turn alter aquatic community composition within certain stream reaches.

The Terrestrial Natural Heritage System Strategy considers all the natural cover in a region (all forest, wetland and native meadow) as one "organism" functioning in the landscape rather than as a collection of individual sites, some of which may be "significant".

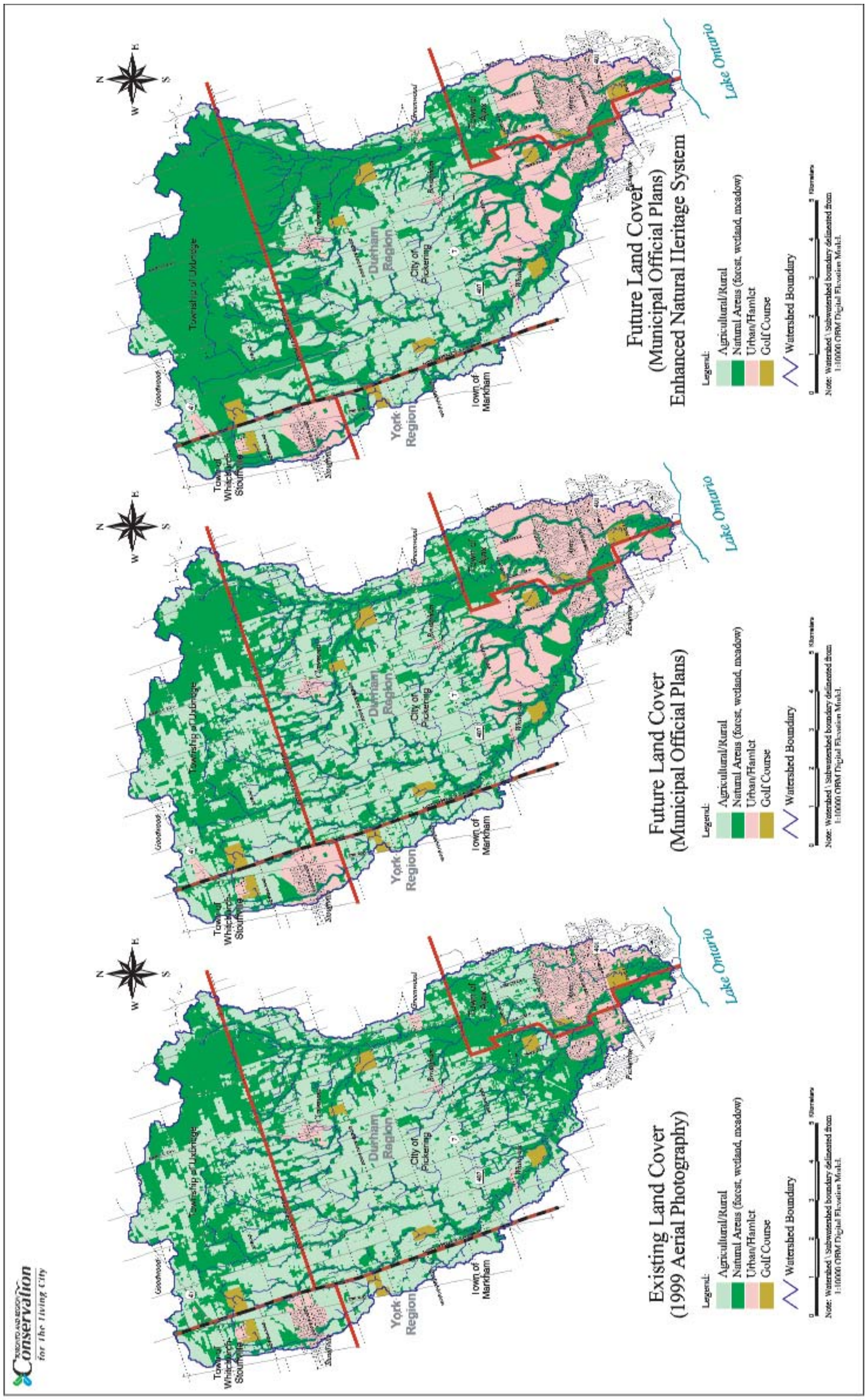
The approach uses the criteria of:

- **quantity**: the per cent of natural cover in a region;
- **quality**: the average habitat patch size, shape and matrix influence; and,
- **distribution**: the distribution of that quantity and quality of natural cover.

The most important characteristic of a habitat patch for biodiversity is its size, which relates to the amount of space required for a species to find resources and remain in viable populations. The second factor is matrix influence, which is a measure of the positive or negative influence that a patch receives from its surroundings.

The Terrestrial Natural Heritage System Strategy has set a goal of at least 49 per cent natural cover in Duffins watershed and at least 30 per cent natural cover in the Carruthers Creek watershed (TRCA, 2003). The Watershed Plan for the Duffins and Carruthers Creeks concluded that modeling for full implementation of the target terrestrial natural heritage system resulted in reductions to peak (flood) flows of up to and including 25 per cent for the 100-year storm (TRCA, 2003). Figures 1 and 2 show the three scenarios used in the development of the watershed plan.

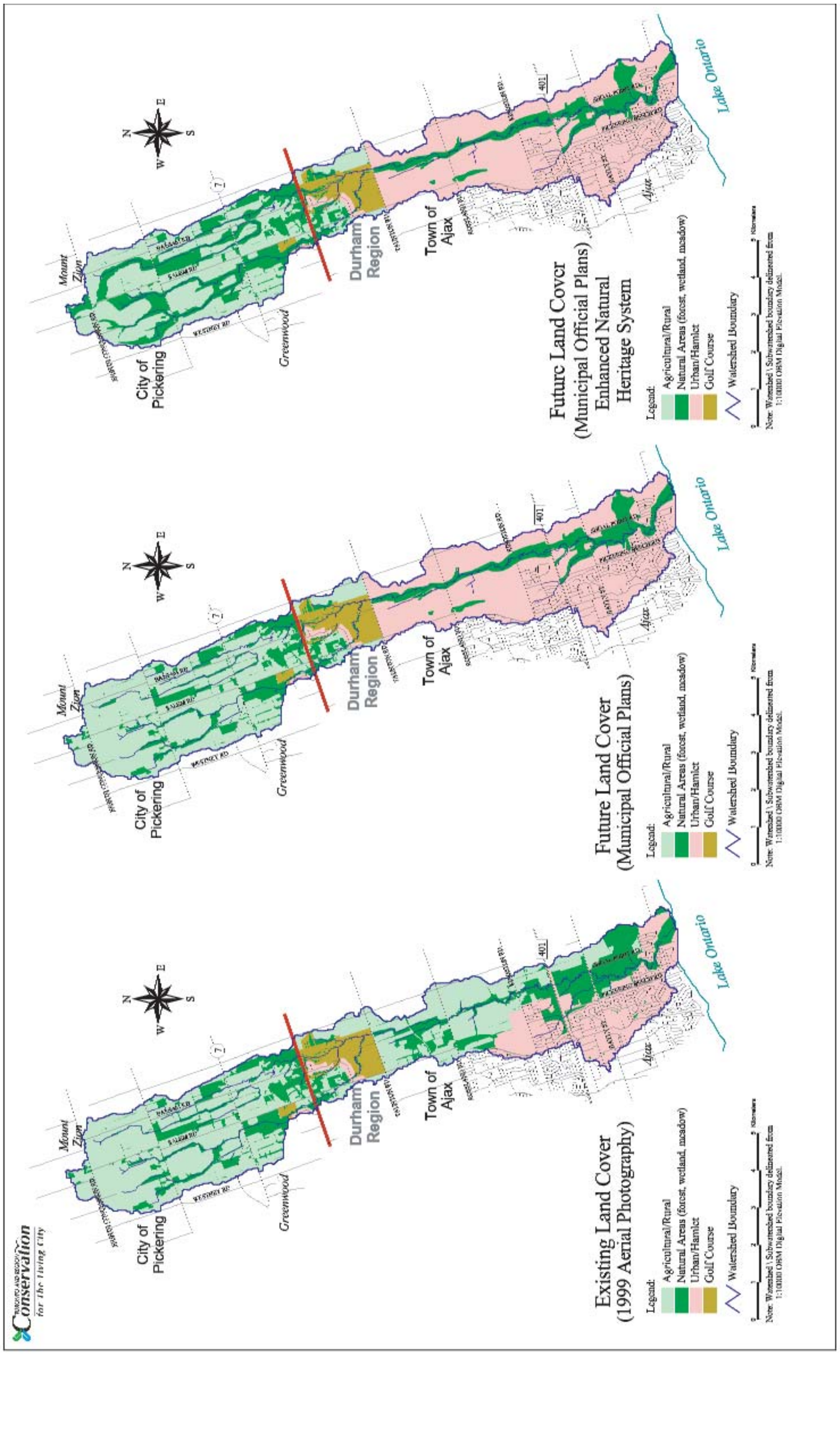
Figure1. Duffins Creek Watershed - Land Cover.



Note: The urban lands outlined in the second and third maps were evaluated as part of the modeling exercise and do not represent the Pickering urban boundary as outlined in the Durham Region and City of Pickering's official plans. The actual urban boundary extends north to Highway 7.

The "Enhanced"Natural Heritage System, as depicted in the third map, is a concept only. It illustrates the benefits of an increase in natural cover. It does not define the exact locations for the increase or limit the increase in natural cover to those areas identified in dark green.

Figure2. Carruthers Creek Watershed - Land Cover.



Note: The urban lands outlined in the second and third maps were evaluated as part of the modeling exercise and do not represent the Ajax and Pickering urban boundary as outlined in the official plans

The "Enhanced"Natural Heritage System, as depicted in the third map, is a concept only. It illustrates the benefits of an increase in natural cover. It does not define the exact locations for the increase or limit the increase in natural cover to those areas identified in dark green.

A Watershed Plan for Duffins Creek and Carruthers Creek

The Fisheries Management Plan is a companion document to the Watershed Plan for Duffins Creek and Carruthers Creek and it's associated background reports (Appendix A), and uses the principles developed in the Plan to guide management direction.

As part of the development of this Plan, seven general principles were developed to guide future management. They are as follows:

- Aquatic habitats should be accessible and healthy enough to support self-sustaining aquatic communities;
- Self-sustaining aquatic communities, not stocking, is the priority;
- The protection and enhancement of native aquatic communities are of first importance. Where exotic species are present and desirable, they should be managed for but not at the expense of native aquatic communities;
- The components of the natural cycle of water should be maintained or enhanced;
- A continuous band of woody and herbaceous vegetation in the riparian zone and it's associated functions should be protected and/or restored;
- All barriers to the passage of desirable species should be mitigated while those necessary for fisheries management should be maintained;
- The preferred mitigation technique for on?line ponds is removal. If removal is not an option, bypass or conversion to bottom-draw are alternatives;

The watershed plan also lists 10 integral management actions that provide focus and a guide for future implementation of protection and restoration initiatives. It is from these management actions that many of the implementation priorities put forward in this Plan were developed. The remainder of this Plan details the biophysical characteristics of the Duffins and Carruthers watersheds, followed by recommended management actions to protect and restore fish and aquatic habitat..

C H A P T E R

2

2.0 BIOPHYSICAL CHARACTERISTICS

The 283 km^2 Duffins Creek watershed is located on the north shore of Lake Ontario, at the eastern end of the TRCA's jurisdiction and contains 373 kilometres of watercourses (Figure 3). It covers the regional municipalities of York and Durham and the local municipalities of the towns of Whitchurch-Stouffville, Markham, and Ajax, the Township of Uxbridge, and the City of Pickering. Arising on the Oak Ridges Moraine, the creek flows south over the Halton Till Plain, the Lake Iroquois shoreline and the Lake Iroquois Plain, with a small portion of the West Duffins Creek flowing over a glacial lake (Figure 4). This physiographic diversity creates cold-water habitats in the upper to mid-reaches and a mix of cold, cool and warm-water habitats in the lower reaches.

Carruthers Creek, located directly to the east of the Duffins Creek watershed, originates near Mount Zion on the Halton Till Plain and flows south over the shoreline of the glacial Lake Iroquois and the Lake Iroquois Plain (Figure 4). The watershed drains approximately 38 km^2 and contains approximately 61 kilometres of watercourses. The Regional Municipality of Durham encompasses the entire watershed, with the local municipalities made up of the City of Pickering and the Town of Ajax.

Further information on the physiography and geology of the watersheds is available in the State of the Watershed Reports (TRCA, 2002; TRCAb, 2002) and Gerber (2003).

Due to its size, Carruthers Creek was not subdivided into smaller management units. It was necessary, however, to subdivide Duffins Creek into smaller management units to facilitate local stakeholder involvement and implementation. The larger subwatersheds, West Duffins Creek and East Duffins Creek, were further subdivided into sub-basins (Table 3 and Figure 5).

Table 3. Subwatersheds and sub-basins of the Duffins Creek watershed

Subwatersheds	Sub-Basins	
West Duffins Creek	West Duffins Creek	major creek
	Stouffville Creek	un-named creek
	Reesor Creek	Whitevale Creek
	Wixon Creek	
East Duffins Creek	East Duffins Creek	Brougham Creek
	Spring Creek	Mitchell Creek
Urfe Creek		
Ganatsekiagon Creek		
Miller's Creek		
Lower Duffins Creek		

Figure 3. Duffins and Carruthers Creek Watersheds in a Regional Context.

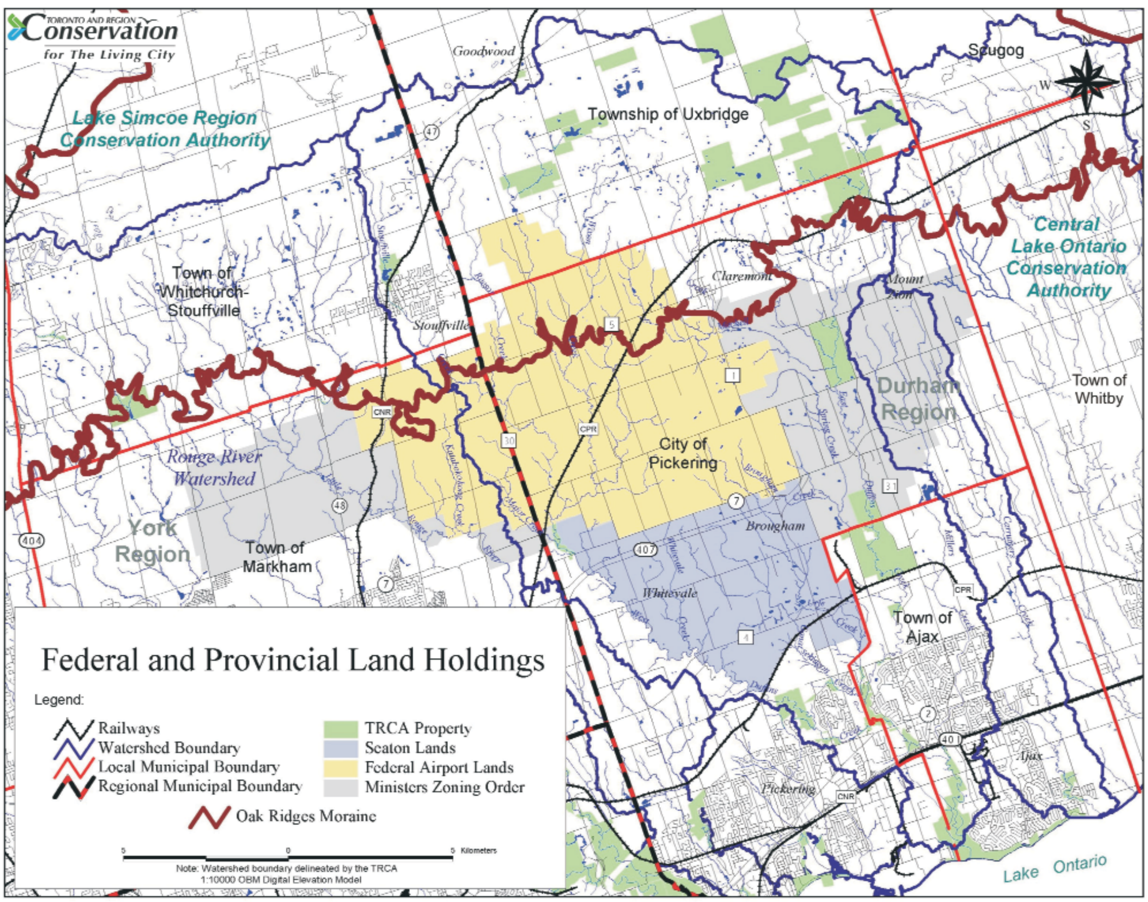


Figure 4. Physiography of the Duffins and Carruthers Creek Watersheds.

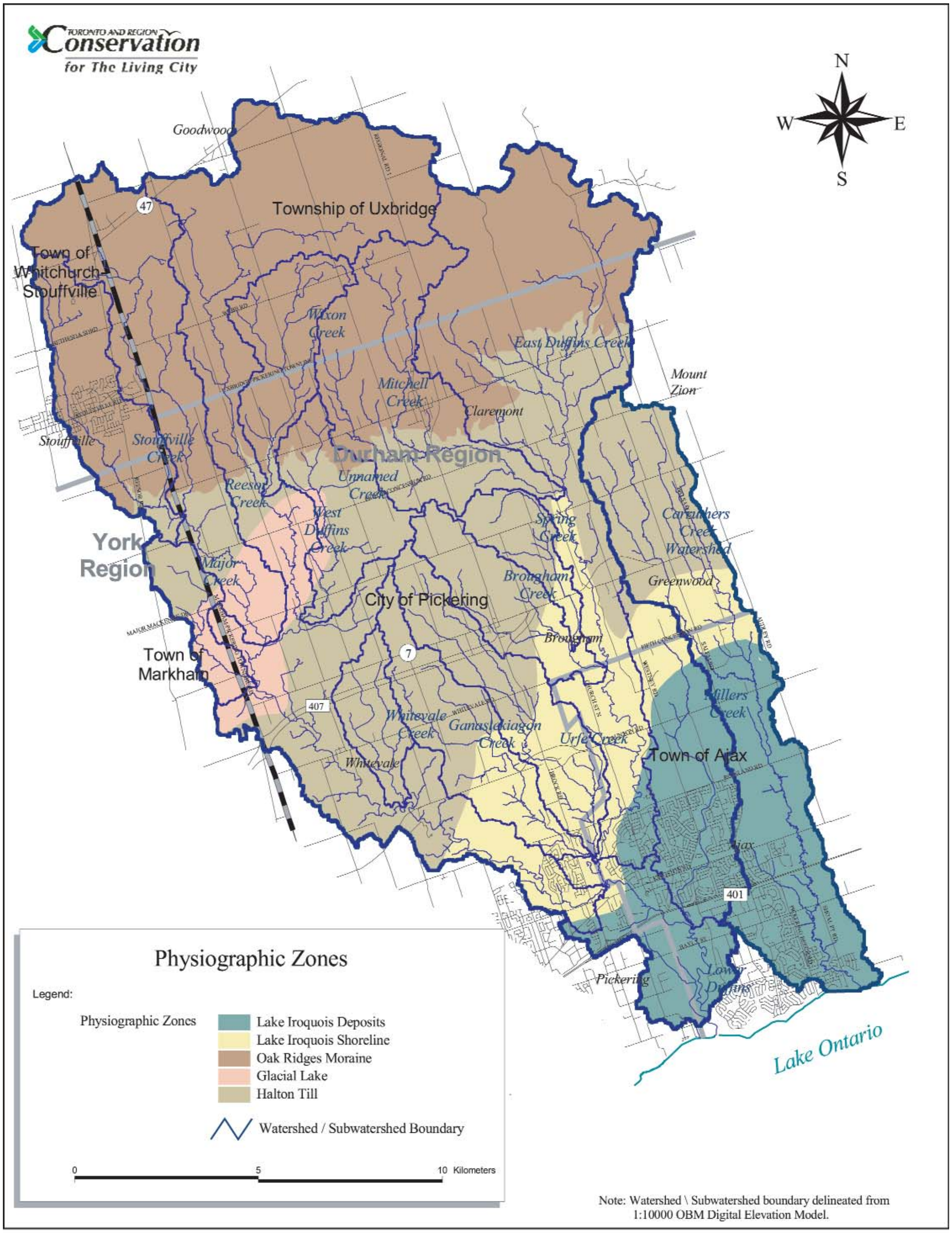
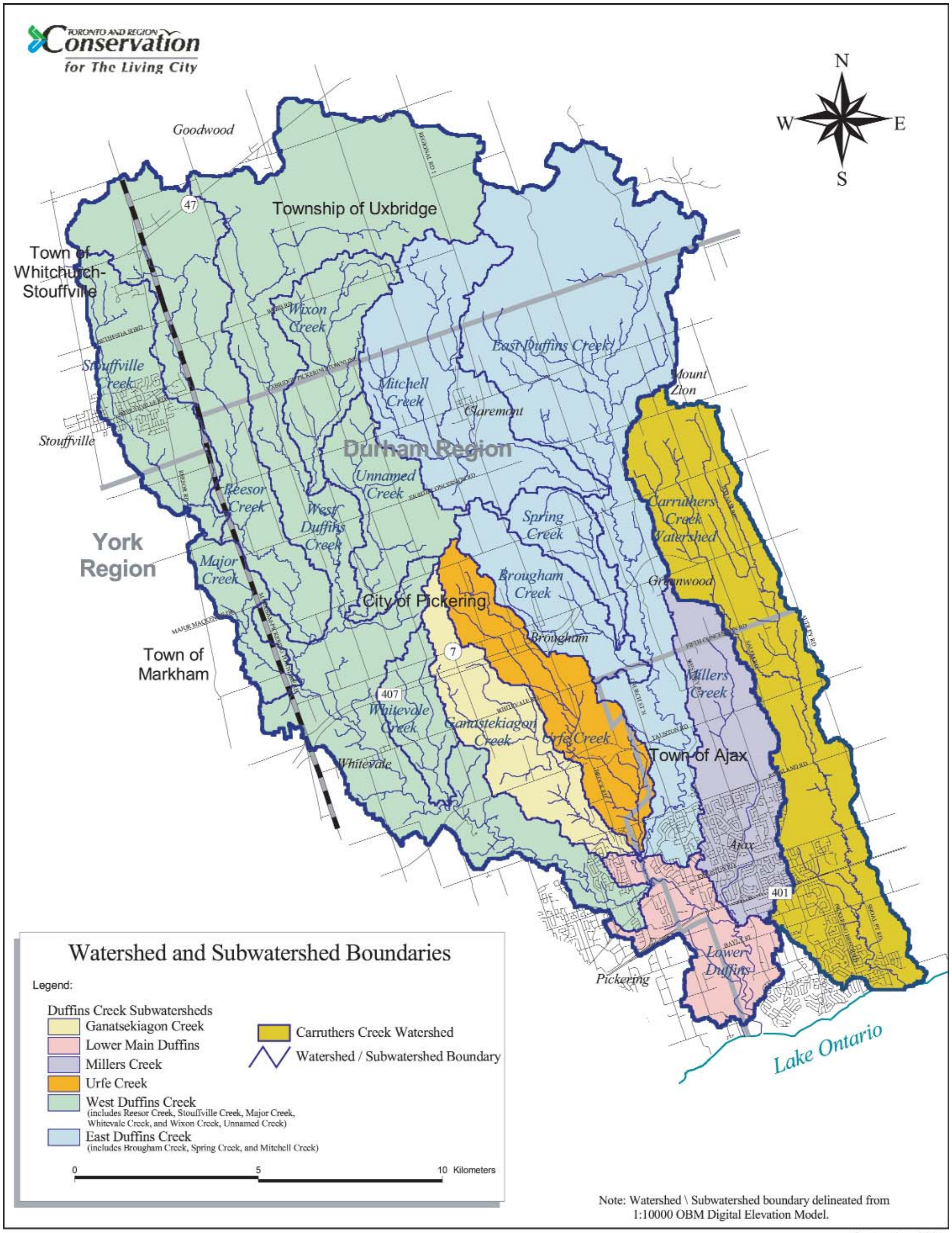


Figure 5. Subwatersheds of the Duffins and Carruthers Creek Watersheds.



In 1999, land cover in the Duffins Creek watershed was 54 per cent agricultural, 37 per cent natural (including forest, meadow and wetland), 2 per cent golf course and 7 per cent urban (Figure 6). Common to most watersheds in southern Ontario, urbanization is concentrated in the lower reaches of the watershed. Future growth in the watershed is expected to occur on the federal airport, Seaton Lands and Stouffville, as well as through urban intensification in the southern portions of the watershed.

Land cover in the Carruthers Creek watershed is predominantly rural with agriculture dominating the landscape. In 1999, approximately 49 per cent of the watershed was agricultural, 17 per cent was urbanized, 5 per cent was golf course and 29 per cent was natural cover, composed of forest, wetland and meadow (Figure 6). For more information on land use and planning projections, refer to the State of the Watershed Reports for Duffins Creek and Carruthers Creek (TRCA, 2002; TRCAb, 2002), as well as local and regional Official Plans.

2.1 AQUATIC HABITAT

Three broad aquatic habitat types are found in the Duffins and Carruthers creeks watersheds and include:

- Riverine Habitat – found in fast-moving water, such as rivers/streams.
- Lacustrine Habitat – found in slow-moving water, such as ponds and lakes.
- Wetland Habitat – found in marsh or swamp habitats.

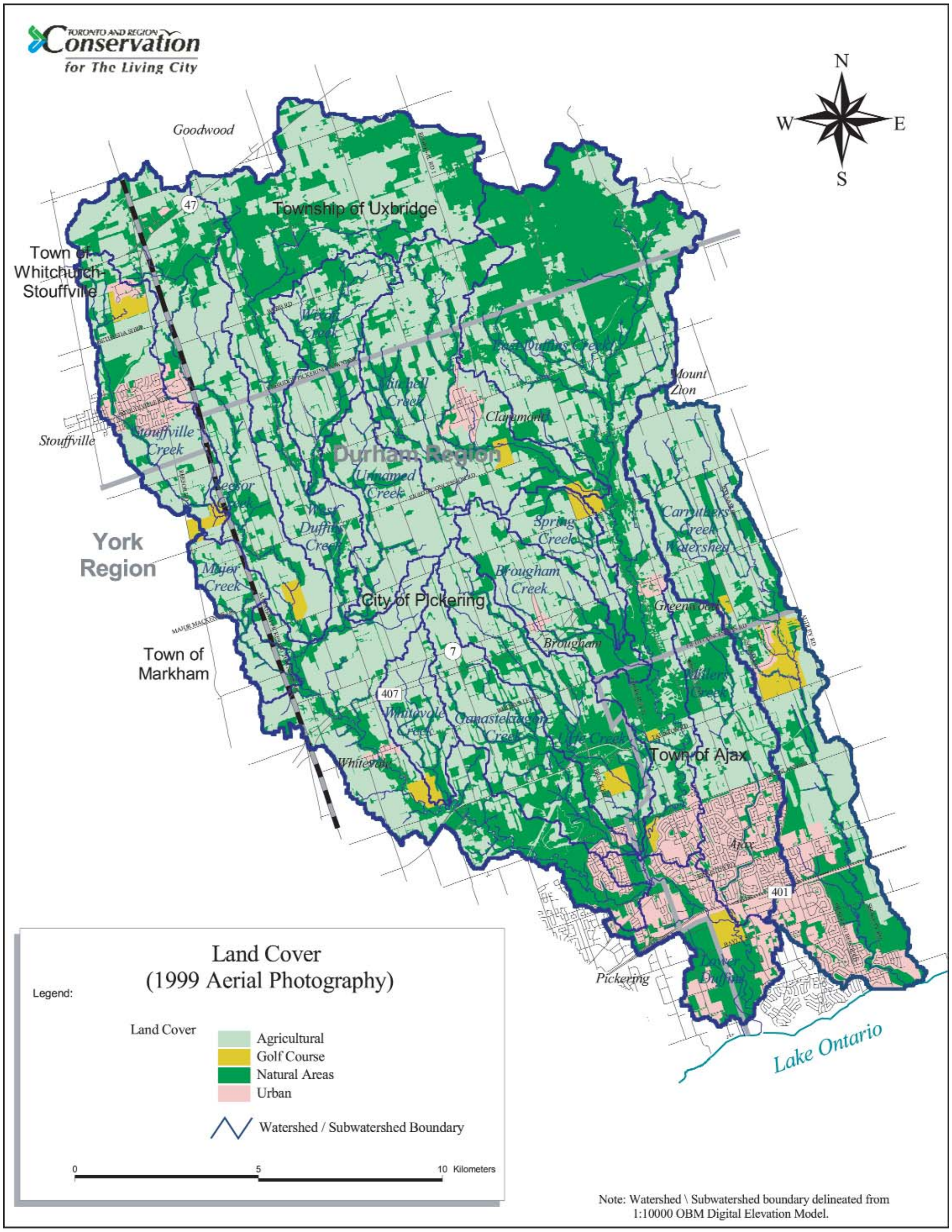
2.1.1 RIVERINE HABITAT

Riverine habitat is the most common habitat type in both watersheds, covering a total length of 370 km in Duffins Creek and 59 km in Carruthers Creek. Factors influencing riverine habitat include stream order, slope, substrate, stream morphology, flow regime, ground water and baseflow, water quality, presence of instream barriers, and riparian vegetation. These characteristics will be discussed in the following sections to identify the existing conditions of riverine habitat in the Duffins and Carruthers watersheds.

Stream Order

The use of stream order was first proposed by Strahler (1964) and is a common method of dividing a watershed into similar components according to stream size and function. A first order watercourse is a single, unbranched tributary. Where two first order watercourses meet, they form a second order stream. When two second order streams join, they form a third order watercourse and so on. In general, the higher the order, the larger the stream or river, and the bigger the drainage area. Small headwater streams, generally orders one through three, share many general characteristics. Aquatic life in these streams is highly dependent upon vegetative cover for stream temperature moderation and the input of organic matter for production. Stream gradient and erosion potential, are also generally greater in headwater steams. As stream order increases, there is greater in-stream productivity and there is a transition from a stream dominated by terrestrial primary productivity to one dominated by aquatic primary productivity. It is generally understood that both species diversity and habitat diversity increase with drainage area (Vannote et al.,1980). For more information, refer to the geomorphology sections in Chapter 5 of A Watershed Plan for Duffins Creek and Carruthers Creek (TRCA, 2003).

Figure 6. 1999 Land Cover.



Determining stream order is entirely dependent upon the scale of map being used. The determination of stream order for this report was completed using TRCA's hydrologically-corrected Digital Elevation Model (DEM) based on Ontario Base Map (OBM) data at a scale of 1:10,000. At its mouth, Duffins Creek is a sixth order stream and Carruthers Creek is a fourth order stream (Figure 7). The percentage of each order watercourse is shown in Table 4.

Table 4. Stream order lengths and percentages in the Duffins and Carruthers creeks watersheds.

Stream Order	Duffins Creek		Carruthers Creek	
	Total Stream Length (km)	*Per cent of Stream Length	Total Stream Length (km)	*Per cent of Stream Length
First	157	41.6	19.3	31
Second	85.9	22.6	13.3	21.2
Third	72.8	19.3	14.2	22.8
Fourth	33.2	8.8	15.6	25
Fifth	20.7	5.5	N/A	N/A
Sixth	8.2	2.2	N/A	N/A
TOTAL	377.8	100	62.4	100

** Some of the length of sixth order watercourses in the coastal marsh are not included in this calculation. The total length of sixth order watercourse is, therefore, slightly larger than that shown here.*

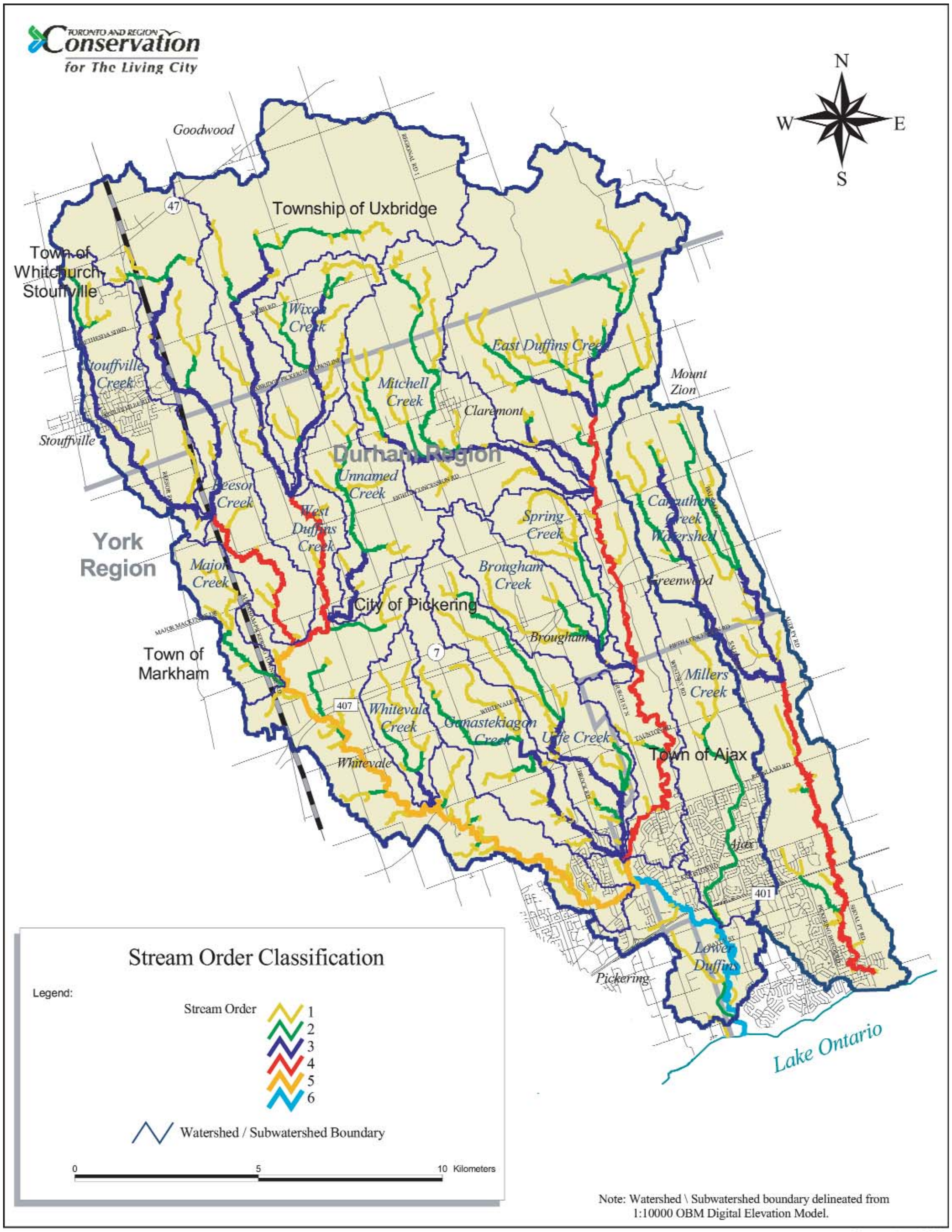
Slope/Substrate/Morphology

Stream slope or gradient influences the rate of erosion and deposition of substrate. Watercourses with steep slopes are typically straighter and have a higher ratio of riffles to pools than streams with low slope. They also tend to have higher erosion potential due to increased water velocities and tend to be erosional rather than depositional. Watercourses with steeper slopes typically contain larger materials like cobbles and boulders, whereas, lower-sloped streams have lower stream velocities which allow suspended sediments to fall out of suspension, resulting in the accumulation of fine materials like sand and silt. Table 5 outlines general stream characteristics found at a range of stream slopes.

Table 5. Stream morphology and substrate at a range of stream slopes.

Slope (%)	Characteristics	Substrate
< 0.3	low gradient; typically sinuous; greater pool-to-riffle ratio	sands and silts
0.31 - 1	relatively sinuous; more or less even pool-to-riffle ratio	gravels and cobbles
1.01 - 5	riffles out-number pools; higher water velocities; less sinuous	large gravels, cobbles and boulders
> 5	riffles predominate; water velocities and erosional forces high; typically straight stream channel	boulders, cobble and hard clay

Figure 7. Stream Order



Stream slope is influenced, in part, by the bed material over which the stream flows. The presence of a layer of hard material such as clay or bedrock, or large material, such as boulders can act to hold the stream bed in position both laterally and vertically. Stream reaches with bed material of clay or bedrock do not erode as readily as less cohesive materials such as sand. In transitional areas between hard and soft bed materials, a notable change in gradient usually occurs. Groundwater discharge often occurs in these transitional areas, where stream down- cutting intercepts the lateral flow of groundwater. The location of cold-water fish communities have also been correlated with sudden gradient changes. Beak Consultants Ltd. (1991) found a strong positive correlation between reach gradient and abundance of cold-water fish communities in the Duffins Creek watershed.

There are two areas in the Duffins Creek watershed where these transitional areas are evident. The first is located in the Uxbridge/Pickering Townline area along the flank of the Oak Ridges Moraine. The second area occurs in the vicinity of Highway 7 on the Lake Iroquois shoreline. Three prominent gradient changes are evident in the Carruthers Creek watershed; the first in the area of Highway 7, the second in the vicinity of the Ajax/Pickering Townline, and the third at Highway 2.

Stream slope in the Duffins Creek watershed ranges between 0 and 1.5 per cent (Figure 8), while in the Carruthers Creek watershed, stream slope ranges between 0 and 2 per cent (Figure 9).

Flow Regime

Once precipitation falls to the ground, it will either evaporate, run-off or infiltrate through the soil. The rate and amount of water that follows each pathway depends upon factors like soil type, topography, land use, soil moisture and precipitation intensity and duration. Typically, as natural areas become developed, the rate and amount of surface run-off to watercourses increases and infiltration decreases. Storm events raise the water level in watercourses more rapidly, more often and to higher levels than under pre-development conditions. As natural areas become developed, watercourses may also experience lower flows during dry periods or may dry up completely due to reduced groundwater inputs.

Critical components of flow include timing, duration, magnitude, frequency, and rate of change. Together, these components constitute the flow regime or hydrological regime. Water temperature, dissolved oxygen concentrations, suspended sediment loads, nutrient availability, and physical habitat structure all vary with hydrological regime (Richter et al. 1997) and as such, aquatic communities are vulnerable to changes in the flow regime. Poff et al. (1997) refers to flow as the master variable limiting the distribution of riverine species.

Alteration to the natural flow regime is typically caused by such factors as the creation of dams, surface water diversions for irrigation, stream channelization, groundwater extraction, deforestation, agriculture and urbanization (Poff et al. 1997). Given that aquatic communities are defined largely by their hydrology, alteration of flow regimes by human activities is a grave concern (Saunders et al., 2001).

Figure 8. Stream Slope for the Duffins Creek Watershed (Beak, 1991).

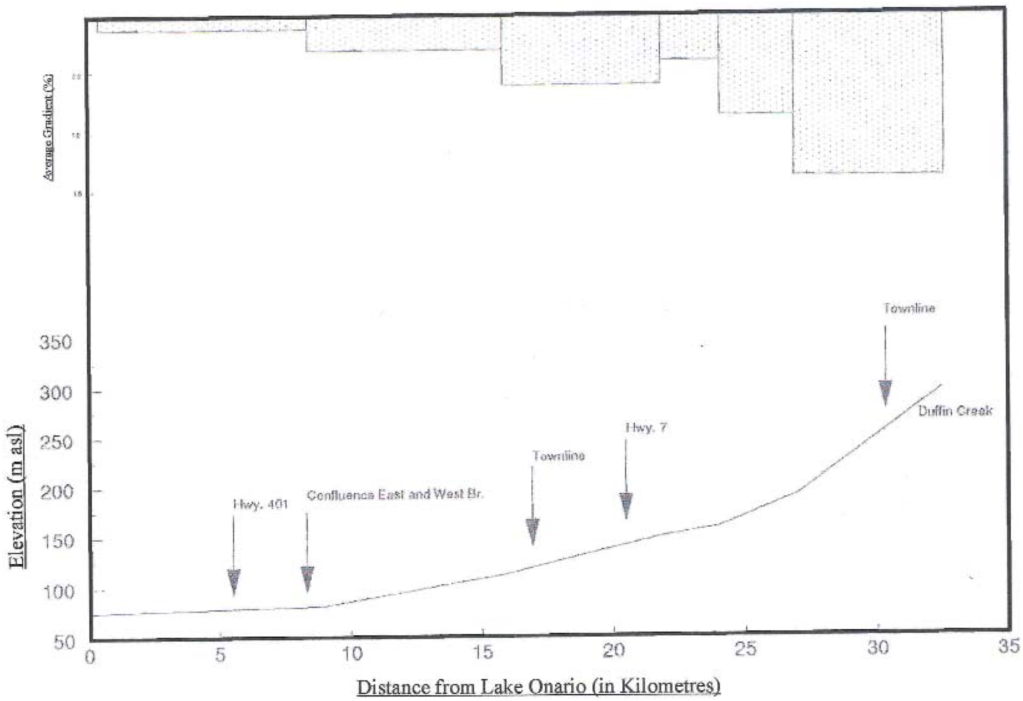
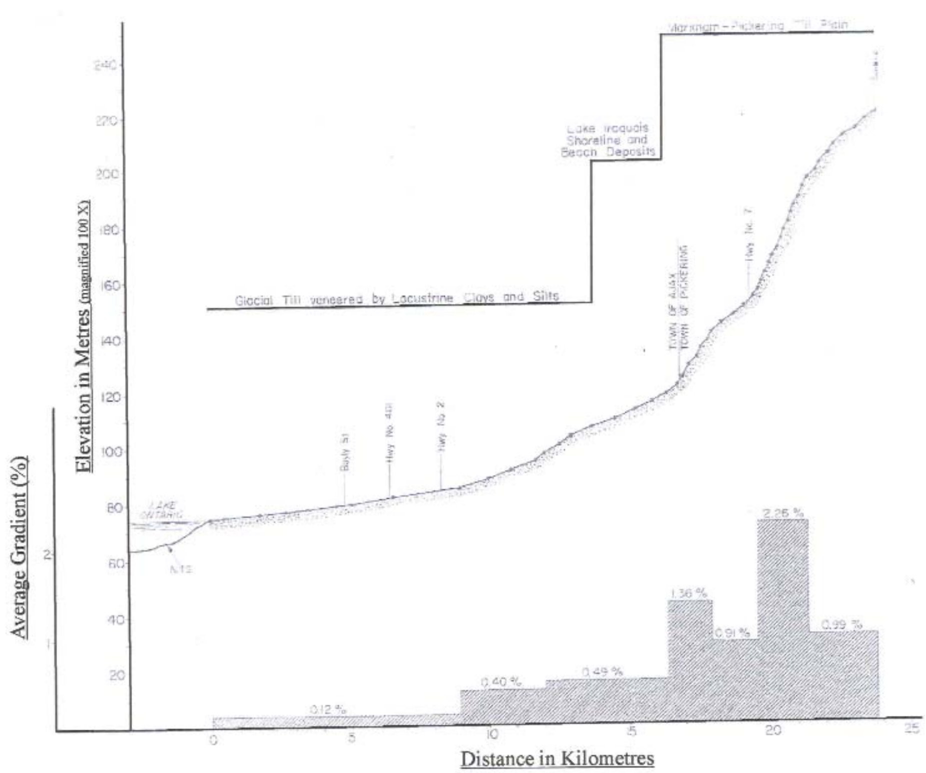


Figure 9. Stream Slope for the Carruthers Creek Watershed (Beak, 1991).



Extensive stream flow data has been collected over the years from stations in the Duffins Creek watershed. Analysis of this data shows that Duffins Creek displays the typical hydrology of an undeveloped watershed, with annual peak flows occurring in the spring (Figure 10). This is due in part to the limited level of urbanization and the extensive natural cover that currently exists. In comparison, a hydrograph illustrating annual peak flows in a more urbanized watershed such as the Highland Creek shows many more peaks throughout the year due to a higher level of imperviousness, which reduces the time period between rainfall reaching the ground and entering the streams. Higher levels of imperviousness also reduce groundwater infiltration and increase the rate of overland flow into streams.

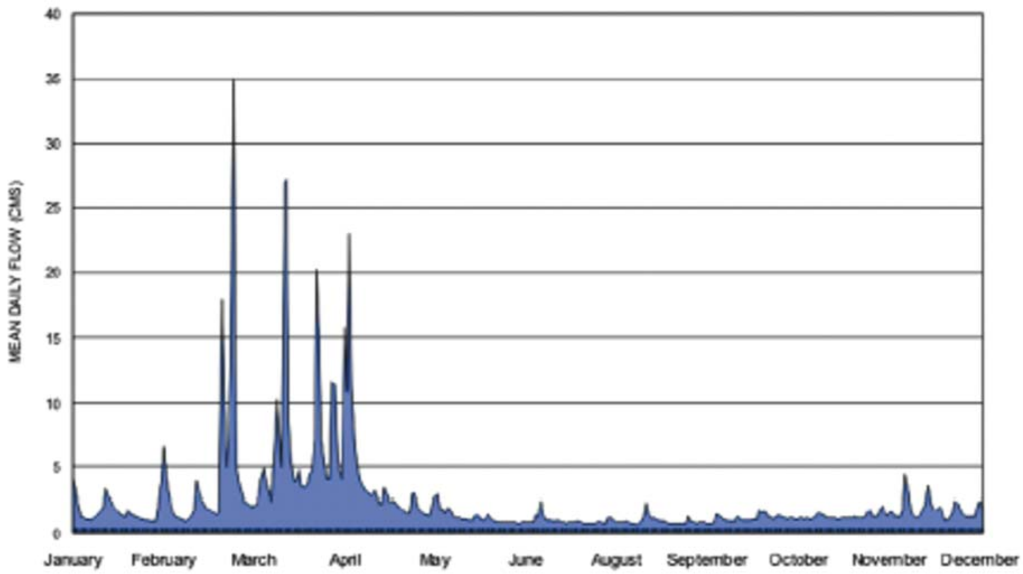


Figure 10. Flow Data From the Duffins Creek Gauging Station at Pickering.

Groundwater and Baseflow

Groundwater is defined as subsurface flow that occurs in fully saturated soils and geologic formations (Freeze and Cherry, 1979). Where these saturated soils or geologic formations intersect the surface, groundwater discharge occurs. Groundwater discharge to a stream forms baseflow and is critical for maintaining water flows, especially during the drier summer months. In the Greater Toronto Area, groundwater temperatures are in the range of 8 - 100C. The more groundwater discharge to a stream, the lower and more stable are water temperatures, which is important to temperature sensitive species like brook trout. Groundwater discharge is also very important for brook trout spawning since they often spawn directly over locations of groundwater discharge. Bowlby and Roff (1986) found that groundwater discharge is one of the major characteristics determining the presence of cold-water fish communities. More information specific to the hydrogeology of the Duffins and Carruthers watersheds can be found in Gerber (2003).

Habitat Suitability Indices developed in the United States utilize annual baseflow as a per cent of average annual daily flow to determine habitat suitability for certain trout species (Raleigh 1982, Raleigh et al., 1984; Raleigh et al., 1986). This ratio is useful in determining flow fluctuations, and provides an indication of flow stability and suggests that the higher the ratio, the more stable the flow and the more likely the habitat will be suitable for sensitive cold-water species. In terms of trout production, ratios greater than 50 per cent are excellent, those between 25 - 50 per cent are good, and ratios less than 25 per cent are poor. Previous Fisheries Management Plans have assessed this ratio to be in the order of 23.5 per cent, 37 per cent, and 25.6 per cent for the West, East and Lower Duffins Creek subwatersheds, respectively (TRCA and OMNR, 1998).

Modeling completed in support of the watershed plan suggests that in areas where urban expansion has been approved, such as Stouffville and Ganatsekiagon Creeks and the lower portions of Urfe, East Duffins and West Duffins Creeks, that the ratio of baseflow to total annual flow may be reduced by up to almost 30 per cent (TRCA, 2003).

In 2000, the TRCA initiated the Low Flow Management Program. This program is aimed at gaining an improved understanding of the connections between surface water and groundwater systems, through the measurement and mapping of the quantity and distribution of baseflows from data obtained at 93 locations in Duffins Creek and 19 in Carruthers Creek. The data collected for this program was used to supplement the development of groundwater and water budget models. One of the mapping products from this program shows estimated baseflow gains and losses on a reach basis (Figures 11 and 12). The assessment of baseflow for the Duffins Creek system suggests that 57 per cent of the total baseflow comes from the East Duffins Creek subwatershed, 38% from the West Creek Duffins subwatershed, and Urfe, Ganatsekiagon, and Miller's Creek subwatersheds contribute 1 per cent, 2 per cent and 2 per cent, respectively. While the amount contributed by the Urfe and Ganatsekiagon creeks seems small, these subwatersheds obtain approximately 50 - 60 per cent of their groundwater from within their drainage areas.

It is important to note that while the upper west branch of Carruthers Creek has been identified to be a source of baseflow, it may also be intermittent. Cold-water habitat in the recharge area north of the 5th Concession Road often dries up by mid August as water soaks into the ground.

The Duffins/Carruthers Low Flow Management Report (TRCA, 2003) provides details on water taking permits in both watersheds. In Duffins Creek, there are 10 active Permits To Take Water (PTTW), all located in the West Duffins Creek subwatershed and Stouffville Creek. Currently, the West Duffins Creek is the only known area in the watershed where active PTTW may be having an impact on the aquatic system. The only significant surface water taking in Carruthers Creek is located below the Lake Iroquois shoreline, where a large portion of the overall system baseflow occurs. While this water taking also collects more than baseflow, the impacts to the aquatic system resulting from this water taking could impact the aquatic system. Efforts are underway to deal with these concerns with the co-operation of the water taker.

It is also likely that there are numerous locations in both watersheds where water is being taken without a permit. This adds to the challenge of estimating the overall amount of water being withdrawn from the watercourse which is potentially negatively impacting the aquatic ecosystem.

Figure 11. Creek Subwatershed Baseflow Contributions. Data came from Geologic Survey of Canada, 1995.

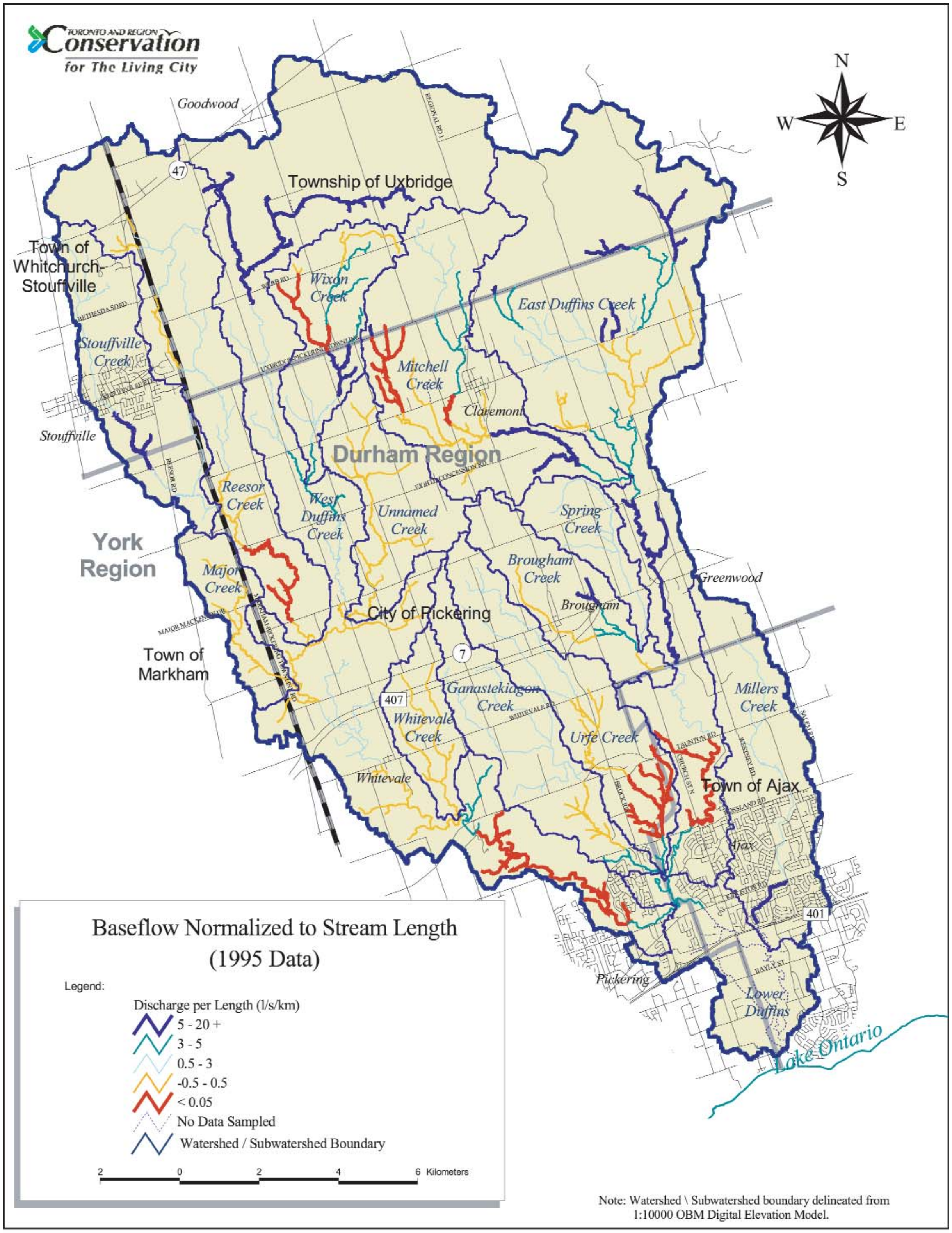
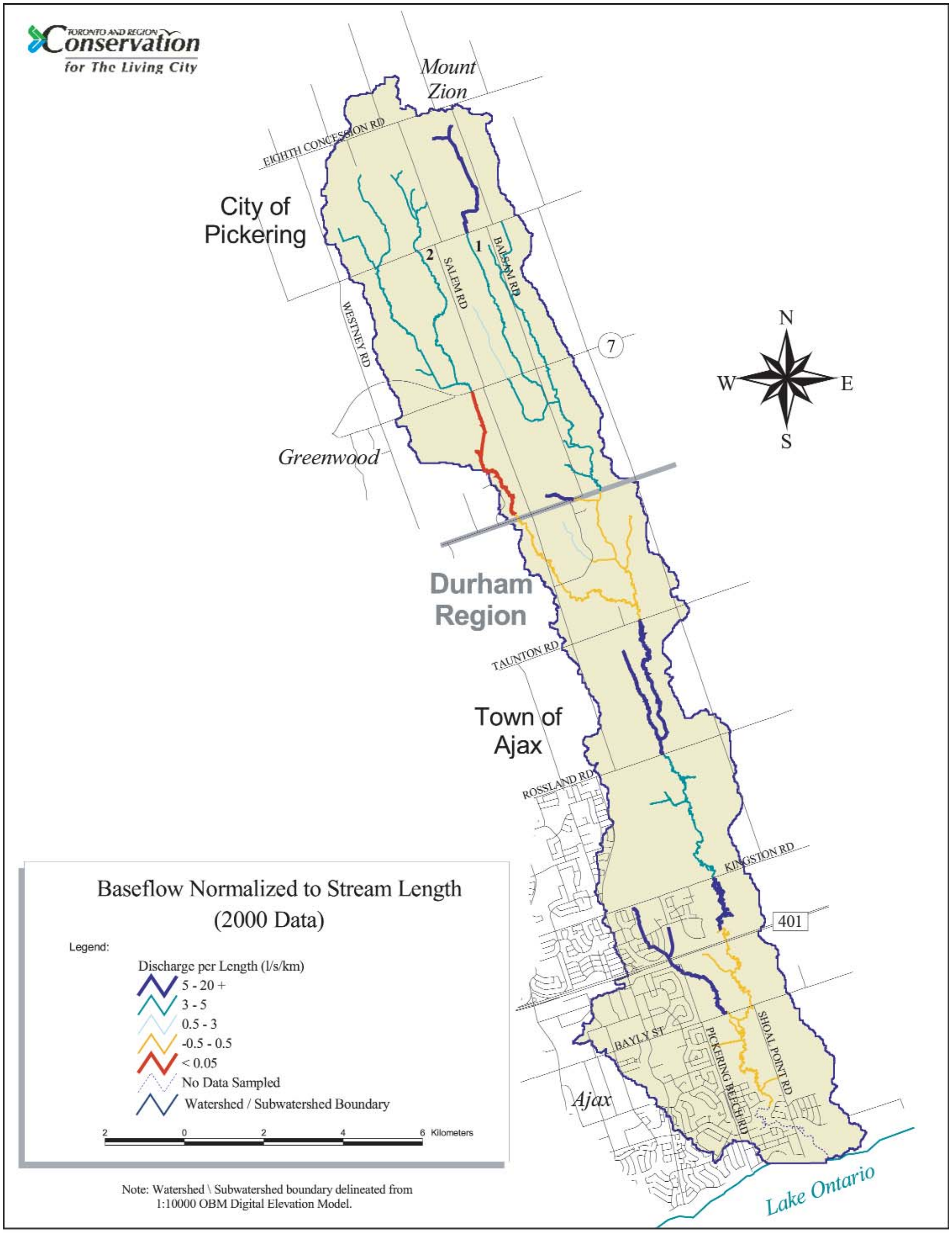


Figure 12. Carruthers Creek Baseflow Contributions.



Further information on groundwater and baseflow can be found in Duffins Creek State of the Watershed Report (TRCA, 2002) and Carruthers Creek State of the Watershed Report (TRCA, 2002) and Gerber (2003).

Water Quality

The quality of surface water is influenced by land use activities, which have the potential to increase the availability of pollutants and/or by generating new pathways for pollutants to enter receiving waters.

Pollutants typically reach receiving waters via one of three routes: overland run-off, atmospheric deposition or direct discharge (ie. through stormwater outfalls, drainage ditches or agricultural tile drains). The first two methods are non?point sources of pollution, while the latter is an example of point source pollution. In urban areas, the primary sources of water quality problems can include run-off from impervious surfaces, sewer and stormwater outfalls, landfill leachate, snow dumps, excessive streambank erosion and atomospheric fallout. In rural areas, sources may include excessive erosion of cultivated soils and streambanks, livestock access to streams, and fertilizers and pesticides.

A good understanding of water quality conditions and trends exists for the Duffins Creek watershed, while a less thorough understanding is available for the Carruthers Creek watershed. Generally, the tributaries of the Duffins Creek watershed exhibit good water quality, with the exception of Stouffville Creek, Miller's Creek and sections of the Lower Duffins Creek. Water quality in Stouffville Creek should improve when the sewage treatment plant is decommissioned. Water quality in Carruthers Creek is slightly more impaired than in Duffins Creek and is typical of a nutrient-enriched urban stream. More in-depth information on water quality in the Duffins and Carruthers watersheds can be found in Duffins Creek State of the Watershed Report (TRCA, 2002) and Carruthers Creek State of the Watershed Report (TRCA, 2002).

Sportfish Consumption

The OMOE regularly monitors the level of contaminants found in sportfish and publishes consumption advisories in the Guide to Eating Ontario Sport Fish. The 2003-2004 guide has consumption advisories for women of childbearing age and children under 15 for species found in the Duffins Creek Marsh, while no locations were listed for Carruthers Creek. Information on consumption advisories for migratory species can be found in the section under western Lake Ontario. For specific consumption advisories, refer to the most recent version of the guide.

Instream Barriers

Instream barriers can take many forms, such as logs, low water levels, beaver dams, low head weirs, pollution, temperature, and road crossings. Naturally occurring structures, like log jams or beaver dams, are short-term in nature and provide a source of woody material for instream structures and food and habitat for many aquatic organisms.

From a fisheries perspective, the more permanent anthropogenic structures are a larger concern than these natural structures. Over the years, dams and weirs have been constructed for a variety of purposes including power to run saw and grist mills, energy dissipation, flood control, irrigation, recreation and aesthetics.

Many of these barriers have caused the creation of on-line ponds, which can adversely effect water temperature and aquatic habitat. The ponding of water causes suspended particles to settle out due to lower water velocities. Over time, the pond fills in with sediment, which puts stress on the barrier structure, ultimately creating the need to dredge the pond. If the sediment is released downstream, the material can smother downstream aquatic habitats and communities.

The accumulation of sediment also means that less sediment is being transported downstream, potentially starving downstream reaches of natural bedload. Where this is the case, changes in downstream morphology such as bank erosion or downcutting of the streambed can occur.

In addition, the pond likely receives little shade and may warm up considerably during the summer months. The warmer water may exceed the thermal limits of cold-water aquatic communities downstream, reducing their extent, or worse, eliminating them entirely.

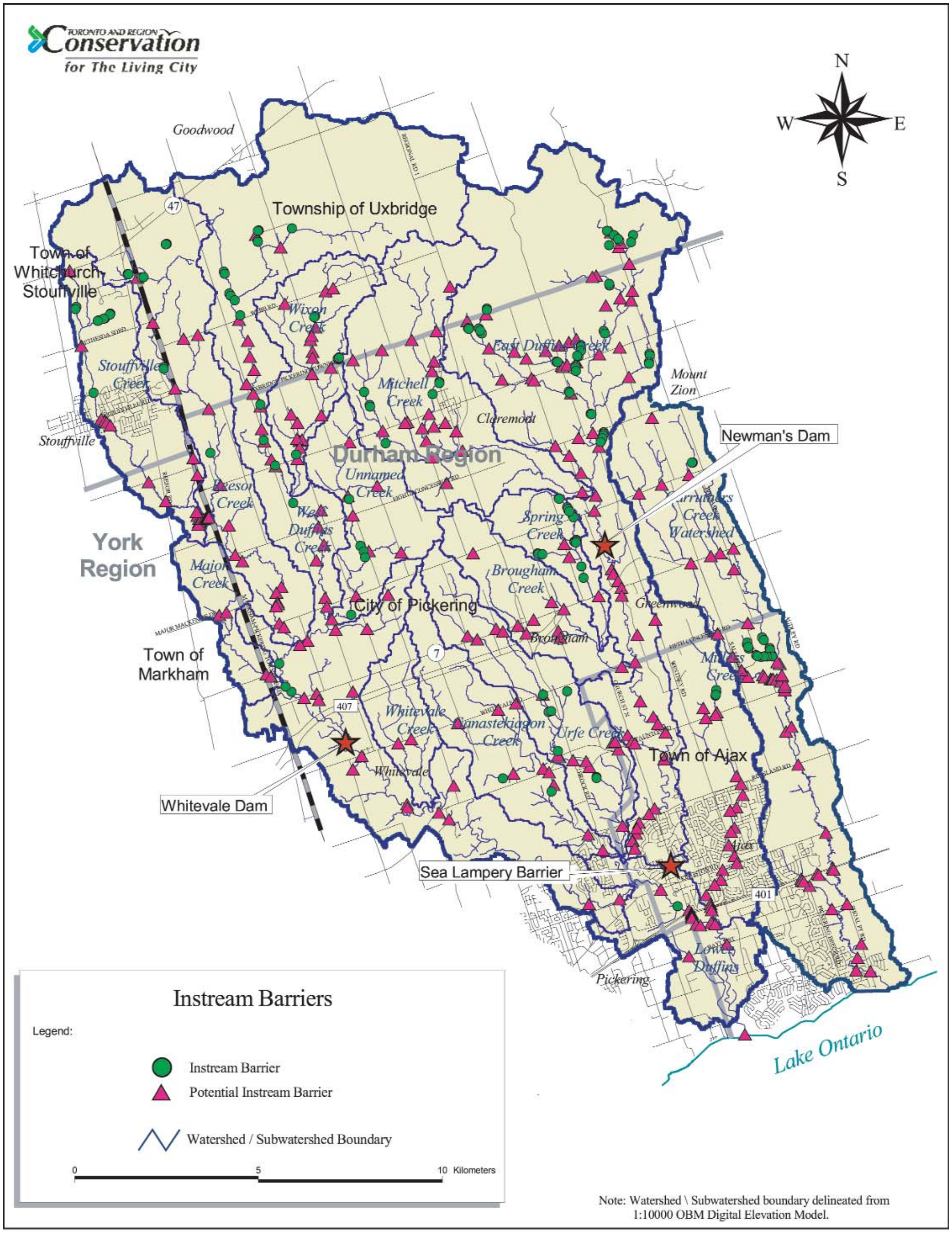
Finally, the dam structure itself can restrict or eliminate access to spawning, nursery or feeding habitats and thermal refuges for both migratory and non-migratory species. This is a positive impact in cases where the upstream movement of certain species is undesirable. The sea lamprey barrier on Duffins Creek, north of Church Street has proven to be successful in reducing the reproductive success of sea lamprey by preventing them from reaching spawning habitat further upstream. However, this structure also limits access for fish species that cannot jump over the barrier.

Whitevale dam on the West Duffins Creek and Newman's dam on the East Duffins Creek currently separate two incompatible but desirable fish communities from each other. These structures prevent migratory populations of rainbow trout and chinook salmon from reaching headwater brook trout populations. Scientific research is still divided regarding the impacts that introduced trout and salmon species have on resident trout species such as brook trout, however, some initial research into the reintroduction of Atlantic salmon suggests that streams with no rainbow trout have better survival of Atlantic salmon fry than streams with rainbow trout. In 2002, structural repairs to the Whitevale dam were initiated.

Using 1999 aerial photos, a total of 92 instream barriers in the Duffins Creek watershed and nine in the Carruthers Creek watershed were identified (Figure 13). Stream crossings, such as road and rail crossings or perched culverts, may also be obstructions to fish passage, adding an additional 257 potential barriers in Duffins Creek and 47 in Carruthers Creek. These require field reconnaissance to assess fish passage limitations. Due to constraints in identifying structures in heavily vegetated areas, additional unidentified barriers may still remain.

Further information on the large on-line ponds in the Duffins system is available in Section 3.1.

Figure 13. Existing and Potential Instream Barriers.



Riparian Vegetation

Riparian vegetation is defined as those plant communities adjacent to and affected by surface or groundwater of perennial or ephemeral water bodies such as rivers, streams, lakes, ponds, playas, or drainage ways (Colorado Division of Wildlife, 2003). The vegetation found in this area provides a number of critical functions including filtering pollutants, nutrients and sediments from the water, detaining flows and evaporating water. Vegetation in the riparian zone provides organic material to the stream, which initiates the aquatic food chain. Riparian vegetation is also an important contributor to instream habitat. Riparian vegetation also moderates water temperature by providing shade, a function which is less effective in higher order streams. Furthermore, deeply rooted vegetation, such as trees and shrubs, can slow or prevent excessive streambank erosion.

The riparian zone also doubles as an important habitat area for many flora and fauna species and acts as a movement corridor for terrestrial fauna. Table 6 provides a description of the five main functions provided by the riparian zone and the criteria commonly used to delineate this zone (City of Toronto, 2001). It should be noted that these criteria generally reflect regulatory limits rather than a scientific delineation.

Table 6. Five categories of riparian functions and their delineation criteria

Function	Method	Commonly Used Delineation Criteria
Water Quality and Quantity Improvement Watercourse Structure Shade	Filtering, polishing, evaporating and attenuating surface waters Provision of instream cover, channel structure, and erosion resistance Moderation of water temperature	30 m measured on both sides of the stream (EC, 1998) 30 m for watercourses located on the Oak Ridges Moraine (ORMCP, 2002) 15 m for warm water watercourses and 30 m for cold water watercourses (OMNR, 1994)
Food Supply	Organic material as food supply for the aquatic food chain	30 m measured on both sides of the stream (EC, 1998) 30 m for watercourses located on the Oak Ridges Moraine (ORMCP, 2002) 15 m for warm-water watercourses and 30 m for cold water watercourses (OMNR, 1994) The 25-year storm floodplain and all plant communities associated with mesic soils (City of Toronto, 2001)
Watercourse Movement	Long-term movement of watercourses and other geomorphic functions	The watercourse meander belt, the maximum lateral extent of meandering in a defined reach

Before European settlement, most streams had a high percentage of woody riparian vegetation. Much of this vegetation is removed when the land is cleared for agriculture or urban development, which then increases bank erosion and water temperature, and reduces the organic inputs and cover necessary for healthy aquatic communities.

The riparian vegetation of the Duffins and Carruthers Creek watersheds was mapped, measured and categorized based on interpretation of 1999 ortho-photography (Figure 14). Riparian communities were divided into five categories and include forest, successional, meadow, wetland and bare (Table 7).

Table 7. Riparian category definitions

Category	Definition
Forest	Areas with a woody component of > 25 per cent and at least 3 trees deep
Successional	Sparsely vegetated areas having a small woody component (10 ? 25 per cent woody vegetation)
Meadow	Dominated by uncultivated grasses, not including grazing/fallow fields or manicured grasses
Wetland	Areas dominated by wetland: marsh, bog (swamp difficult to distinguish due to canopy cover)
Bare	Areas lacking riparian vegetation where it is either dominated by cropped grasses or was devoid of any vegetation at the time of the air photo

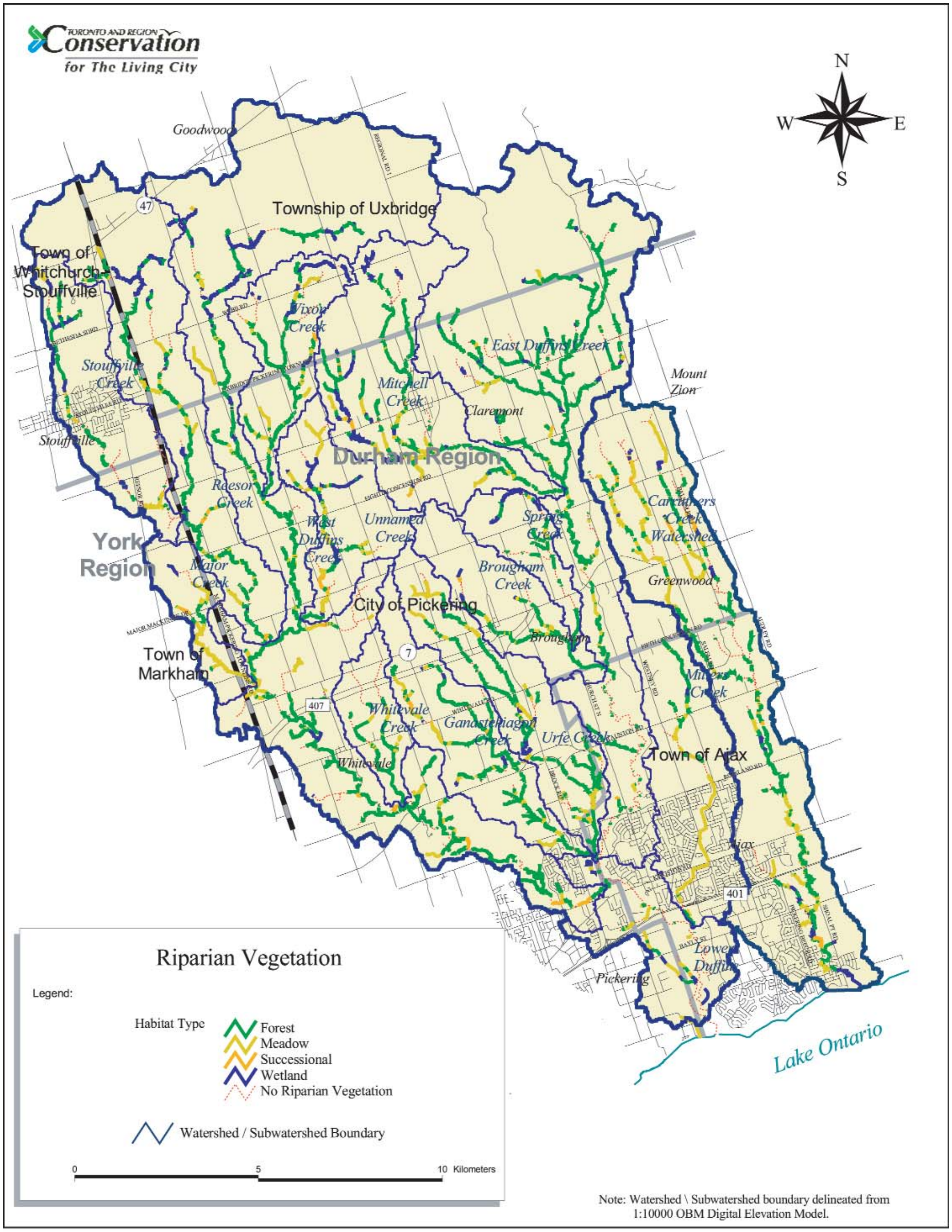
Each category type was measured along both stream banks and quantified in kilometres and as a percentage of total stream length (Table 8). In total, 76 per cent of the watercourse length in the Duffins Creek watershed has riparian vegetation, but only 51 per cent of stream length has woody riparian vegetation. Seventy-six per cent of the watercourse length in the Carruthers Creek watershed has riparian vegetation, but only 41 per cent has woody riparian vegetation.

Table 8. Assessment of riparian vegetation for the Duffins and Carruthers creeks watersheds.

Vegetation Type	Duffins Creek		Carruthers Creek	
	Length of Watercourse with Vegetation (km)	Per cent of Stream Length with Vegetation	Length of Watercourse with Vegetation (km)	Per cent of Stream Length with Vegetation
Forest	189	50	23.4	37
Successional	3.4	1	2.3	4
Meadow	60	16	16.8	27
Wetland	35	9	4.7	8
Bare	90	24	14.8	24
Total Woody Vegetation*	**192.4**	**51**	**25.7**	**41**
Total Naturally Vegetated	**287**	**76**	**47.2**	**76**

** Woody vegetation includes forest and successional vegetation categories*

Figure 14. Riparian Vegetation.



2.1.2 RIVERINE HABITAT CATEGORIES

Based on the information presented in the previous sections, watercourses in the Duffins and Carruthers creeks watersheds can be classified into one of six habitat categories, originally developed in the Don Watershed Fish Community and Habitat Management Plan (MTRCA, 1997). These six habitat categories are:

- small riverine cold-water;
- small riverine warm-water;
- intermediate riverine cold-water;
- intermediate riverine warm-water;
- large riverine; and
- estuarine

These six habitat categories have been separated into three parts: riverine habitat, lacustrine and estuarine habitats. This distinction has been made due to the unique nature of the second two habitats, which are explained in more detail in the next sections.

Separating watercourses into small, intermediate or large is based upon stream size or drainage area. The river continuum concept (Vannote et al., 1980) suggests that as a watercourse becomes larger, habitat complexity increases and the watercourse is able to support a greater number of species. Data from Steedman (1987) showed that species' richness initially rises dramatically in streams with drainage areas up to 10 km^2, increases more slowly in streams with drainage areas between 10 and 200 km2 and then levels off as the drainage area increases beyond 200 km^2. It is on this basis that small, intermediate and large riverine habitats were defined (Table 9).

To define a watercourse as either cold or warm-water, physical and biological attributes were used (Table 9). Flow regime, and more specifically, surficial geology – the ratio of baseflow to average annual flow - and stream slope were used to gauge whether a watercourse would have the cold, stable flows necessary to support cold-water habitat. The historic presence or absence of trout was also used to identify cold- or warm-water tributaries. Figure 15 and Table 10 show the locations and extent of each habitat category.

Table 9. Habitat category definitions.

Habitat Category	Physical Characteristics				Biological Characteristics
	Mean Baseflow ($m^3/s/km^2$)	Drainage Area (km^2)	Stream Order	Temperature	
Small Riverine Coldwater	high	less than 10	1ST and 2nd order (sometimes 3rd)	stable	trout historically and currently present
Small Riverine Warmwater	low	less than 10	1st and 2nd order	fluctuates	trout not historically or currently present
Intermediate Riverine Coldwater	moderate - high	10 - 200	3rd and 4th order, (although some 2nd and 5th)	stable	trout historically and currently present
Intermediate Riverine Warmwater	low	10 - 200	3rd, 4th and 5th order	fluctuates	trout not historically or currently present, but important migratory corridor
Large Riverine	low - moderate	> 200	6th order and higher	fluctuates	trout not historically or currently present, but important migratory corridor

Table 10. Extent of each habitat category in the Duffins and Carruthers watersheds.

Habitat Category	Extent of Habitat	
	Duffins Creek	Carruthers Creek
Small Riverine Coldwater	150km or 40%	16 km or 25%
Small riverine Warmwater	136 km or 36%	31 km or 50%
Intermediate Riverine Coldwater	83 km or 22%	8 km or 13%
Intermediate Riverine Warmwater	not present	30 km or 5%
Large Riverine	4 km or 1%	none

Figure 15. Aquatic Habitat Categories.

2.1.3 LACUSTRINE HABITAT

Lacustrine habitats are characterized as being low slope, depositional areas containing slow-moving or standing water. In general, there are two types of lacustrine habitat: on-line and off-line ponds. On-line ponds, including reservoirs, are directly connected to a watercourse and are created when an obstruction is built in the stream. These obstructions are built for a number of reasons including recreation, aesthetics, fisheries management, flood control, erosion reduction, water supply or water power. The impacts of on-line ponds are described in the section on instream barriers.

Off-line ponds are completely isolated, with no connection to a watercourse, or indirectly connected where a surface channel or pipe directs some flow from the watercourse to the pond. Off-line ponds may also have subsurface flow of groundwater, which can influence nearby ponds or rivers. This is often the case in gravel pits, where extraction activities have cut into the water table.

Based on 1999 air photos, 92 on-line and 110 off-line ponds in the Duffins Creek watershed and nine on-line and 19 off-line ponds in the Carruthers Creek watershed were identified. Physical characteristics of the major lacustrine habitats found in the Duffins Creek watershed are listed in Table 11. The many smaller on and off-line ponds in each watershed are too numerous to discuss individually.

Table 11. Major waterbodies in the Duffins and Carruthers creeks watersheds.

Waterbody	Municipality	Subwatershed	Function	Size (ha)	Ownership
Stouffville Reservoir	Whitchurch-Stouffville	West Duffins Creek	Flood Control Reservoir	5	TRCA
Secord Pond	Uxbridge	West Duffins Creek	Recreational Pond	7	TRCA
Whitevale Pond	Pickering	West Duffins Creek	Historic Mill Pond	2	Ontario Realty Corporation

2.1.4 WETLAND HABITAT

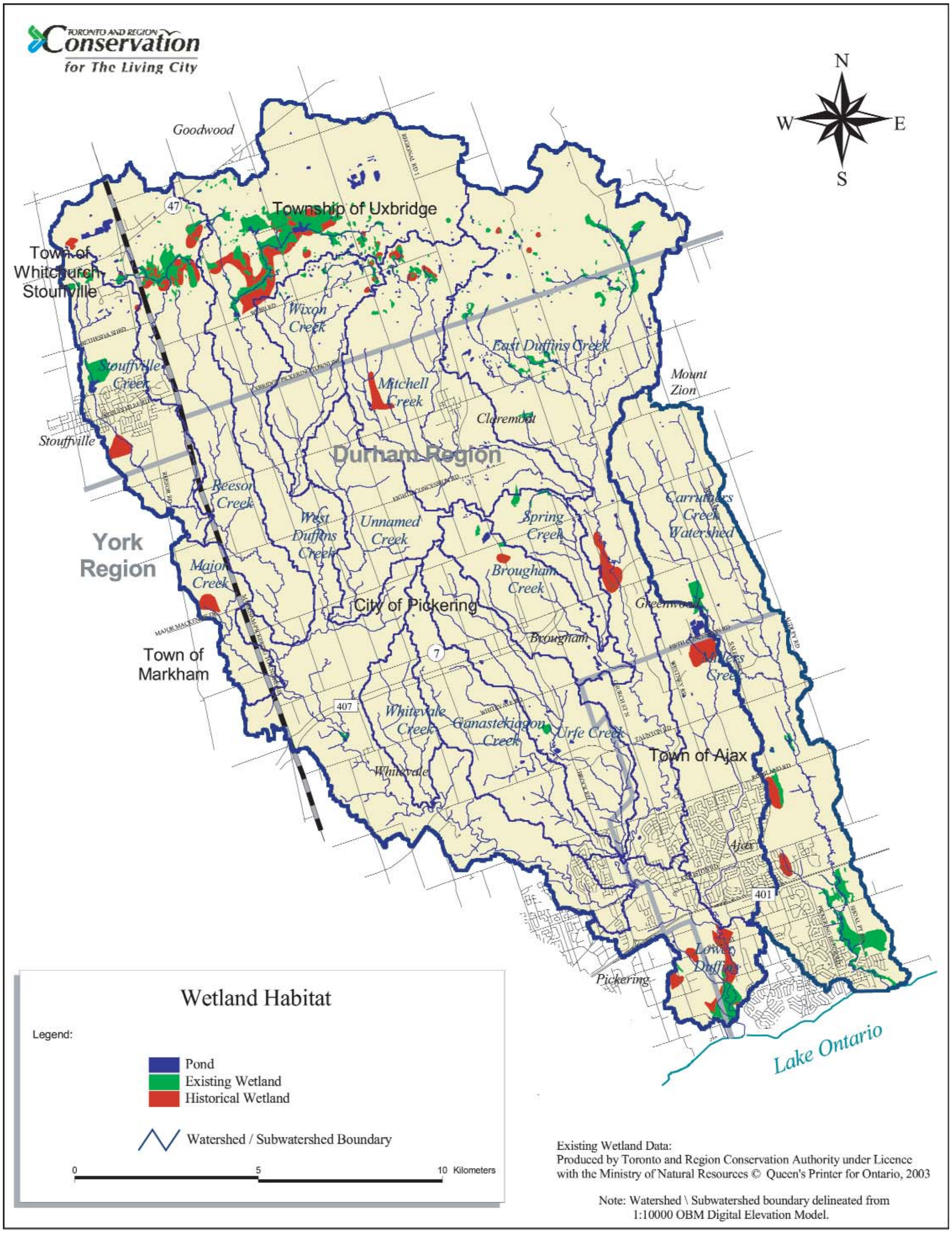
Wetlands are areas that are seasonally or permanently covered by shallow water, or where the water table is close to or at the surface (OMNR/OMMA, 1992). Lands under active agricultural production that are periodically flooded, soaked, or wet are not considered to be wetlands by definition (OMNR, 1994). Temporary wetlands may occur as a result of beaver dams which flood the surrounding area. Wetlands maintain and improve water quality, protect shorelines from erosion, aid in flood control, provide fish and wildlife habitat, and contribute substantial social and economic benefits, including resource products, outdoor recreation, and tourism-related activities (OMNR, 1994). An evaluation based on biological, social, hydrological components determines whether a wetland is provincially significant (OMNR, 1994). However, all wetlands have value, both intrinsically and to society.

Wetland types are determined on the basis of major plant associations, physical, and hydrological information obtained in the wetland and the immediate surroundings. The four types of wetlands are swamps, marshes, bogs, and fens. The physiographic position of a wetland in the landscape defines its type: estuarine – river mouth; lacustrine – lake; riverine – river (permanent inflow and outflow); palustrine – streams with absent or intermittent inflow and intermittent or permanent outflow; and isolated – no surface outflow (OMNR/OMMA, 1992; OMNR, 1994). Many areas contain closely spaced wetlands that, as a group, have similar or complementary biological, social and/or hydrological functions. The group is referred to as a wetland complex and the area between the individual wetlands as adjacent upland habitat (OMNR, 1994).

Snell (1987)approximated the extent of historic wetlands by mapping all naturally wet soils, which were assumed to have originally supported wetland vegetation. Losses were identified as those areas of originally wet soil no longer supporting natural vegetation and suggested that over 80 per cent of the pre?settlement wetlands in the Toronto area have been lost (Snell, 1987). Since 1987, additional losses have probably occurred, while some former agricultural lands may have reverted to wetlands. In the Duffins Creek watershed, wetlands historically covered 791 hectares, approximately 1.3 times more than the inventoried amount found today (Figure 14). In the Carruthers Creek watershed, historic wetlands were estimated to cover 53 hectares, almost three times less than that inventoried today (Figure 16).

Both watersheds have coastal wetlands or estuarine habitat at their mouths, which is characterized by low gradient (0.03 per cent or less), slow-moving turbid water and is directly influenced by the water level in Lake Ontario. In both watersheds, this habitat extends from the river mouth to approximately Bayly Street. This area of high sediment deposition typically contains emergent and submergent vegetation. Coastal wetlands are areas of high productivity and high species diversity located where two aquatic habitat types, riverine and lacustrine, converge. Lake-dwelling fish species are attracted to the foraging, rearing and breeding potential of coastal wetlands, and provide a source of species and genetic diversity to the riverine environment.

Figure 16. The Locations of Historic and Current Wetlands.



2.2 AQUATIC COMMUNITIES

This section of the Fisheries Management Plan provides information on the historic and present conditions of the fish and benthic invertebrate communities in both watersheds. A good understanding of the historic and current aquatic ecology of a system is key to understanding system function and potential, which is critical when setting management targets and rehabilitation goals.

2.2.1 FISH COMMUNITY – HISTORIC AND CURRENT

Historic fish survey data provides an important record of the past distribution of fish species and communities in a watershed. This context provides a reference point against which to compare the present condition of the aquatic resource. Without this, management decisions would be made relative to an existing condition that may already be impacted. Comparison of the composition and distribution of the historic and current fish community allows for the development of an expectation for the fish community if conditions currently limiting their presence were eliminated.

The earliest available fish surveys on the Duffins Creek watershed were conducted by the Department of Planning and Development during the 1950′s and establishes the building blocks of nearly 50 years of documented data (ODPD, 1956). Overall, fish surveys performed in the watershed during the 70′s, 80′s and 90′s were the most comprehensive and broadest in spatial coverage. Data from the 1950′s was the most sparse, covering only a minimal number of sites. It is interesting to note that no fish survey data was found for the 1960′s. In total, more than 500 locations of historical sampling were found in Duffins Creek. Historic fisheries data in the Carruthers Creek watershed is limited, with the earliest recorded surveys conducted by the OMNR in the 1970′s and some periodic data since.

Further inspection of collection data, however, revealed these to be incomplete and, therefore, potentially misleading. In many cases, precise sample locations are missing, while in others, dates are missing. More importantly, in all cases, the purpose for sampling is not included in the data sheets. Knowing the collection purpose and objectives, reach length, electroshocking seconds, habitat sampled, etc., is crucial in interpretation of the collections.

TRCA sampling also contains certain limitations with regard to watershed level conclusions. This is due to the few stations and habitats sampled and the limited number of seasons sampled. The migrational movements of salmonids are generally understood but the same cannot be said for cyprinid species and as a result, some species may not be collected during the sampling. Sampling is designed to provide a general picture, which then allows for the development of recommendations for future data collection.

In 2000, TRCA conducted surveys at 32 stations in Duffins Creek and at six stations in Carruthers Creek using a single pass electrofishing method described in the Ontario Stream Assessment Protocol (OMNR, 1998). The coastal wetlands of both watersheds were surveyed in 2002 using protocols outlined in the Durham Region Coastal Wetland Monitoring Project (Environment Canada, 2003a). Figure 17 shows the location of the historic and 2000 surveys. A total of 51 species have been found in Duffins Creek, of which 33 were captured in 2000 and 2002 (Table 12). Species found historically in Duffins Creek but not identified in 2000 or 2002 include sea lamprey, alewife, coho salmon, Atlantic salmon, northern pike, central mud minnow, northern hog sucker, redside dace, common carp, brassy minnow, river chub, golden shiner, spotfin shiner, yellow bullhead, American eel, white perch, white bass and fantail darter.

A total of 41 species have been found in Carruthers Creek, of which 18 were collected in the 2000 and 2002 sampling events (Table 12). Species found historically, but not identified in recent surveys, include American brook lamprey, alewife, northern pike, central mud minnow, redside dace, golden shiner, emerald shiner, fathead minnow, longnose dace, banded killifish, threespine stickleback, white perch, white bass and rock bass.

Table 12. Fish species historically and currently found in the Duffins and Carruthers creeks watersheds.

Common Name	Carruthers Creek		Duffins Creek	
	Historic	2000/02**	Historic	2000/02**
Lamprey Family				
American brook lamprey	♦	♦	♦	
northern brook lamprey[3,7]	♦			
sea lamprey[1]	♦			
Herring Family				
alewife[1]	♦		♦	
gizzard shad	♦	♦	♦	♦
Salmon Family				
chinook salmon[1]	♦			
coho salmon[1]	♦			
rainbow trout[1]	♦	♦	♦	♦
Atlantic salmon[2]	♦			
brown trout[11]	♦	♦		
brook trout	♦	♦	♦	
Pike Family				
northern pike	♦		♦	
Mud minnow Family				
central mud minnow	♦		♦	
Sucker Family				
white sucker	♦	♦	♦	♦
northern hog sucker	♦			
Minnow Family				
goldfish[1]				
northern redbelly dace4	♦	♦	♦	♦
redside dace [3,6]	♦		♦	
lake chub				
common carp[1]	♦		♦	♦
brassy minnow[4]	♦		♦	

Common Name	Carruthers Creek		Duffins Creek	
	Historic	2000/02**	Historic	2000/02**
hornyhead chub	♦	♦		
river chub	♦			
golden shiner	♦		♦	
emerald shiner[5]	♦	♦	♦	
common shiner	♦	♦	♦	♦
spottail shiner[5]	♦	♦		♦
rosyface shiner		♦	♦	
spotfin shiner	♦		♦	
spottail shiner			♦	
sand shiner	♦	♦	♦	
bluntnose minnow	♦	♦	♦	♦
fathead minnow	♦	♦	♦	
blacknose dace	♦	♦	♦	♦
longnose dace	♦	♦	♦	
creek chub	♦	♦	♦	♦
Catfish Family				
yellow bullhead	♦			
brown bullhead	♦	♦	♦	♦
channel catfish				
stonecat[5]	♦	♦	♦	
Freshwater Eel Family				
American eel[4]	♦			
Killifish Family				
banded killifish			♦	
Stickleback Family				
brook stickleback	♦	♦	♦	
three-spine stickleback			♦	
Temperate Bass Family				
white perch1	♦		♦	
white bass	♦		♦	
Sunfish Family				
rock bass	♦	♦	♦	
pumpkinseed	♦	♦	♦	♦
smallmouth bass	♦	♦	♦	
largemouth bass	♦	♦	♦	♦
black crappie			♦	♦
Perch Family				
yellow perch	♦	♦	♦	♦
rainbow darter[4]	♦	♦	♦	
Iowa darter	♦	♦		
fantail darter	♦			
johnny darter	♦	♦	♦	♦
logperch	♦	♦	♦	♦
Sculpin Family				
mottled sculpin	♦	♦	♦	♦
slimy sculpin	♦	♦		
Total Number of Species	51	33	41	18

*** Though not captured in 2000, some species such as American brook lamprey and chinook salmon are known to be present. Other species such as sea lamprey, alewife, northern pike, most minnow species, brook and 3-spine stickleback, rock bass, smallmouth bass and rainbow and fantail darter are expected to be present in the watershed where they were found historically.*

[1] - Introduced species [2] - Extirpated species [3] - COSEWIC - Species of Special Concern
[4] - COSEWIC - Group 2, Intermediate Priority [5] - COSEWIC - Group 3, Lower Priority [6] - COSSARO - Threatened

The true number of species currently inhabiting each watershed may be higher than that shown in Table 12 due to the number of stations and timing of the 2000/2002 assessments. With this in mind, the present dataset was expanded to include data from 1995. This adds an additional seven hog sucker, central mud minnow and fantail darter to the present number of species in Duffins Creek. An additional six species were found in Carruthers Creek and include redside dace, brassy minnow, fathead minnow, longnose dace, brook stickleback and three-spine stickleback.

Of the additional species found in Duffins Creek, sea lamprey and coho salmon are not native, while Atlantic salmon were the result of research-based stocking. The remaining four native species are not particularly sensitive, and were likely missed in the 2000 survey due to the limited area covered by the fish surveys.
Of the additional six species found in Carruthers Creek, redside dace and brassy minnow are considered to be sensitive and "relatively" sensitive, respectively. Recent anecdotal information suggests that redside dace still resides in Carruthers Creek, but may be sparsely distributed. The remaining four species do not have special requirements and were therefore likely missed in the 2000 sampling event rather than extirpated from the watershed.

Introduced Species

Introduced species are defined as non?native fish species, either regionally or nationally, that have either been purposefully or accidentally introduced into a waterbody. The establishment of exotic species is often to the detriment of native species (Saunders et. al, 2002). Introduced species compete for food, territory and spawning sites, or they may prey upon desirable native species as a predator or as a parasite, often resulting in their displacement and/or extirpation.

Seven introduced species have been found in Duffins Creek, of which rainbow trout, brown trout and chinook salmon were encountered in the 2000/2002 surveys. Two introduced species, rainbow trout and common carp have historically been found in Carruthers Creek and were both present in 2000/2002. Young of the year rainbow trout were also found in Carruthers Creek in 1997 (Bird and Hale, 1997). Table 13 provides a summary of the introduced species found in both watersheds.

Figure 17. Historic and 2000 Fish Sampling Stations.

Table 13. Status of the introduced fish species in the Duffins and Carruthers creeks watersheds.

Common Name	Date of Introduction to the Great Lakes	Method of Introduction	Duffins Creek	Carruthers Creek
sea lamprey	between 1819 and 1900	ballast water or Erie Canal	a lamprey barrier north of Church Street prevents upstream access; lampricide is applied on a 3 - 5 year cycle	currently not found; lampricide last applied in 1976
alewife	1819	stocked inadvertently or migrated through the Erie Canal	none found in recent surveys	none found in recent surveys
chinook salmon	1874	intentional	migratory runs; accounts of natural reproduction	unknown
rainbow trout	1876	intentional	migratory runs of naturalized population; not stocked presently	small migratory run; may not be self-sustaining; not stocked presently
brown trout	1883	intentional	resident and migratory population	unknown
common carp	1880	likely an intentional introduction	present only in coastal wetland	present only in coastal wetland
white perch	1950(?)	believed to have gained access via the Oswego River	last documented in the 1990s	unknown

Information presented in this table was derived primarily from the Great Lakes Fishery Commission, 1985.

Sea lamprey feed on the body fluids of other fish, clinging to its victim with a suction cup mouth and rasping through the scales and skin with a sharp tongue. Sea lamprey prey on all large Great Lakes fish species and are so destructive that only one in seven fish attacked will survive (Environment Canada, Green Lane Website). Sea lamprey spend most of their adult life in lacustrine environments, and return to streams to spawn.

Carp are aggressive omnivores that inhabit lacustrine habitats such as that found in embayments and wetland areas. They feed on molluscs, insects, worms, crustaceans algae and aquatic plants and seeds. During feeding they suck in and expel water, mud and debris. In doing so, aquatic plants become uprooted, nutrients and sediments are released and resuspended, causing an increase in water turbidity. High turbidity can reduce aquatic plant growth by limiting light penetration, and reduces the ability of sight-feeding predatory fish to catch their prey. Common carp are prolific in suitable habitats, and as they increase in numbers they compete for food and space with other more desirable fish species (GLFC, 1985).

Species at Risk

At the federal level, the designation of species of national significance is governed by the Canadian Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The status of these species is affirmed through the new Species at Risk Act, which is being brought into force in phases beginning in 2003. The purposes of this Act are to prevent wildlife species from becoming extirpated or extinct; to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity; and to manage species of special concern in order to prevent them from becoming at risk. At a provincial level, the OMNR designates species of significance under the Committee of the Status of Species at Risk in Ontario (COSSARO).

Based on the Canadian Species at Risk list (COSEWIC, 2002), two Species of Special Concern and nine candidate species of intermediate and lower priority have been found in fish collection records for the Duffins and Carruthers creeks watersheds (Table 14).

Table 14. Species at Risk and their status in the Duffins and Carruthers watersheds.

Species	Risk Category	Duffins Creek	Carruthers Creek
American brook lamprey	COSEWIC – Group 2 Intermediate Priority Candidate List	currently	found historically (1997)
northern brook lamprey	COSEWIC – Species of Special Concern; COSSARO – Vulnerable	found historically (90's)	no record
northern redbelly dace	COSEWIC – Group 2 Intermediate Priority Candidate List	found currently	found currently
redside dace	COSEWIC – Species of Special Concern; COSSARO – Threatened	found historically (50's - 80's)	found in 2000 (anecdotal account)
brassy minnow	COSEWIC – Group 2 Intermediate Priority Candidate List	found historically (70's - 90's)	found historically (80's)
emerald shiner	COSEWIC – Group 3 Lower Priority Candidate List	found currently	found historically (80's)
spottail shiner	COSEWIC – Group 3 Lower Priority Candidate List	found historically (80's, 00's)	found historically (80's)
stonecat	COSEWIC – Group 3 Lower Candidate List	found historically and currently	found historically (80's)
American eel	COSEWIC – Group 2 Intermediate Priority Candidate List	found historically (80's)	no record
white perch*	COSEWIC – Group 2 Intermediate Priority Candidate List	found historically (80's)	found historically (80's)
rainbow darter	COSEWIC – Group 2 Intermediate Priority Candidate List	found currently	found historically (80's)

** – The Quebec population is considered at potential risk, while the Ontario population is expanding*

It is thought that records of northern brook lamprey are inaccurate since their recorded distribution does not coincide with either the Duffins or Carruthers creeks watersheds.

Once locally abundant throughout the Ontario range, redside dace populations have experienced a substantial decline over the last 50 years (OMNR and OSCIA, 2002). Habitat degradation has caused local extinction in several watersheds (McKee and Parker, 1981), however, healthy populations still exist in the Rouge and Humber rivers, as well as Morrison, Fourteen Mile, Bronte and Spencer creeks. The last documented sightings of redside dace in the Duffins Creek watershed occurred in fish surveys from the 1980's. Based on current available habitat, redside dace likely still occurs in the Duffins watershed but have likely been missed in recent years because of the location and timing of fish surveys. Redside dace have, however, been recently identified in the Carruthers Creek watershed by Bird and Hale Ltd. (1997) and in the 2000 survey as an anecdotal account by TRCA staff.

Redside dace (Clintostomus elongatus) is a sensitive species requiring cool, clear water, with substrate for reproduction and overhanging bushes and trees for cover, and habitat for prey items like terrestrial insects. Redside dace leap out of the water as they feed on insects that swarm over the water's surface, and need clear water in order to see their prey (OMNR and OSCIA 2002). Although sensitive to turbidity, redside dace have been found in some streams of moderate turbidity (Holm and Crossman, 1986). Preferred habitat includes slow-moving sections of small headwater streams, which have mixtures of stream side shade, pool and riffle habitat (Holm and Crossman, 1986). Redside dace prefer temperatures less than 20°C and dissolved oxygen concentrations at least 7 mg/L (McKee and Parker, 1981).

Redside dace can be a useful indicator of the health of the aquatic ecosystem. When it's habitat starts to deteriorate, redside dace is one of the first to suffer (OMNR and OSCIA, 2002). Destruction and degradation of habitat have been the major factors in the reduction of redside dace distribution. Siltation, removal of riparian vegetation, channelization, agricultural run-off, and pollution of streams in urban areas all reduce suitable habitat and food sources for this fish species. Once widespread, the range of this species is considerably reduced.

Though not listed as a Species at Risk, Atlantic salmon have been designated a heritage species. When the first settlers arrived in southern Ontario in the late 1700's, Atlantic salmon were found in both watersheds, though likely not in large numbers in Carruthers Creek. They were fished commercially and for subsistence, mainly when adults returned to the streams to spawn. But, as the land was cleared for farming, water temperatures and erosion increased and the suitability of spawning and nursery habitat decreased. Dams were built for water?powered saw and grist mills, and access to spawning areas was blocked. Between fishing pressure and changes to the landscape, once?thriving Atlantic salmon populations were extirpated in less than a century. The Lake Ontario population was declared extinct in 1896 (Marion Daniels, unpublished report).

More information on Species at Risk can be found in Section 3.2 of the Plan.

Species Richness

Species richness is the total number of species present and is used to provide a general indication of the health of the fish community. Generally, the more degraded a watercourse, the lower the species richness. However, smaller streams, even healthy ones, typically have a lower species richness than larger watercourses. The river continuum concept (Vannote et al., 1980) suggests that as a watercourse becomes larger, habitat complexity increases, which allows for higher species diversity. Furthermore, it is recognized that the larger the watershed, the greater the habitat heterogeneity, number of niches, and, therefore, a greater potential for a higher number of species. Species richness must, therefore, be compared between similar-sized streams or to an expected value for a given stream size or drainage area. Steedman (1987) developed a relationship between the expected number of native species and drainage area for southern Ontario streams (Figure 18).

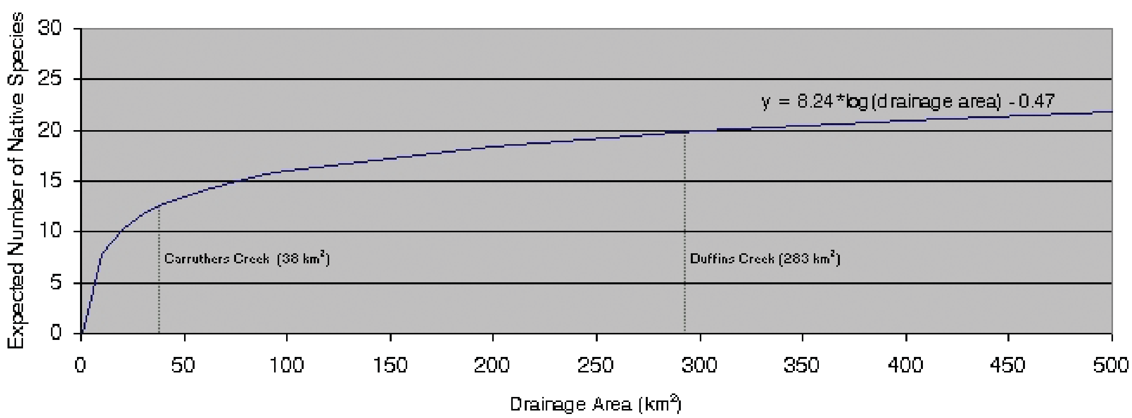


Figure 18. Graph illustrating the relationship between the expected number of native species and drainage area.

Data collected in 2000 were analyzed and compared to this relationship. Species richness in the Duffins Creek watershed ranges between one and eleven with a median of seven species while species richness in Carruthers Creek is between four to six species, with a median of five species.

Data from Carruthers Creek reflects a trend of increasing discrepancy from the headwaters to the river mouth between the expected and actual number of species. This trend is coincident with the distribution of urbanization in the watershed. This trend is not apparent in the Duffins system, where lower than expected species richness values occur in the headwaters of the East and West Duffins creeks. In these subwatersheds, barriers and on-line ponds are likely negatively impacting the ecosystem, contributing to lower than expected species richness values.

Small Riverine Coldwater Habitat

This habitat type was surveyed at 16 stations in the Duffins Creek watershed and one station in the Carruthers Creek watershed (CC01). Based on a maximum drainage area of 10 km2, the number of native species expected at a single location in this habitat category ranges from one to eight (Steedman, 1987). Under half of the stations sampled exhibited a species richness value that was either equal or higher than expected. Representative species found in this habitat include American brook lamprey, brown trout, brook trout, white sucker, common shiner, bluntnose minnow, fathead minnow, blacknose dace, longnose dace, creek chub, rainbow darter, Iowa darter, johnny darter, mottled sculpin, slimy sculpin, northern redbelly dace, pumpkinseed, and brook stickleback. Sensitive species historically found include Atlantic salmon, mottled sculpin, redside dace, and darter species, of which Atlantic salmon is the only species no longer present. OMNR data suggests that redside dace are still found in this type of habitat.

Small Riverine Warmwater

This habitat type was surveyed at two stations in Carruthers Creek in 2000 (CC02 and CC03), but none in the Duffins system. Based on a maximum drainage area of 10 km^2, the number of native species expected at a single location in this category ranges from one to eight (Steedman, 1987). Both stations exhibited a species richness that was lower than expected. Representative species found in this habitat included: white sucker, bluntnose minnow, fathead minnow, creek chub, pumpkinseed, johnny darter, and brown bullhead.

Intermediate Riverine Coldwater

This habitat type was surveyed at 14 stations in the Duffins and one station in the Carruthers Creek (CC04). Based on a drainage area between 10 - 200 km^2, the number of species expected at a single location in this habitat category ranges between eight and 18. Of the stations sampled, two on Reesor Creek were the only ones where the actual species richness was equal to or higher than that expected. Representative species found in this habitat include: rainbow trout, brook trout, brown trout, white sucker, common shiner, fathead minnow, bluntnose minnow, blacknose dace, longnose dace, creek chub, brook stickleback, brown bullhead, stonecat, pumpkinseed, largemouth bass, rainbow darter, johnny darter and mottled sculpin. As with small riverine cold-water habitat, sensitive species historically found in this habitat type include Atlantic salmon, mottled sculpin, redside dace, and darter species, of which Atlantic salmon is the only species no longer present. OMNR data suggests that redside dace are still found in this type of habitat.

Intermediate Riverine Warmwater

This habitat type exists only in the Carruthers Creek system and was surveyed at one station (CC05) in 2000. Based on a drainage area between 10 - 200 km^2, the number of species expected at a single location in this habitat category ranges between eight and 18. The actual species richness at this station was found to be below expected values. Representative species found in this habitat type include: white sucker, creek chub, pumpkinseed, johnny darter, and logperch.

Large Riverine Habitat

This habitat type exists only in the Duffins Creek watershed and was sampled at one station (DU01). Based on a drainage area of more than 200 km^2, the number of species expected is 20, while the actual species richness found was 14 species. Representative species found in this habitat category include: chinook salmon, brown trout, lamprey spp, white sucker, common shiner, spotfin shiner, fathead minnow, blacknose dace, longnose dace, rock bass, pumpkinseed, rainbow darter, Iowa darter and logperch.

Estuarine and Lacustrine Habitats

Due to different sampling techniques, it is not possible to calculate or compare species richness values for stations in these habitats with those of riverine habitats due to different sampling techniques. However, recent work in the Durham Region coastal wetlands indicates that the two coastal marshes in the Duffins and Carruthers creeks systems had the second and third highest fish community Index of Biotic Integrity scores, respectively, out of the five wetlands evaluated (Environment Canada, 2003a).

Index of Biotic Integrity

The Index of Biotic Integrity (IBI) is a measure of fish community associations that is used to identify the general health of the broader stream ecosystem. It was first developed to assess small to moderate-sized warm-water rivers in the United States (Karr, 1981). Steedman (1987) adapted this method for streams in southern Ontario. He used 10 measures of fish community composition, grouped into four general categories: species richness, local indicator species, trophic composition and fish abundance. These 10 measures were summed to determine an IBI on a scale from ten (poor) to 50 (very good) (Table 15). A detailed explanation of these indices can be found in Steedman (1987).

Table 15. Nine sub-indices used in calculating the Index of Biotic Integrity

SPECIES RICHNESS

- number of native species
- number of darter and /or sculpin species
- number of sunfish and/or trout species
- number of sucker and/or catfish species

LOCAL INDICATOR SPECIES

- presence or absence of brook trout
(only in streams designated as cold-water)
- per cent of sample as Rhinichthys species

TROPHIC COMPOSITION

- per cent of sample as omnivorous species
- per cent of sample as piscivorous species

FISH ABUNDANCE

- catch per minute of sampling

Two modifications of Steedman's work were necessary for the calculation of IBI in the Duffins and Carruthers creeks watersheds. The presence/absence of blackspot was eliminated from the IBI since the presence of blackspot does not necessarily reflect unhealthy habitat conditions. The second modification relates to the presence/absence of brook trout, which Steedman (1987) assumed should be present at all stations.

While brook trout were more widespread historically, they were not found in all streams and their absence does not necessarily reflect unhealthy conditions. Based on this, the brook trout sub?indices was only calculated for stations that are considered to be or potentially are cold-water habitats. IBI scores for stations located on warm-water streams were calculated based on eight rather than nine sub-indices, and were then transformed for direct comparison with scores from cold-water streams. Twenty-eight of the 32 stations sampled on Duffins Creek were on cold-water streams, while in Carruthers Creek, two were on cold-water streams and four were on warm-water streams.

The modified IBI scores range from a low of nine (scoring one for each index) to a high of 45 (scoring five for each index). Four ranges of IBI scores have been designated to reflect stream quality (Table 16). Steedman (1987) suggests that the shift from good to fair biotic integrity is a threshold of degradation, then the domain of degradation for Toronto area streams ranges from 75 per cent removal of riparian forest from the smaller streams at 0 per cent urbanization to 0 per cent removal of riparian forest at 55 per cent urbanization.

Table 16. 2000 IBI ratings and scores. Numbers in brackets indicate per cent of stations.

IBI Rating	IBI Score	Number of Stations						
		West Duffins Creek	East Duffins Creek	Urfe Creek	Ganatsekiagon Creek	Miller's Creek	Lower Duffins Creek	Carruthers Creek
Poor	9 - 20	4 (25)	1 (8)	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)
Fair	21 - 27	4 (25)	4 (33)	1 (100)	0 (0)	2 (100)	2 (100)	5 (83)
Good	28 - 37	6 (37)	7 (58)	0 (0)	0 (0)	0 (0)	0 (0)	1 (17)
Very Good	38 - 45	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

The IBI scores in both watersheds received an average stream quality rating of "fair", indicating some degradation. Most sites receiving a score lower than "good" rated poorly due to a low catch per unit effort (a measure of biomass), poor trophic composition (few large piscivores), and in some cases either too many or too few indicator species (Rhinichthys and trout species, respectively). Low scores in the headwaters resulted primarily from poor trophic composition and a low catch per unit effort, possibly due to denuded riparian areas. Low ratings found in the more urbanized sections of the system were typically due to a high percentage of Rhinichthys species and a lack of specialized feeders and are suggestive of impacts from urbanization. Appendix B shows the IBI scores for each 2000 sample station.

2.2.2 BENTHIC INVERTEBRATES.

Benthic invertebrates are small, bottom-dwelling aquatic animals that live in the stream substrate during all or part of their life cycle. They play a critical role in aquatic ecosystems by serving as a link between bacteria, alochthonous nutrients (nutrients originating outside of the watercourse, such as twigs and leaves), fish and other vertebrates. They function both as processors of primary production and secondary production, and as a food source for many species of fish including brook trout, white sucker, redside dace, golden shiner, longnose dace, pumpkinseed and fantail darter. Examples of benthic invertebrates include crayfish, aquatic worms, snails, clams, and the larval stages of blackflies, mosquitoes, mayflies, dragonflies and damselflies.

Invertebrates can be grouped as either collectors, shredders, scrapers or predators depending on their feeding strategy. Shredders break up coarse organic matter, such as leaves, while collectors filter fine organic matter and/or living drifting organisms. Scrapers remove algae and bacteria from stream substrates, and predators capture living prey (Merrit and Cummins, 1996). The river continuum concept suggests that benthic invertebrates are distributed throughout the stream in an organized manner (Vannote et al., 1980). In headwater streams where vegetative cover is generally high, collectors and shredders dominate the community. As the stream widens, and more primary production occurs in the stream, significant populations of scrapers are found. In the larger sections of a stream where turbidity is likely higher, collectors are the dominant invertebrate. Throughout this continuum, the number of predator species remains relatively constant as a small percentage of benthic community.

There are numerous advantages to using benthic invertebrates as indicators of stream health; they are good indicators of localized conditions, they integrate the effects of short-term environmental variations, their distribution is ubiquitous, they are normally abundant and easy to collect and they are the food source for many commercially and recreationally important fish (Plafkin et al., 1990).

While several methodologies are used for assessing benthic communities, none should be used exclusively since most indices have their limitations and inherent biases. These use the number of taxa or taxa richness as the basic component of most evaluation techniques, with richness generally increasing with improved water quality, habitat diversity and habitat suitability. The absence of pollution-sensitive benthic groups such as mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera), known as EPT, and the dominance of worms and midges may indicate impairment, while the absence of clams, snails, isopods, amphipods, crayfish or annelids may indicate repetitive disturbance, or a community that is recovering from a disturbance. Also, overall low species richness may suggest degradation, although some high quality headwater streams may be naturally unproductive, supporting only a very limited number of taxa. The relative abundance or per cent contribution of each taxa provides a rapid indication of balance or evenness of the community, with greatly skewed abundances indicating faunal embalances. Table 17 lists some common benthic invertebrate indices used in impact assessment.

Table 17. Common criteria used in benthic invertebrate impact assessment.

Index	Impact Indicator	Source
Taxa richness	< 15	Barton, 1996; Griffith, 1998
EPT taxa richness	0	Barton, 1996
% Oligochaeta	> 30	Griffith, 1998
% Chironomidae	0 or > 50	Griffith, 1998
% Isopoda	> 10	Griffith, 1998
Ratio of EPT to Oligochaetes	when largely disproportional	unknown reference
Taxa abundance	> 20%	Plafkin et al., 1990

Additional diagnostic information may be gained from an observed abundance or absence of characterizing species/taxa. Taxa with defined habitat requirements are listed in Table 18.

Table 18. Common benthic indicator taxa

Sensitive Taxa	General Stream Health Implication
Beetles (Coleoptera)	Diverse community indicative of cooler, faster flowing streams with limited **Promeresa sp.**— sensitive to degraded water quality; require cool, well-oxygenated, flowing water
Mayflies (Ephemeroptera)	**Heptageniidae.**— indicator of healthy cool-water environment
Caddisflies (Trichoptera)	**Glossosoma.**— typical of high gradient cold-water steams with enclosed riparian canopy.
Stoneflies (Plecoptera)	
Midges (Chironomidae)	Some species found in cool flowing water and are sensitive to eutrophication (Brillia, Natarsia, Parametriocnemus)
Tolerant Taxa	**General Stream Health Implication**
Pill Bugs (Isopoda) Tubifex Worms (Tubificidae) Midges (Chironomidae)	High abundances reflect high organic materialTypical of warm, organically-enriched depositional zones and low dissolved oxygen Generally tolerant to sedimentation, organically-enriched, slower, warmer water (Chironomus sp, Cladotanytarsus sp, Procladius)

Several biotic indices have been developed to determine stream ecosystem health. One index is Hilsenhoff's Family Biotic Index (F.B.I) which provides an indication of water quality in terms of eutrophication. Each species is pre?assigned a value on a scale of 0 - 10 based on its known tolerance to organic pollution, (i.e., sewage treatment plants) where the higher the value, the more tolerant the organism (Hilsenhoff, 1988). The pollution tolerance value is multiplied by the relative abundance of each taxon and summed to provide a score for each station. The Hilsenhoff values are grouped into six water quality categories and given a rating (Table 19).

Table 19. Hilsenhoff's six water quality ratings associated with the F.B.I.

Hilsenhoff's F.B.I	Degree of Organic Pollution	Water Quality Rating
0.00 - 3.75	Organic pollution unlikely	Excellent
3.76 - 4.25	Possible slight organic pollution	Very good
4.26 - 5.00	Some organic pollution probable	Good
5.01 - 5.75	Fairly substantial pollution likely	Fair
5.76 - 6.50	Substantial pollution likely	Fairly poor
6.51 - 7.25	Very substantial pollution likely	Poor
7.26 - 10.00	Severe organic pollution likely	Very Poor

The Shannon-Weaver Diversity Index takes into account species richness and proportion of each species in the local aquatic community (Shannon, 1948). Typically, a Shannon-Weaver diversity index greater than three indicates a relatively unimpaired benthic community, while an index below one generally reflects a degraded habitat. The Shannon-Weaver Index is generally applied to quantitative data and its application to the semi-quantitative data derived from TRCA sampling is to provide a general indication of diversity only.

Benthic invertebrate records date back approximately 50 years, with the earliest available benthic surveys were conducted by the Department of Planning and Development in the early 1950′s, but are not comprehensive in nature and cover only a minimal number of sites. In most cases, historical records consist of a few listed taxa and no documentation of collection methodology. Surveys were also conducted in the 1970′s and 1980′s by various groups, including the OMNR and the University of Toronto. The Seaton Lands were assessed as part of the Jones and Guy (1997) study of the Seaton Lands. Results from this work show some degree of nutrient enrichment at all stations, with the degree of enrichment generally decreasing downstream.

Benthic surveys were conducted at six stations in the Carruthers watershed and at 32 stations in the Duffins watershed in 2000 using a modified kick-and-sweep technique (TRCA, 2002). Each station sample was assessed for taxa richness, number of Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa, percentage of each major taxonomic group as a percentage of the total fauna, Shannon-Weaver Diversity Index, and Hilsenhoff's Family Biotic Index.

Analysis of benthic invertebrate data suggests that the majority of tributaries in Duffins Creek are in relatively good condition, with a few tributaries and reaches showing signs of degradation. Not surprisingly, benthic communities appear to be most degraded in the most urbanized sections of the watershed (e.g. Miller's, Stouffville and Lower Main Duffins creeks), where agricultural land use influences are felt (e.g. Brougham, Spring and Major Creeks) and where barriers are impacting the fish community (e.g. headwaters of the East and West Duffins creeks). Unfortunately, no benthic data was found for Ganatsekiagon Creek.

In Carruthers Creek, analysis of benthic invertebrate data suggests that four of the six stations are significantly impaired, one is slightly impaired and the last is in good condition. Those stations that ranked poorly (CC02, CC04, CC05 and CC06) had little, if any, EPT species present and had"poor" to "very poor" water quality rankings based on Hilsenhoff's FBI. FBI scores also point to chemical discharge as a significant contributor of organics at these stations. High sedimentation, limited availability of riffle habitat, urbanization and poor water quality are all likely impacting the benthic community in Carruthers Creek south of the 5th Concession.

An invertebrate species recently identified in Duffins Creek, but not Carruthers Creek, is the rusty crayfish (Orconectes rusticus). Though native to parts of the Great Lakes, the rusty crayfish is believed to have been spread by anglers who used them as bait. This crayfish is of concern because it is aggressive and displaces native crayfish through direct competition. The rusty crayfish is also less susceptible to fish predation due to its more aggressive demeanour. Although most species of crayfish eat aquatic plants, rusty crayfish eat larger amounts due to their higher metabolic rate and appetite. The reduced abundance of aquatic plants may impact the available food resource for some fish species. The rusty crayfish also competes with fish for food, with juvenile crayfish feeding particularly heavily on benthic invertebrates.

Benthic invertebrate analysis, including a summary of results, is presented in further detail in Section 4 for each of the subwatersheds, while Hilsenhoff scores are presented in Appendix C.

2.3 CONCLUSION

Little historical fisheries data exists on Carruthers Creek, making it difficult to identify trends in ecosystem health. Analysis of recent data points to an ecosystem that becomes increasingly degraded from the headwaters to the mouth. Some localized pockets of quality habitat do, however, still exist in the system. The main issues affecting stream health include a lack of riparian vegetation, low baseflow, high sediment deposition, thermal instability, and poor water quality.

Significant land use changes have occurred in the lower sections of the watershed, including the construction of Highway 401 and urban intensification. The impacts of these changes are likely the predominant cause of the decline in species richness and habitat degradation. The physiographic setting of Carruthers Creek also lends to its sensitivity. The creek's lack of connectivity to the Oak Ridges Moraine, it's generally low slope and sandy substrate contribute to the watercourse's reduced ability to handle shear stress, and sediment transport (Parish 2000).

Cold-water stream reaches of Carruthers Creek are showing signs of degradation. Areas of particular concern include the headwater reaches, which are suffering from low baseflow, thermal stress and a lack of riparian vegetation. Data suggests that some areas, such as upstream of Rossland Road, are experiencing a shift from cold- to warm-water communities as a result of this degradation. More tolerant species, such as creek chub, johnny darter and pumpkinseed are moving in to claim territories once held by brook trout and mottled sculpin. Evidence also suggests that the historically good runs of spawning pike in the coastal estuary may be decreasing.

Although sightings of rainbow trout in Carruthers Creek are limited, their presence is a positive sign. Bird and Hale (1997) reported catching young-of-the year rainbow trout in the mid to lower reaches, suggesting that fish are finding suitable, although likely limited, spawning grounds. Fisheries records show that migratory rainbow trout are currently moving just over seven kilometres upstream from Lake Ontario to approximately Kingston Road. It is curious that even with cold-water habitat upstream of Kingston Road and no known barriers, the fish do not appear to be moving past this point. Kingston Road does, however, coincide with the termination of a stretch of riparian vegetation that extends upstream from Carruthers Marsh.

Redside dace were sighted in the Carrruthers Creek watershed (Bird and Hale, 1997) and in 2000 (TRCA, anecdotal report), another positive indicator of watershed health. The presence of both redside dace and rainbow trout provides the impetus for protection and restoration efforts.

Overall, analysis of physical characteristics and biological data for the Duffins Creek watershed points to a healthy watershed with localized pockets of degraded habitat. Sub-basins that stand out as being degraded include Miller's Creek, Major Creek, sections of the Lower Main Duffins Creek, the headwaters of East Duffins Creek and West Duffins Creek, and sections of Stouffville Creek, Brougham Creek and Spring Creek. A lack of riparian vegetation due to urbanization is the prevailing issue in Miller's Creek, the Lower Main Duffins, and Stouffville Creek, and to a lesser degree, in the Urfe and Ganatsekiagon creeks, while a lack of riparian vegetation due to agricultural land uses is the prevailing issue in Brougham Creek, Spring Creek and Major Creek. Habitat degradation in the headwaters of the East Duffins and the West Duffins is related to the existence of numerous instream barriers.

Future development of federal and provincial lands will require special care and attention to achieve the protection of infiltration, run-off and evaporation and the associated aquatic resources.

The apparent absence of redside dace in the 2000 survey is a concern given the overall health of the system, the number of stations sampled and the area covered. Notwithstanding, it is still believed that healthy populations of redside dace still inhabit Duffins Creek and further monitoring should be conducted to identify their range. Despite some localized concerns regarding aquatic ecosystem health, the Duffins Creek watershed remains the healthiest system in the TRCA's jurisdiction. Studies conducted by the OMNR continue to regard the Duffins as a potential system for the reintroduction of Atlantic salmon.

CHAPTER

3

3.0 AQUATIC ECOSYSTEM MANAGEMENT

Effective aquatic ecosystem management requires considerable understanding of ecosystem functions, as well as knowledge of present and future human pressures. As such, integrated resource management is critical to successfully identify relevant and realistic management targets and recommendations. These should include the elements of good science, cost effectiveness, management practicality, and public input (OMNR, 1989). They must also address the major problems and issues related to the resource and its users.

In the development of the Plan, a variety of issues were identified through analysis, knowledge of the watersheds, management needs and topics raised by the public. These were summarized and addressed as the following main issues:

- aquatic habitat;
- aquatic community
- consumptive uses;
- public access;
- education;
- plan input and review, and;
- broader issues.

The following is a list of recommended management actions developed to address these issues and achieve the goals of this document and the watershed plan.

3.1 AQUATIC HABITAT

Water Budget

As indicated in earlier sections of the Plan, aquatic communities are vulnerable to changes in the timing, duration, magnitude, frequency and rate of change of flow. Converting land to urban or agricultural uses has generally meant that water is quickly removed and not allowed to percolate into the ground. Parking lots, storm sewers, concrete channels and tile drains all work to rapidly remove water from an area. As a result, streams quickly rise following storm events and peak earlier than they did historically. Furthermore, less water infiltrates through the ground, potentially affecting groundwater resources. During drier periods, especially in the summer, baseflows may be reduced due to lower groundwater levels.

The protection of groundwater and stormwater management and water use are three critical water quantity issues. Ensuring groundwater recharge and discharge areas are protected from development is another step in maintaining or improving water quantity. Enhancing recharge by creating wetlands or renaturalizing lands are two methods of increasing groundwater recharge and slowing run-off.

Flow attenuation is the second major component of improving water quantity. Lakes, ponds, floodplain areas and the many wetlands that once covered the watershed stored water from the spring melt, or following a summer rain and released it slowly during the year. With development, the watershed's ability to store precipitation has been dramatically reduced and as a result, precipitation quickly rushes overland and into nearby watercourses. Flow peaks, therefore, are larger and occur more quickly after a storm event. The construction of wetlands or stormwater management ponds, holding water on the top of buildings, and renaturalization are just a few of the methods of slowing the rush of water into the river. Further information on the impacts of watershed change to the water budget are available in Clarifica (2002).

Water taking is the removal of water from either the surface or sub?surface of the earth and is used for irrigation, watering of livestock, golf courses and municipal and domestic drinking water. The removal of too much groundwater can impact watercourses by reducing or eliminating groundwater discharge. Unfortunately, the time that human users require water is usually the time when it should not be removed from the aquatic system.

The OMOE oversees the permits to take water and has set limits on the amount allowed. A permit is required when the amount to be withdrawn is greater than 50,000 L/day (50 m3/day). Recently, the OMOE and TRCA have been setting the invert elevation of intake pipes to be at the 60 per cent duration flow (i.e., baseflow).

Water budget analysis by Clarifica (2002) indicates that water quantity issues are currently not a significant aquatic habitat concern in most of the Duffins watershed due to the limited amount of existing urbanization. However, concerns do exist in Miller's Creek and the Lower Duffins and Carruthers Creeks, while there are future concerns related to the proposed development of Stouffville, Ganatsekiagon, Urfe and Carruthers creeks.

Management recommendations for water budget are:

1. Maintain the existing water balance in each watershed.
2. Maintain or enhance baseflows.
3. Maintain or enhance groundwater levels and discharge for watershed functions.
4. Ensure sustainable rates and timing of surface and ground water use.
5. OMOE should consult with other government agencies to determine acceptable flow alterations to protect aquatic communities.

Water Quality

Excess sediment, nutrients, bacteria, oils, grease, and heavy metals are some of the most common substances that impact water quality and aquatic ecosystems.

There are many methods, technologies, programs and regulations for mitigating potential water quality impacts, including best management practices, stormwater management, sewage treatment, Provincial Water Quality Objectives, non-point source management programs, hazardous waste days, sediment and erosion management and vegetative buffers.

Water quality in both watersheds is generally good, however, non-point sources including agricultural and urban run-off are principle contributing sources to degraded water quality. In 2000, the OMOE priority pollution study showed the Duffins Creek watershed to be in good health. The Stouffville sewage treatment plant is the only point source of pollution in the Duffins Creek watershed and it is scheduled to be decommissioned in 2004/05. Spills management is the responsibility of the OMOE and should be reported immediately to OMOE and the appropriate municipality. Suspected spills should be reported to the 24-hour Spills Action Centre (toll free: 1-800-268-6060; tel: (416) 325-3000).

Management recommendations for water quality are:

1. Manage the quality and quantity of run-off from rural and urban areas to maintain instream uses.
2. Minimize sediment run-off associated with construction or agricultural activities.
3. Reduce water quality contamination associated with wastewater discharges.
4. Protect groundwater quality to ensure provision of ecological functions.
5. Golf courses, cemeteries and agricultural industry develop integrated pesticide and nutrient management programs.
6. All stormwater should be treated at the "enhanced" level prior to discharge into streams.
7. Apply agricultural, industrial and residential Best Management Practices.
8. Protect and establish riparian buffers.

Instream Barriers and On-line Ponds

The impacts of instream barriers and on-line ponds have been dealt with in detail in Section 2.1.1 and include alteration of channel hydraulics, the deposition of sediment and the warming of water in the head pond and restricting access of aquatic organisms upstream of the barrier. Instream barrier mitigation and/or removal is critical to rehabilitating stream functions and the biological community in both watersheds.

Taking a pond off-line or removing the barrier entirely are the preferred alternatives to mitigate the impacts of on-line ponds. If these are not feasible, conversion of the outlet to a bottom draw or providing fish passage should be considered. With a bottom draw configuration, cooler water from the pond bottom is drawn to the outlet, while the warmer surface water remains. Downstream aquatic communities also benefit from the higher oxygen content of the cooler water. This method, however, still precludes fish passage.

Various types of fishways including rocky ramps, step-pool, vertical slot and Denil fishways can be used to provide fish passage. In some cases, sections of the dam can be removed to lower the height of the outlet. When mitigating barriers, the human heritage significance of the structure must also be considered.

Barriers can be beneficial, particularly when they are used to harness the water's energy or when controlling the access of undesirable fish species. Sea lamprey have had a devastating effect on many Great Lakes fish species, and limiting sea lamprey access to spawning grounds is crucial. Unfortunately, this also precludes the passage of non-jumping species.

Management goals for the Duffins Creek watershed include the protection of brook trout populations in the headwaters, while also managing for migratory salmon and trout. Scientific research is still divided on the competitive interactions between native and introduced trout and salmon species, however, given that the literature suggests incompatibility, a cautious approach should be taken with regards to potential implications of removing all barriers. Secondly, some initial research into the reintroduction of Atlantic salmon suggests that streams with no rainbow trout have better Atlantic salmon fry survival than streams with rainbow trout (Reference). Given that early reports by OMNR (Daniels, 2001) suggest that the Duffins watershed is a good candidate for the reintroduction of Atlantic salmon, an important fisheries management goal is to keep migratory salmon and trout separated from native brook trout populations using two strategic barriers, Newman's dam on the East Duffins Creek and Whitevale dam on the West Duffins Creek.

Management recommendations for instream barriers and on-line ponds are:

1. Barriers and on-line ponds should be removed or by-passes created, where feasible. Where not feasible, fish passage should be considered and/or pond outlets converted to bottom draw structures.
2. Maintain the Whitevale dam and Newman's dam for fisheries management purposes.
3. Initiate negotiations with landowner to maintain Newman's dam.
4. DFO to conduct additional research to evaluate alternative sea lamprey barriers that allow for the passage of non-jumping fish species (eg. inflatable barriers).
5. Conduct fish passage investigations at known and potential barriers.

Riparian Vegetation

The benefits of riparian habitat are outlined in more detail in Section 2.1.1, but include bank stabilization, stream shading, source of material for cover and inputs of organic materials. Indirect benefits include attracting insects that then provide a source of benthic invertebrates to the aquatic environment.

Considerable insight into the relationship between the percentage of riparian vegetation by stream length and stream health was developed by Steedman (1987). His work suggested that at 0 per cent urbanization, a stream would require approximately 80 per cent of its bank by length in a naturally vegetated state to be considered unimpaired. Additionally, as a watershed becomes more urbanized, it requires an increasingly higher percentage of riparian vegetation to remain in this unimpaired state. Beyond 15 per cent urbanization, Steedman's analysis suggests that a stream would require more than 100 per cent of stream bank length have riparian vegetation. Furthermore, Steedman's work indicates that at least 75 per cent of total riparian vegetation should have a woody component to maintain the integrity of the biological system.

Based on the above analysis, Environment Canada (1998) recommends that 75 per cent of stream length should be naturally vegetated. Given the health of these watersheds, this has been revised to be 100 per cent of stream length should be naturally vegetated, with 75 per cent having a woody component. This target should be applied to both warm- and cold-water streams, so that both are managed and protected equally.

Much controversy still exists regarding the delineation of buffer widths. Environment Canada (1988) currently recommends that streams should have a 30-metre wide vegetatedbuffer on both sides, while OMNR recommends a 15-metre buffer on warm-water streams and a 30-metre buffer on cold-water streams. In the meantime, it is recommended that buffer width delineation follow protocols outlined in the Oak Ridges Moraine Act (2001) and the Valley and Stream Corridor Management Program (TRCA, 1994).

Management recommendations for riparian vegetation are:

1. 100 per cent of stream bank length should be naturally vegetated.
2. 75 per cent of stream bank vegetation should have a woody component.
3. Riparian vegetation should not be mowed or cropped to the stream's edge.
4. Delineation of riparian buffer widths should be applied following the Oak Ridges Moraine Act (2001) and the Valley and Stream Corridor Management Program (TRCA 1994).
5. Restoration plantings are required on private lands.
6. Develop a naturalization program for TRCA and other public land that includes riparian zone management.

Habitat Rehabilitation

In-water and riparian habitat features are an important component of the aquatic community, providing refugia, a source of organic matter, and potential spawning habitat. There are a wide variety of techniques used to restore aquatic habitat features and functions, all of which require varying levels of effort and intervention. In general, it is preferable to minimize the use of techniques that inhibit natural processes, and to emphasize those that mimic natural ones. Traditionally, stream alteration has involved the use of concrete channels, sheet piling or other 'hard' techniques. Today, the use of natural channel design principles is viewed as the best way to improve habitat in an altered watercourse. It is an attempt to mimic the natural form and function of a stream channel by applying geomorphological and physical relationships to its' design (Gerdes, 1994). *The Adaptive Management of Stream Corridors in Ontario* (Ontario Ministry of Natural Resources and Watershed Science Centre, 2002) is a recent document that provides additional guidance on natural channel design principles while the fluvial geomorphology sections in the *Duffins and Carruthers Creeks State of the Watershed Reports* (TRCA, 2002; TRCA, 2002b) provides additional details on this component of the ecosystem.

Regardless of the approach, however, a clear understanding of site-specific conditions and channel characteristics is needed to ensure that the proposed technique is appropriate. Initial measurements of the stream characteristics need to be completed, including meander length, bankfull width, slope and bed and bank materials. Mathematical relationships have also been established between many of these variables to use as the basis for a natural channel design project (Newbury and Gaboury, 1993).

Stream rehabilitation techniques include bioengineering (e.g. live staking, fascines, brush layers, brush mattress, live crib walls, willow posts and native material revetments) and instream habitat improvements (e.g. LUNKERS, boulder placement, log cover, and log jams), and riparian plantings. More detail on rehabilitation measures can be found in *Ontario's Stream Rehabilitation Manual* (Heaton et al, 2001) or *Stream Corridor Restoration: Principles, Processes, and Practices* (Federal Interagency Stream Restoration Working Group, 1998).

Stream habitat isn't the only type of habitat requiring restoration. The loss of wetlands has been severe in southern Ontario. Wetland restoration and protection is key to improving aquatic ecosystem health for the recharge, flow attenuation and habitat functions they provide. Like the restoration of natural channels, restoring wetland features and functions is a multi-disciplinary endeavour and it is best to consult professionals prior to initiating large scale restoration projects.

Before work begins on any rehabilitation project, it is important to check with the local CA or OMNR office to see if any permits are required. This is particularly important in the case of instream and wetland works where extensive channel alterations are proposed or fill is proposed in floodplains or valley slopes. These agencies may also be able to recommend rehabilitation locations, offer advice or tie the project in with other local initiatives.

Management recommendations for habitat rehabilitation are:

1. Initiate projects and provide advice to interested groups to restore and develop fish habitats, in support of the management philosophy of net gain.
2. Instream works must be planned with an understanding of reach level function.
3. Rehabilitation works should be appropriately scaled, particularly where projects are significant in either size or impact.
4. Natural channel design should be the primary method used in stream restoration.
5. Land-owners should be made aware of laws and legislation relating to works in and around water.
6. Implement TRCA's Terrestrial Natural Heritage System Strategy.

3.2 AQUATIC COMMUNITY

Target Species for Management

The previous sections of this Plan have established the physical and biological characteristics of the two watersheds and identified impacts to both, which allowed for the assessment of "aquatic potential" and ultimately, designation of cold- and warm-water streams into habitat categories. This designation did not, however, take into account limitations imposed by land use change, planned development, instream barriers or human wants. As second level of designation is necessary based upon these human-related issues.

Based on the habitat categories, target species were identified for both watersheds. The term "target species" is interchangeable with the term "indicator species", or those species whose habitat needs represent or encompass those of the whole community. Target species were primarily selected to be represented by a native fish species that is at the top of the trophic pyramid for a given habitat type (i.e., brook trout), but in one instance a naturalized exotic species was selected. One target species, rainbow trout, is introduced, but was selected for management due to strong recommendations and support from the angling community. Each of the habitat categories identified in Section 2.1.2 were assigned target species as shown in Table 20.

Table 20. Comparison between habitat categories and target species for management.

Habitat Category	Target Species for Management
Small Riverine Coldwater Habitat	brook trout (and Atlantic salmon in Duffins only)
Small Riverine Warmwater Habitat:	redside dace and darter species
Intermediate Coldwater Habitat:	Atlantic salmon and brook trout upstream of the Whitevale and Newman's dams; rainbow trout and redside dace downstream of the Whitevale and Newman's dams
Large Riverine Habitat	smallmouth bass
Estuarine Habitat	northern pike, smallmouth bass, largemouth bass

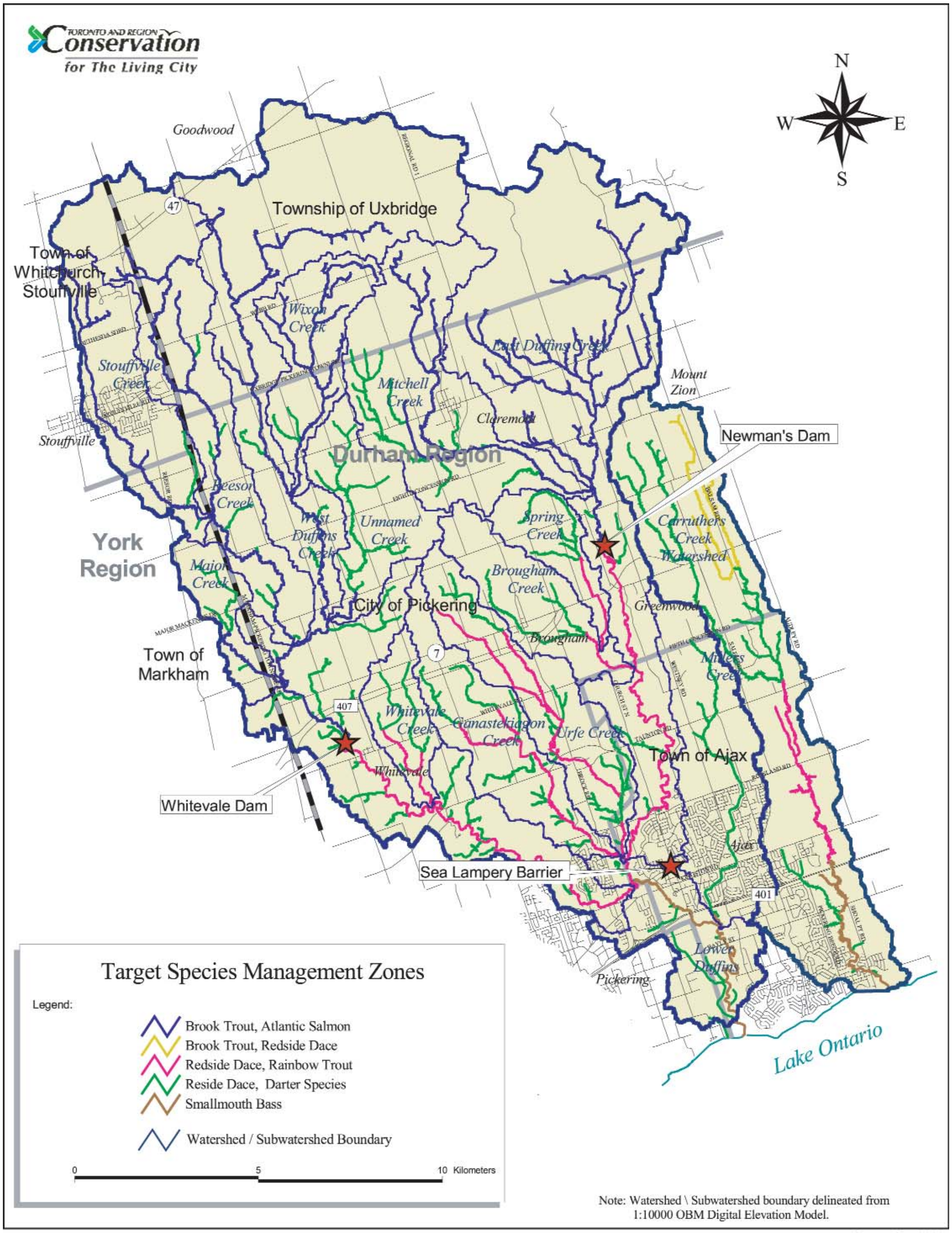
Due to potential negative interactions between Atlantic salmon and brook and rainbow trout, it was decided that maintaining the separation between the native and introduced salmonids was an important management goal. Two existing barriers on the East and West Duffins creeks, Newman's dam and Whitevale dam, respectively, were identified as appropriate structures to provide this separation. This was put forward at public meetings in 2002 and based on public input, was chosen as the preferred management direction. Figure 19 identifies the location of these target species management zones.

Species at Risk

Destruction and degradation of habitat have been the major factors in reducing the distribution of redside dace, a Species of Special Concern. Siltation, removal of riparian cover, channelization and agricultural pollution of streams, and direct disturbance by people and domestic animals has significantly reduced suitable habitat and food sources. In 2000, the development of a recovery plan for the redside dace was initiated. In 2002, Ontario Streams began implementing this plan to restore redside dace in a significant portion of their historic range in Canada. Protection and rehabilitation of riparian habitats and improved water quality are key to restoring the population.

Species of Intermediate Priority include American eel, American brook lamprey, rainbow darter, brassy minnow, and northern redbelly dace. Barriers, overfishing, pollution and ecological change are all considered factors in the apparent decline of the American eel population, to the point where the Great Lakes Fisheries Commission - Lake Ontario has stated that "without management intervention, extirpation of the American eel in the Great Lakes Basin is likely" (GLFC, 2002). American brook lamprey and rainbow darter have been recently found in the Duffins Creek, but not the Carruthers Creek watershed. Northern redbelly dace have been recently found in both watersheds, and brassy minnow was absent from recent surveys on both accounts.

Figure 19. Target Species Management Zones.



Species of Lower Priority include emerald shiner, spottail shiner and stonecat. Both spottail shiner and stonecat were recently identified in the Duffins Creek, but not Carruthers Creek, while emerald shiner has been absent in recent surveys of both watersheds. Accounts of stonecat in the Duffins system has declined in the last 10 years, possibly due in part to the application of lampricide. TFM has been linked to the near extirpation of stonecat (Dahl and McDonald, 1980) and is also known to be lethal to mudpuppies (Dodge, 2002) and other amphibians. Currently, the amount of TFM used is 50 per cent less than the average use for the 1980's.

Potential species at risk also include native clams, mussels and crayfish which could be on the decline due to habitat degradation and competition from introduced species.

Management recommendations for Species at Risk are:

1. Protect and restore riparian habitat. Restoration plantings should include a high proportion of grass and shrub material in redside dace management zones.
2. Apply the Valley and Stream Corridor Management Program (TRCA, 1994).
3. Investigate the status of native mussels, clams and crayfish.
4. Great Lakes Fishery Commission to continue to investigate alternatives to the use of TFM.
5. DFO to notify TRCA before applying lampricide on TRCA properties.
6. DFO to put up appropriate signage when applying lampricide on TRCA properties.
7. Initiate implementation of the Redside Dace Recovery Plan.

Introduced Species

Seven introduced species have been found in Duffins Creek and include sea lamprey, chinook salmon, rainbow and brown trout, common carp, white perch, alewife and rusty crayfish. Two introduced fish species, common carp and rainbow trout, have been found in Carruthers Creek.

Sea lampreys are an invasive species established in the Great Lakes as a result of the development of canal systems in the 1900's. Blamed for a crash in the Great Lakes fishery, implementation of a sea lamprey control program was assigned to the Great Lakes Fishery Commission (GLFC) under the 1955 Convention on Great Lakes Fisheries. The sea lamprey control program is implemented in Ontario by DFO, who is designated as the Canadian Agent for the GLFC.

Sea lamprey control is generally undertaken using a liquid formulation of the selective lampricide TFM, which is applied to streams infested with larval sea lampreys. Although minor fish kills are known to occur after the application of TFM, most bony fish are capable of metabolizing the compound. Lampricide has been used in Duffins Creek on a three-to five-year cycle since 1971. One application was made to Carruthers Creek in 1976, with no subsequent re-establishment. Results of sea lamprey control are evident in the recovery of the Great Lakes fishery since the program was implemented in the 1950's. Today, sea lamprey control is implemented using an integrated pest management strategy, which combines the use of lampricide with other control alternatives to maximize the effectiveness of the program.

The primary alternative for controlling sea lampreys is the installation of low head barriers on streams to block lamprey from accessing spawning grounds. Most lamprey barriers allow passage for jumping fish species such as migratory salmonids, but block access to non-jumping fish such as minnows, smallmouth bass and darter species. Some lamprey barriers include fishways that are manually operated to pass all species of fish while removing lampreys. A lamprey barrier and trap exists on the Lower Duffins Creek just north of Church Street. Between 1997 and 2000 the lamprey trap caught approximately 1, 792 lamprey. In those same years, Duffins Creek had the second highest capture rate for traps in Lake Ontario, except for 1999, where it ranked the highest.

Lamprey traps are built into most lamprey barriers and capture lampreys efficiently, providing a population assessment tool, fish-up of spawning lampreys and a source of lampreys for research and for the sterile male release program. The GLFC funds an on-going sea lamprey research program to investigate new control methods and enhance the effectiveness of existing methods.

TRCA has taken steps to control carp access to the Duffins Creek Marsh through the installation of a carp gate in 2002 in one of the eastern lagoons. The gate's effectiveness will be monitored over time, however, as of early 2003, a marked decrease in water turbidity of approximately 300 percent has been observed (TRCA, 2003). Carruthers Creek Marsh has a different shape and, as such, considerable earthworks would be required to install a similar system.

Rusty crayfish is a new invader to the Duffins watershed and was first found at seven locations in 2002. As a first step, the distribution and potential impact of the crayfish must be identified.

Other introduced species, such as chinook salmon and rainbow and brown trout, are commonly found throughout the lower reaches of the Duffins and Carruthers systems. These species are very popular in the angling community and are still stocked into Lake Ontario by the OMNR.

Management recommendations for introduced species are:

1. DFO to maintain the sea lamprey barrier on Duffins Creek.
2. GLFC to conduct additional research to evaluate alternative sea lamprey barriers and fish passage technology to improve passage for non-jumping fish.
3. GLFC to continue to investigate alternatives to the use of TFM in the control of sea lamprey.
4. DFO to evaluate the existing structure designated as a sea lamprey barrier in Carruthers Creek more closely to determine if it is performing well as a sea lamprey barrier.
5. Investigate the distribution and potential impact of rusty crayfish.
6. TRCA and OMNR to control carp access to Duffins Creek Marsh and Carruthers Creek Marsh.
7. OMNR investigate the potential for "carp derbies" as a way to reduce the existing carp population.

Stocking

Stocking is a fisheries management tool which can have one of three main purposes: to provide for recreational fisheries, species rehabilitation or research. Permits from the OMNR are required for the sale, transfer and stocking of fish and spawn in Ontario. Recreational stocking includes put-and-take stocking where catchabl- sized fish are released for public or private angling benefits. Put, grow and delayed take stocking is similar, but the fish are released at a small size with the intention of having them grow in the environment in which they were stocked, with the expected benefit to the public occurring years later. The chinook salmon fishery of Lake Ontario is a put, grow and delayed take fishery.

Historically, stocking by the OMNR has included Atlantic salmon and rainbow, brown and brook trout and is typically done on public waters (Appendix D). The most recent stocking events were Atlantic salmon in 1999 and brown trout in 2001.

In addition to stocking of publically-owned areas, the stocking of private ponds also takes place. The amount and species stocked into private ponds is unknown. Some of the more common species used in the stocking of private ponds are brook and rainbow trout and largemouth bass.

Management recommendations for recreational stocking are:

1. Fish species to be stocked on either public or private land must be consistent with the management zones defined in this Plan.
2. Native strains are preferred.
3. No additional stocking of non-native salmonid species into the tributaries of Duffins Creek.
4. OMNR to conduct genetic analysis to assess the presence and extent of the historic brook trout population in Duffins Creek.
5. OMNR to investigate the habitat suitability for a self-sustaining population of rainbow trout downstream of Taunton Road in Carruthers Creek and if appropriate, consider stocking.

A final type of stocking is for rehabilitative purposes and is typically done when an existing population is extirpated or has diminished beyond the point of recovery. Fish are stocked at various life stages, either fry, fingerling or yearling, with the intention of having them grow to maturity and become self?sustaining over a number of years of stocking effort.

Management recommendations for rehabilitative stocking are:

1. OMNR to investigate the habitat suitability for redside dace and Atlantic salmon in the appropriate management zones in Duffins Creek and if appropriate, consider stocking.
2. OMNR to investigate the habitat suitability for brook trout and redside dace in the appropriate management zones in Carruthers Creek and if appropriate, consider stocking.

3.3 CONSUMPTIVE USES

Consumptive uses include any method of harvesting the resource, such as angling, baitfish harvesting or water removal. It is critical that consumptive-use opportunities be provided, while at the same time protecting the integrity of natural resources.

Angling

Recreational angling, especially in Duffins Creek, continues to be a popular sport. Rainbow trout, particularly in the spring, draws many anglers from southern Ontario. While there is some headwater angling for resident brook trout and warm-water species in the coastal marsh over the summer, the fall again sees anglers return for chinook salmon and brown trout. Popular locations in the watershed for angling include Highway 401, Greenwood Conservation Area, Duffins Creek marsh and the Whitevale area. The pressure these anglers place on sportfish and the ecosystem is currently unknown but is important to understand in order to better manage the fishery.

Recommendations for angling are:

1. OMNR co-ordinate creel surveys over all seasons to better understand angler use.
2. OMOE expand the list of fish species in the Sportfish Contaminant Monitoring Program to include coarse species.

Enforcement and Regulations

Fishing seasons, sanctuaries, methods and limits are administered by the OMNR under the Ontario Fisheries Regulations which fall under the Fish and Wildlife Conservation Act. For further information, consult the Ontario Sport Fishing Regulations published annually by the OMNR.

Enforcement of the fishing regulations is done by OMNR Conservation Officers (COs) with some limited assistance from local police and the public. It is the responsibility of COs to control illegal activities such as poaching, overfishing, angling without a licence, etc. If you see any illegal activities, please contact the OMNR, Crimestoppers or the local police detachment.

To reduce illegal activities, the Fish and Wildlife Guardian Program should be initiated on both watersheds. Fish and Wildlife Guardians are volunteers who assist OMNR's compliance efforts by providing the public with local knowledge and awareness about fishing and hunting rules and regulations and acting as the "eyes and ears" for OMNR, noting any non-compliance activities they may observe and sharing this with district enforcement staff. Each volunteer accepted into the Guardian program will be given an introduction to the various statutes, conflict avoidance and conflict resolution, cross-cultural awareness and note-taking and observational skills. Anyone who is over eighteen, and who has not been convicted of a fish and wildlife-related or criminal offence within the last five years, is eligible to apply to the Guardian Program.

Except for a small portion of the watershed in York Region which is in Division 4, the Carruthers and Duffins creek watersheds are in Division 6. This means that there is NO angling upstream from Highway 2 from the middle of November to the last Saturday in April. Consult the current version of the Ontario Sport Fishing Regulations for the exact dates in November and April.

A number of angling regulations were suggested during the development of the Fisheries Management Plan, including reduced trout and salmon catch-and-possession limits, use of barbless hooks and catch and release areas. Due to a Lake Ontario-wide review of trout and salmon regulations in 2004, these changes have not gone forward. However, in the short term, there is an opportunity to apply stricter rules on TRCA properties as a condition of access.

Recommended changes to enforcement and angling regulations are:

1. **Short term** – artificial bait and single barbless hooks on TRCA properties upstream of Highway 7 only; trout and salmon catch and possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence.
2. **Long term** – artificial bait and single barbless hooks only upstream of Highway 7, catch-and-possession limits in both watersheds for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.
3. OMNR to assess the need for a fish sanctuary between Whitevale dam and Whitevale Road.
4. OMNR to increase enforcement, particularly during spring and fall migration periods.

Baitfish Harvesting

Ontario's bait industry is comprised of approximately 1,100 baitfish harvesters and 800 dealers engaged in the retail, wholesale and export of live bait for angler use, and is estimated to contribute between $40 million and $60 million to the economy. Businesses and commercial harvesters engaged in the collection and sale of bait are required to be licenced by the OMNR. The baitfish resource is allocated to harvesters through the exclusive use block system, with one harvester per Bait Harvest Area (BHA). Both the Duffins and Carruthers creeks watersheds have been a location for commercial baitfish harvest for many years and are known as Bait Harvest Area AU-14. Generally, the most common baitfish collected are emerald shiner, spottail shiner, common shiner, creek chub, white sucker and northern redbelly dace.

On a smaller scale, recreational anglers are permitted, as part of their regular sportfish licence, to catch baitfish as defined in the Ontario Sport Fishing Regulations. Anglers are allowed collect baitfish using a baitfish trap, dip-net or seine and can have no more than 120 minnows in their possession at any time. It is also illegal to sell angler-caught baitfish.

Management recommendations for baitfish harvesting are:

1. Baitfish collection to be restricted at known redside dace locations.
2. Commercial harvesters should reduce the risk of accidental harvest of Species at Risk and game species through timing, location and collection techniques.
3. Commercial harvesters should be capable of identifying all species and have taken a fish identification course.
4. All Species at Risk and game species should be released.
5. Complete and accurate records to be sent to OMNR and include data on amounts, species and locations collected. For collections on TRCA properties, data should also be sent to TRCA.
6. OMNR and TRCA work with the Ontario Baitfish Association to explore opportunities to use baitfish harvest records as additional data in assessing fish community trends in the watersheds.

3.4 PUBLIC ACCESS AND LANDS

Public lands provide access to various sections of the river for angling, walking, wildlife viewing, and educational opportunities. Many of these lands have parking opportunities as well. In the Duffins Creek watershed, public land is owned by the federal and provincial government, local municipalities and the TRCA (Figures 1 and 18). Public land in the Carruthers Creek watershed is very limited, with only a few properties in public ownership (Figures 3 and 20). Trails like the Oak Ridges Moraine Trail, Trans-Canada Trail, Seaton Trail, Waterfront Trail and municipal trails also provide important access nodes. While the majority of public land is open to the public, some lands require additional permission to enter. Check with the landowner, whether they are public or private, before entering property for any reason. In addition, all signs, such as No Trespassing, No Angling, or Private Property, should be obeyed.

TRCA and Municipal Land

The TRCA owns approximately 593 hectares of land in the Duffins Creek watershed and 25 in the Carruthers Creek watershed. TRCA lands in Duffins Creek include the Greenwood and Goodwood Conservation Areas, Claremont Field Centre and the Glen Major conservation lands.

Recommendations for TRCA and municipal lands are:

1. Create specific access areas/nodes for anglers.
2. Promote catch-and-release angling, and the use of barbless hooks within identified reaches.
3. Improve angling opportunities and stewardship practices by exploring the possibility of establishing angling clubs within conservation areas.
4. Additional public lands should be secured in the Carruthers Creek watershed, particularly in Carruthers Creek Marsh.
5. Investigate opportunities to establish additional conservation easements in both watersheds.
6. Continue to reduce the amount of mowed areas adjacent to streams, where feasible.
7. Implement TRCA's Terrestrial Natural Heritage System Strategy and approved Conservation Land Management Plans. Develop management plans for other TRCA properties.

Federal and Provincial Lands

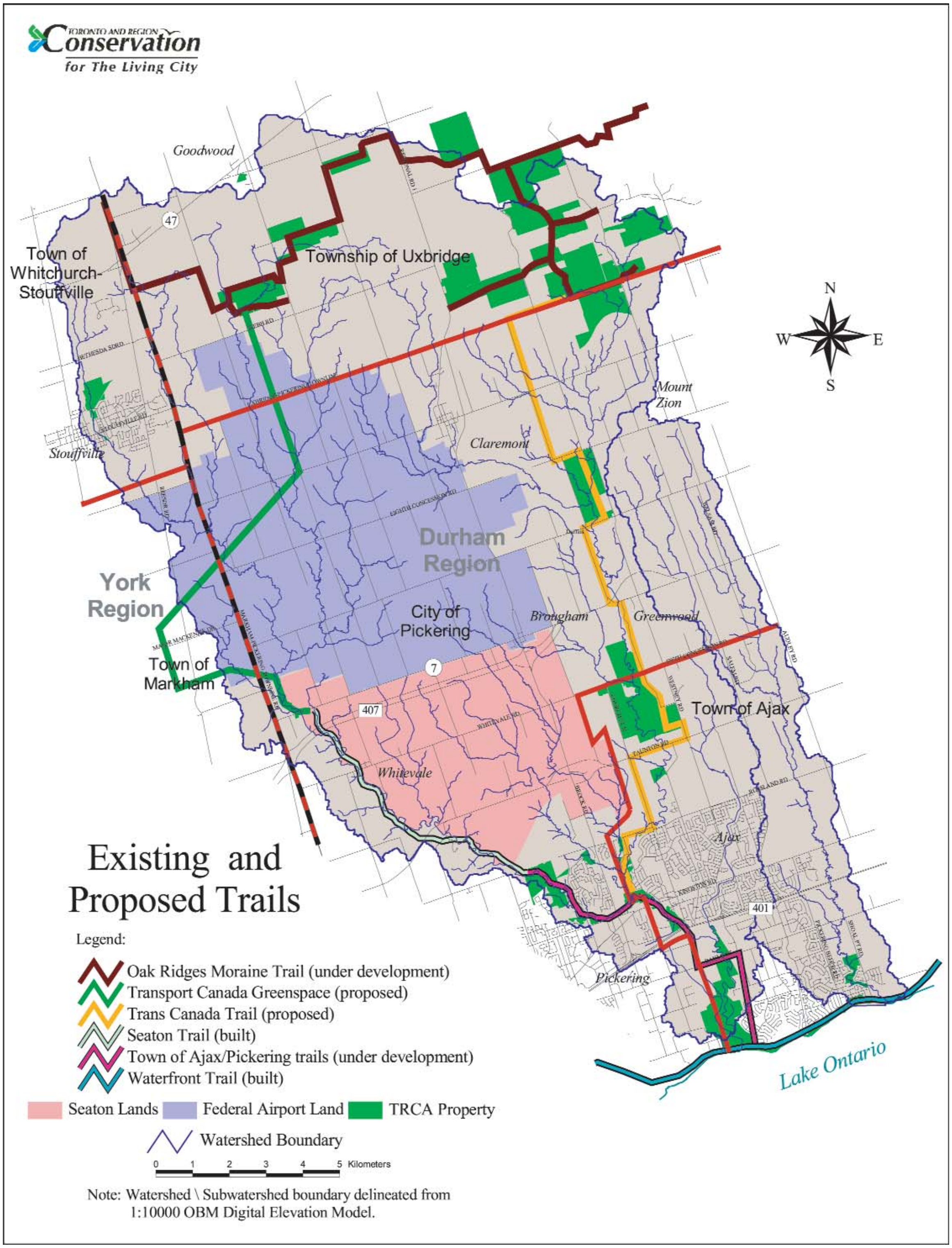
The federal government owns approximately 7,500 hectares of land in the Duffins Creek watershed. This property straddles portions of the West Duffins, Urfe, Ganatsekiagon, Mitchells and Brougham Creeks. This land was originally expropriated in the 1970s to be developed as an international airport. In 2002, the federal government set aside just over 2,200 hectares as part of Transport Canada's Greenspace Strategy for lands on the Oak Ridges Moraine. Should an airport be developed in the Duffins Creek watershed, every attempt should be made to enhance the aquatic resources in the watershed.

The provincial government owns approximately 3,200 hectares of land in the southwest portion of the Duffins creeks watersheds, and covers portions of the West Duffins, Urfe and Ganatsekiagon Creek subwatersheds known as the Seaton Lands. Though it has been farmed for many years, it will likely be developed and converted into housing. Discussions with the Province of Ontario, the City of Pickering and the Regional Municipality of Durham relating to the ultimate land uses are currently underway to ensure that the environment is considered in land-use designations, and best management practices are incorporated into urban designs.

Management recommendations for federal and provincial Lands are:

1. All development should be conducted on an "environment first" basis and should include a development setback of at least 30 m from top of bank.
2. Additional aquatic surveys are required to determine use by salmonids and redside dace.
3. All existing natural features must be identified and receive full protection.
4. Implement TRCA's Terrestrial Natural Heritage System Strategy.

Figure 20. Locations of Trails and Public Land.



3.5 EDUCATION

Environmental education is an integral part of helping increase people understanding, awareness and appreciation of the importance of healthy habitats and clean water. This educational experience can occur through TRCA programs such as Yellow Fish Road, Adopt a Pond, Adopt a Stream or the Aquatic Plants Program, through a local interest or community group, or through classroom study. An increase in or the promotion of educational programs only serves to heighten interest in the health of the watershed.

Fish viewing can also be an educational experience. Trout, salmon and white sucker spawning runs in the spring and fall provide an excellent opportunity to see fish up close. Presently, people are attracted to the area below the sea lamprey barrier and Whitevale dam to watch for spawning rainbow trout or chinook salmon. Of concern, however is that the time when fish are most easily seen coincides with critical periods when the fish are spawning. These fish may be easily scared and disturbed, especially if people enter the water. Care must be taken when viewing fish that disturbance is minimized.

Management recommendations for education are:

1. Viewing opportunities should be expanded and/or formalized on appropriate TRCA lands.
2. Signs at road crossings be posted to indicate the presence of self-sustaining trout and salmon populations.
3. Continue to implement programs like Yellow Fish Road and Adopt a Stream.

3.6 PLAN INPUT AND REVIEW

The long-term health of aquatic ecosystems, including the protection of fish habitat, is an essential consideration in any land use planning process. Discussion at the early stages of project design should occur between proponents, DFO[1], OMNR, OMOE and TRCA to ensure that appropriate fish habitat protection measures are considered at the proper planning stage. DFO, OMNR, OMOE and TRCA use opportunities in the planning process defined under the *Planning Act* and the *Environmental Assessment Act* to ensure that future activities resulting from development approvals will be consistent with the provisions of the *Fisheries Act*. Approval under the *Planning Act* does not absolve a proponent from meeting the requirements of any other statutes, required after the Planning Act approvals have been received, such as a work permit under the *Public Lands Act*, the *Lakes and Rivers Improvement Act*, the *Ontario Water Resources Act*, and the *Conservation Authorities Act*. However, in many cases, consideration of fish habitat protection for the proposed development under the *Planning Act* may address the concerns that are commonly

[1] In 1998, the 'Canada – Toronto and Region Conservation Authority Fish Habitat Management Agreement Respecting Worksharing Arrangements for Initial Review Determinations, Mitigation Requirements and Compensation Planning for the Purposes of Section 35 of the Fisheries Act, was signed. TRCA has signed a Level 3 agreement whereby TRCA approves works where fisheries impacts are satisfactorily mitigated and provides advice to proponents on compensation for a HADD (Harmful Alteration, Disruption, or Destruction) and facilitates the process for DFO authorization of a HADD.

raised when applications are received for legislative approvals.OMNR is responsible for setting these construction timing windows (Table 21). These are periods when instream work is not permitted due to fish spawning. Project planning must take these timing windows into account.

Table 21. Construction timing windows in the Duffins and Carruthers creeks watersheds

Habitat Category	Construction Period	Comments
Small Riverine Coldwater Intermediate Riverine Coldwater	July 1 to September 15	N/A
Small Riverine Warmwater Intermediate Riverine Warmwater Estuarine Lacustrine	July 1 to March 31	Where migratory species are present, passage must be maintained. The presence of redside dace in warm-water systems changes the timing guideline to July 1 to September 15.

3.7 BROADER ISSUES

There are a number of broader issues that, while important, are beyond the scope of this document, but do require further study. These include:

- monitoring of the potential impacts of climate change;
- monitoring of the potential impacts of air quality;
- assessment of the socio-economic benefits of the fisheries of both watersheds, and;
- expansion of the number of locations and species included in the sportfish contaminant sampling program.

CHAPTER

4

4.0 IMPLEMENTATION – A SUBWATERSHED PERSPECTIVE

This section provides the opportunity to focus on the current conditions and issues affecting each subwatershed. This section also identifies subwatershed restoration and protection needs, based on the management recommendations outlined in Section 3.0.

Every effort has been taken to ensure consistency with the management direction provided here and that outlined in the watershed plan. If through error or omission a discrepancy is found, please contact the TRCA for clarification.

4.1 EAST DUFFINS CREEK SUBWATERSHED

4.1.1 INTRODUCTION

This subwatershed begins in the northeastern portion of the Duffins Creek watershed and flows in a southerly direction, collecting water from a number of smaller tributaries until it's confluence with the West Duffins Creek north of Highway 2. The subwatershed drains approximately 9,202 hectares of land and contains approximately 124 kilometres of 1st to 4th order watercourses. Three tributaries contribute to the main branch of the East Duffins Creek, including Mitchell Creek, Brougham Creek and Spring Creek (Figure 21).

Setting

Land cover in this subwatershed is predominantly rural and natural cover, with approximately 50 per cent in agriculture, 45 per cent is natural cover, composed of meadow, wetland or forest, 1 per cent is golf course and 4 per cent is urbanized (Table 22).

Table 22. Current land cover in the East Duffins Creek subwatershed

Tributary	Total Area (ha)	% Agricultural	% Natural	% Urban
East Duffins Creek	5439	39	57	4
Mitchell Creek	2359	64	32	4
Brougham Creek	844	74	23	3
Spring Creek	560	73	27	0
East Duffins Creek subwatershed	9202	51	45	4

It is estimated that the subwatershed once contained approximately 146 hectares of wetlands, compared to a current wetland area of approximately 112 hectares.

The East Duffins Creek subwatershed contains 60 km of small riverine cold-water habitat (50 per cent of stream length), 34 km of small riverine warm-water habitat (28 per cent of stream length) and 27 km of intermediate riverine cold-water habitat (22 per cent of stream length).

4.1.2 AQUATIC COMMUNITY;

A list of the 40 fish species historically found and the 19 found in 2000 is shown in Table 23.

Table 23. Fish species found historically and in 2000 in the East Duffins Creek subwatershed

Common Name	Historic	2000*	Common Name	Historic	2000*
American brook lamprey	♦		spottail shiner[5]	♦	
northern brook lamprey**	♦		spotfin shiner	♦	
sea lamprey[c]	♦		bluntnose minnow	♦	
chinook salmon[1]	♦		fathead minnow	♦	♦
coho salmon[1]	♦		blacknose dace	♦	♦
rainbow trout[1]	♦	♦	longnose dace	♦	♦
Atlantic salmon[2]	♦		creek chub	♦	♦
brown trout1	♦	♦	brown bullhead	♦	♦
brook trout	♦	♦	stonecat[5]	♦	♦
northern pike	♦		white perch[1]	♦	
white sucker	♦	♦	rock bass	♦	♦
northern hog sucker	♦		pumpkinseed	♦	♦
northern redbelly dace[4]	♦		smallmouth bass	♦	
redside dace[3,6]	♦		largemouth bass	♦	♦
common carp[1]	♦		yellow perch	♦	
brassy minnow[4]	♦		rainbow darter[4]	♦	♦
hornyhead chub		♦	fantail darter	♦	
river chub	♦		johnny darter	♦	♦
emerald shiner[5]		♦	mottled sculpin	♦	♦
common shiner	♦		slimy sculpin	♦	♦

** – Though not captured in 2000, American brook lamprey and chinook salmon are known to be present while northern hog sucker, common shiner, bluntnose minnow and fantail darter are expected to be present. The status of coho salmon, northern redbelly dace, redside dace, brassy minnow, river chub, spottail shiner, spotfin shiner, white perch, smallmouth bass and yellow perch are unknown.*

*** – Likely a misidentification since recorded range does not include north shore of Lake Ontario*
[1] - Introduced species
[2] - Extirpated species
[3] - COSEWIC - Species of Special Concern
[4] - COSEWIC - Group 2, Intermediate Priority
[5] - COSEWIC - Group 3, Lower Priority
[6] - COSSARO - Threatened

Atlantic salmon, once common in Duffins Creek, are extirpated from the watershed. Historically, they likely spawned in East Duffins Creek, but it is not known which tributaries they utilized.

Although some historical benthic invertebrate records were found for the East Duffins system, the study intentions and methodology tended to be vague and study locations were often cryptic and/or did not correspond well with recent sample station location. The decision, therefore, was made to focus on the invertebrate data collected in 2000 rather than the historic information. General results of the invertebrate survey are listed in Table 24.

Table 24. Summary of 2000 benthic invertebrate analysis for the East Duffins Creek subwatershed.

Station	Total No. of Taxa	Most Common Taxa	% Of Total Sample	Next Most Common Taxa	% of Total Sample	EPT	Hilsenhoff's Family Biotic Index /Rating	Shannon Weaver Diversity Index
SP01	19	Amphipoda (scuds)	79	Plecoptera (stoneflies)	6	2	5.8/ Fairly Poor	1.38
BR02	29	Amphipoda (scuds)	69	Simuliidae (black flies)	22	7	5.9/ Fairly Poor	1.79
EDU01	30	Amphipoda (scuds)	44	Ephemeroptera (mayflies)	15	9	5.4/ Fair	2.85
EDU02	31	Amphipoda (scuds)	81	Trichoptera (caddis flies)	4	13	5.7/ Fairly Poor	1.52
EDU03	8	Amphipoda (scuds)	89	Ephemeroptera (mayflies)	5	3	5.9/ Fairly Poor	1.46
EDU04	36	Amphipoda (scuds)	45	Coleoptera (beetles)	33	16	5.1/ Fair	2.69
EDU05	31	Ephemeroptera (mayflies)	36	Chironomidae (midges)	32	10	5.3/ Fair	3.57
EDUO6	32	Ephemeroptera (mayflies)	46	Chironomidae (midges)	1410		5.2/ Fair	3.47
EDU07	33	Coleoptera (beetles)	33	Chironomidae (midges)	33	8	5.5	3.65
MIT01	19	Pelecypoda (clams)	39	Chironomidae (midges)	28	5	5.6	3.3
MIT02	34	Chironomidae (midges)	42	Ephemeroptera (mayflies)	20	12	5.6	3.92

Aquatic Ecosystem Health

Index of Biotic Integrity (IBI) ratings and species richness scores in the East Duffins system do not coincide with what appears to be for the most part, good quality habitat. Half of the stations sampled in 2000 received a rating of "good" stream quality, while the other half received ratings of "fair". EDU05, located north of Taunton Road, received a rating of "poor". Most stations with scores less than "good" were typically due to a lower than expected total fish catch, and poorer than expected community composition and diversity. Two sites, EDU04 and EDU05, received low scores due to a high percentage of Rhinichthys species, indicators of disturbed and/or eutrophic conditions. MIT01, located west of the Village of Claremont, received a score of "fair", possibly due to its proximity to the village. The high number of online ponds and instream barriers in the headwaters are likely also impacting the biological integrity of subwatershed.

Analysis of current benthic invertebrate data suggests that the majority of sample stations are in relatively good condition with a few sites showing signs of degradation. Some station such as Spring Creek, Brougham Creek and the headwaters of the East Duffins Creek suggest a community imbalance, where amphipods dominated the catch. These stations also received low scores for EPT and for species diversity from both the Hilsenhoff Index and the Shannon-Weaver Index (Table 24). Hilsenhoff scores suggest that there is likely substantial organic pollution present at these stations.

When comparing subwatersheds in the Duffins system, or between watersheds in the GTA, the East Duffins Creek subwatershed is presently only mildly degraded. Overall, water temperature, riparian cover, land use, bank stability, and flow all appear to be in good order, however, eutrophication and instream barriers appear to be impacting the aquatic ecosystem.

An important characteristic of this subwatershed is the presence of an instream barrier located on private property north of Highway 7 on the main branch of the East Duffins Creek, referred to as Newman's dam. This barrier currently prevents migratory trout and salmon from accessing resident brook trout habitat upstream. Based on discussions with anglers and agency staff, it was decided to maintain this barrier as the upstream limit of migratory access.

4.1.3 MANAGEMENT TARGETS;

Table 25 summarizes the aquatic management components and targets for the East Duffins Creek subwatershed.

Table 25. Aquatic management components and targets for the East Duffins Creek subwatershed.

Management Component	Management Target	Existing Conditions by Habitat Category		
		Small Riverine Coldwater	Small Riverine Warmwater	Intermediate Riverine Coldwater
Baseflow	Protect existing baseflow. Maintain baseflow to average annual flow ratio of at least 25 per cent.	Nearly all sub-catchment areas have a baseflow to annual flow ratio that is suitable for the production of salmon and trout species. Modeling results suggest that if current development projections are met this ratio will not drastically change. As urban expansion occurs, however, this ratio may be reduced.		
Water Extraction	Allocate so that there are no conflicts with aquatic habitat and species.	No active permits found in the East Duffins Creek subwatershed. Unknown and unpermitted water takings may still be present.		
Water Quality and Nutrients	PWQO or better.	Nutrients levels are generally good. Invertebrate data indicates a fairly substantial level of organic pollution with the highest levels of eutrophication noted in Brougham Creek, Spring Creek, and in some headwater reaches of the East Duffins Creek (EDU02, EDU03). The 2003/04 “Guide to Eating Ontario Sport Fish” shows one location on East Duffins Creek.. Smaller tributaries not listed.		
Instream Barriers and Ponds	Remove or mitigate except where integral to fisheries management (e.g. Newman’s dam)	- 23 in East Duffins Creek - One in Mitchell Creek	- One in Mitchell Creek - Eight in Brougham Creek	- One in East Duffins Creek (Newman’s dam).
Riparian Vegetation	a) 100 per cent stream length naturally vegetated b) 75 per cent of stream length with woody vegetation.	a) 79 per cent naturally vegetated b) 60 per cent of stream length with woody vegetation		
Altered Watercourses	Natural channel principles used when alterations are necessary or improvements proposed	None proposed at this time.		
Wetland	a) > 10 per cent of watershed b) Six per cent (414 ha) of subwatershed	a) Two per cent for Duffins Creek watershed b) One-point-five per cent for East Duffins Creek subwatershed		
IBI	Minimum of “Good”	“Fair” to “Good”	Not sampled	“Poor” to “Good”
Target Species	**Small Riverine Coldwater** – brook trout and Atlantic salmon **Small Riverine Warmwater** – redside dace and darter species **Intermediate Riverine Coldwater** – brook trout and Atlantic salmon above Newman’s dam; rainbow trout and redside dace below Newman’s dam	Atlantic salmon not present; OMNR co-ordinating Atlantic salmon Recovery Program; will ultimately need to be stocked. Brook trout currently found.	Redside dace not found in 2000 survey; may be a function of number of sampling stations. Darter species currently found.	Above Newman’s Dam: Atlantic salmon not present; OMNR co-ordinating Atlantic salmon Recovery Program; will need to be stocked. Brook trout currently found. Below Newman’s dam: Redside dace not found in 2000 survey; may be a function of number of sampling stations

4.1.4 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS.

In order to attain and/or maintain the management objectives and targets, conservation and restoration efforts are required. Table 26 lists recommended management activities required to protect and enhance the aquatic community. Figure 21 shows the location of recommended activities.

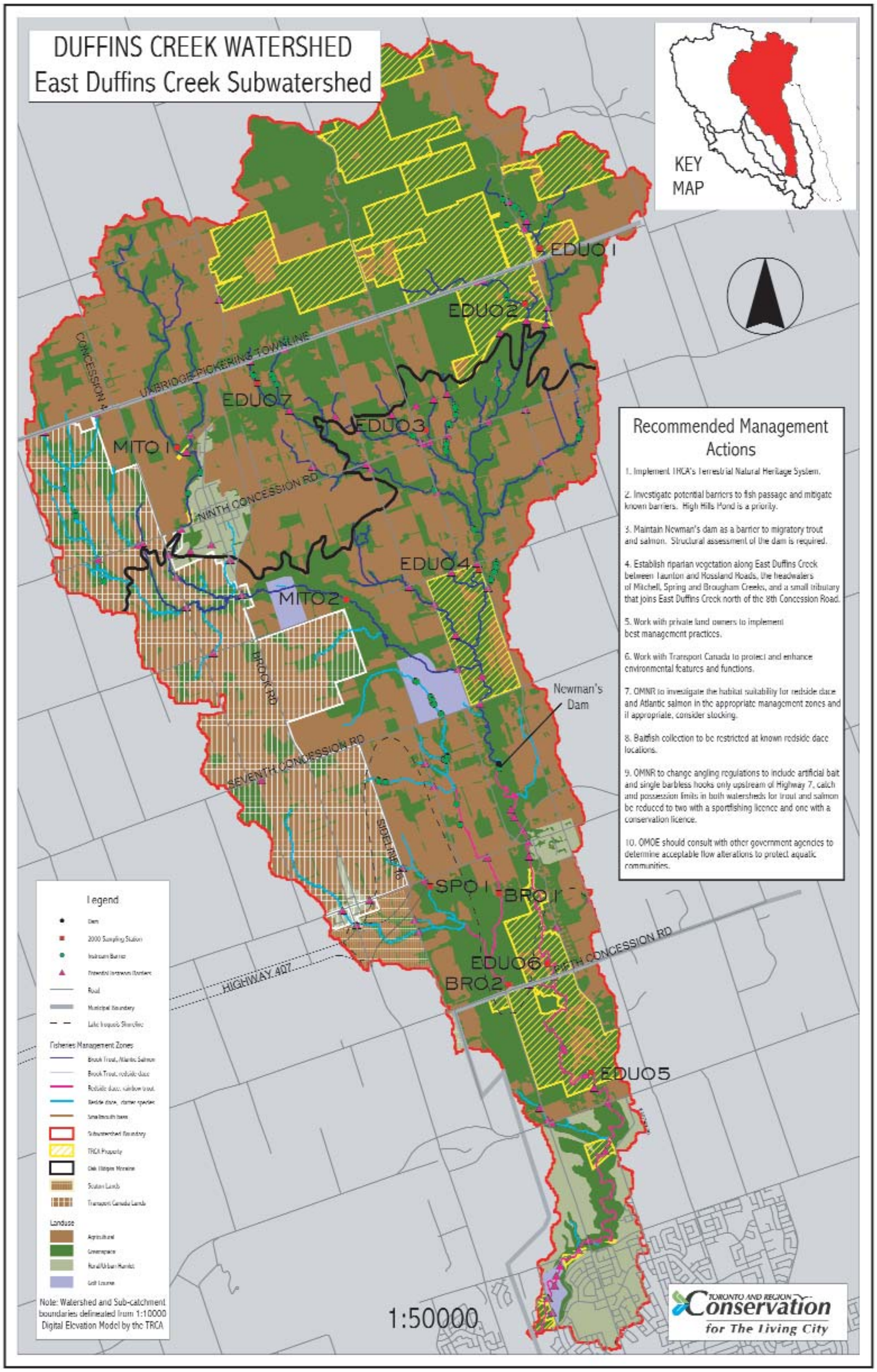
Table 26. Recommended management activities for the East Duffins Creek subwatershed.

Management Target	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur (e.g. federal airport lands and areas south of Taunton Rd.). ♦ Protect areas of recharge and discharge. ♦ implement TRCA's Terrestrial Natural Heritage System Strategy. ♦ assess extent of unpermitted water takings. ♦ precise volume limits and timing of water extraction need to be determined to ensure sufficient baseflow requirements for aquatic community.
Monitoring	♦ expand assessment of federal airport lands to determine presence of redside dace, and salmonid spawning areas ♦ add sample stations in Brougham, Mitchell and Spring Creeks. ♦ add sample stations to include small riverine warm-water habitat.
Baitfish Harvest	♦ baitfish collection to be restricted at known redside dace locations.
Public Land	♦ Upper reaches of Brougham Creek will be affected by the development of the federal airport lands. Development should be conducted on an environment first basis and should include a setback from top of bank of at least 30 m. ♦ Additional aquatic surveys including electrofishing and spawning surveys should be conducted on the federal airport lands. ♦ Explore establishing an angling club in the Greenwood Conservation Area. ♦ Conservation lands should provide specific areas/nodes for angling access. ♦ Conservation lands should promote catch and release angling, and the use of barbless hooks within identified reaches of their land. ♦ Implement TRCA's approved Conservation Land Management Plan.

Riparian Vegetation	♦ Maintain and protect existing riparian vegetation, including a minimum setback of 30m.
	♦ Woody riparian vegetation should be established along:
	    ♦ East Duffins Creek between Taunton and Rossland Roads.
	    ♦ the headwaters of Mitchell, Spring and Brougham Creeks, and along a small easterly tributary that originates just north of 9th Concession Road and joins the main branch of the East Duffins north of 8th Concession Road.
	♦ Restoration plantings at Paulynn Park should be continued.
	♦ Future construction of Highway 407 should minimize impacts to the riparian corridor.
	♦ Golf course and agricultural operations are encouraged to allow woody vegetation to grow adjacent to watercourses.

Management Component	Recommended Activity
Instream Barriers and Ponds	♦ Barriers in headwater areas should be removed and or mitigated. Where removal is not an option, outlets should be converted to bottom draw structures. ♦ The barrier north of Highway 7 on East Duffins Creek (Newman's Dam) must remain in place for fisheries management purposes. Structural inspection is recommended
	Medium Priority
Wetland Creation & Restoration	♦ Existing wetlands must receive full protection. ♦ Opportunities to create additional wetlands should be explored. Where possible, historic wetlands should be recreated.
Water Quality	♦ investigate potential locations where cattle have unrestricted access to watercourses. ♦ fence off cattle on Brougham Creek at 7th Concession west of Brock Rd.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Short term – artificial bait and single barbless hooks on TRCA properties upstream of Highway 7 only; trout and salmon catch & possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence. ♦ Long term – artificial bait and single barbless hooks only upstream of Highway 7, catch-and-possession limits for trout and salmon be reduced to two with a sport-fishing licence and one with a conservation licence.
Stocking	♦ Stocking of non-native species for put-and-take fishery is not recommended. ♦ OMNR to conduct genetic analysis to assess the presence and extent of the historic Brook trout population. ♦ OMNR to investigate the habitat suitability for redside dace and Atlantic salmon in the appropriate management zones and if appropriate, consider stocking.
Instream Habitat	♦ Assessments required to evaluate the need for instream habitat works.
Stormwater Retrofits	♦ None recommended at this time.
Altered Watercourses	♦ Natural channel principles to be used when alterations or improvements proposed.

Figure 21. Recommended Implementation Strategies in the East Duffins Creek Subwatershed.



4.2 WEST DUFFINS CREEK SUBWATERSHED

4.2.1 INTRODUCTION

The West Duffins Creek subwatershed is located in the northwestern portion of the watershed and flows southeasterly, collecting water from seven smaller tributaries until its confluence with the East Duffins Creek north of Highway 2. The subwatershed drains approximately 13,537 hectares of land and contains approximately 173 kilometres of 1st to 5th order watercourses. The sub-basins in the West Duffins Creek subwatershed are West Duffins Creek, Stouffville Creek, Reesor Creek, Wixon Creek, Unnamed Creek, Major Creek, and Whitevale Creek (Figure 22).

Setting

Approximately 63 per cent of the subwatershed is agricultural, 3 per cent is urbanized, two per cent is golf course and 32 per cent is natural cover in the form of either forest, meadow or wetland (Table 27).

Table 27. Current land cover in the West Duffins Creek subwatershed.

Tributary	Total Area (ha)	% Agricultural	% Natural	% Urban
Reesor Creek	2580	67	30	2
Stouffville Creek	1367	61	19	20
Major Creek	527	79	21	0
Whitevale Creek	556	79	21	<1
Unnamed Creek	1298	84	16	0
Wixon creek	1082	66	34	0
West Duffins Creek	6127	57	32	2
West Duffins Creek subwatershed	13537	64	32	4

The West Duffins Creek subwatershed contains approximately 340 hectares of wetlands while it is estimated that historically, it once contained approximately 444 hectares of wetlands, representing a 23 per cent loss.

The West Duffins Creek subwatershed contains small riverine cold-water habitat (66 km or 38 per cent by length), small riverine warm-water habitat (58 km or 34 per cent by length) and intermediate riverine cold-water habitat (49 km or 28 per cent by length).

4.2.2 AQUATIC COMMUNITY

Atlantic salmon, once common in Duffins Creek, are extirpated from the watershed. It is likely that they historically spawned in the West Duffins system, but it is not known which tributaries they utilized. A list of the 34 fish species found historically and the 21 found is shown in Table 28.

Table 28. Fish species found historically and in 2000 in the West Duffins Creek subwatershed.

Common Name	Historic	2000*	Common Name	Historic	2000*
American brook lamprey	♦	♦	longnose dace	♦	♦
sea lamprey[1]	♦		creek chub	♦	♦
rainbow trout[1]	♦	♦	yellow bullhead	♦	
Atlantic salmon[2]			brown bullhead	♦	♦
brown trout[1]	♦	♦	stonecat[5]	♦	♦
brook trout	♦	♦	brook stickleback	♦	♦
white sucker	♦	♦	rock bass	♦	
northern hog sucker	♦		pumpkinseed	♦	♦
central mud minnow	♦		largemouth bass	♦	♦
northern redbelly dace[4]	♦	♦	smallmouth bass	♦	
redside dace[3,5]	♦		yellow perch	♦	
brassy minnow[4]	♦		rainbow darter[4]	♦	♦
golden shiner	♦		Iowa darter	♦	♦
common shiner	♦	♦	fantail darter	♦	
bluntnose minnow	♦	♦	johnny darter	♦	♦
fathead minnow	♦	♦	mottled sculpin	♦	♦
blacknose dace	♦	♦	slimy sculpin	♦	

** – Other species such as northern hog sucker, central mud minnow, rock bass, smallmouth bass, fantail darter and slimy sculpin are expected to be present. The status of redside dace, brassy minnow, golden shiner, yellow bullhead and yellow perch is unknown*

[1] - Introduced species
[2] - Extirpated species
[3] - COSEWIC - Species of Special Concern
[4] - COSEWIC - Group 2, Intermediate Priority
[5] - COSEWIC - Group 3, Lower Priority
[6] - COSSARO - Threatened

Although some historical benthic invertebrate records were found for the West Duffins system, they tended to have vague study intentions and methodology, and study locations were often cryptic and/or did not correspond well with recent sampling station locations.

The decision was made, therefore, to focus solely on data collected in the summer of 2000. The general results of the invertebrate survey are listed in Table 29.

Table 29. Summary of 2000 benthic invertebrate analysis for the West Duffins Creek subwatershed.

Station	Total No. of Taxa	Most Common Taxa	% Of Total Sample	Next Most Common Taxa	% of Total Sample	EPT	Hilsenhoff's Family Biotic Index /Rating	Shannon Weaver Diversity Index
MAJ01	26	Chironomidae (midges)	72	Amphipoda (scuds)	16	2	6.55/ Fairly	3.1
RS01	55	Chironomidae (midges)	36	Ephemeroptera (mayflies)	19	12	5.3/ Fair	4.3
RS02	53	Ephemeroptera (mayflies)	35	Chironomidae (midges)	30	14	5.3/ Fair	4.3
ST01	26	Ephemeroptera (mayflies)	48	Isopoda (aquatic sow bugs)	24	7	5.9/ Fairly Poor	2.3
ST02	35	Ephemeroptera (mayflies)	52	Simuliidae (black flies)	10	9	5.5/ Fair	2.7
UNN01	45	Chironomidae and (midges) Ephemeroptera (mayflies)	36	Coleoptera (beetles)	9	12	5.6/ Fair	3.6
WDU01	18	Chironomidae (midges)	63	Amphipoda (scuds)	18	2	6.3/ Fairly Poor	3.3
WDU02	35	Amphipoda (scuds)	46	Chironomidae (midges)	11	9	5.4/ Fair	2.9
WDU03	19	Amphipoda (scuds)	64	Chironomidae (midges)	17	2	5.9/ Fairly Poor	2
WDU06	36	Chironomidae (midges)	35	Ephemeroptera (mayflies)	30	12	5.5/ Fair	3.8
WDU08	48	Ephemeroptera (mayflies)	47	Coleoptera (beetles)	20	14	4.9/ Good	4.1
WDU09	36	Ephemeroptera (mayflies)	46	Chironomidae (midges)	27	10	5.3/ Fair	3.5
WDU10	41	Ephemeroptera (mayflies)	62	Trichoptera (caddisflies)	16	11	4.9/ Good	3.6
WDU12	23	Ephemeroptera (mayflies)	47	Chironomidae (midges)	32	6	5.6/ Fairly Poor	4.3
WIX01	35	Trichoptera (caddisflies)	28	Ephemeroptera (mayflies)	24	12	5.0/ Fair	3.9
WTV01	17	Ephemeroptera (mayflies)	60	Chironomidae (midges)	15	2	5.2/ Fair	2.9

Aquatic Ecosystem Health

Index of Biotic Integrity (IBI) ratings calculated from the 2000 data for the West Duffins Creek subwatershed ranged between "poor" and "good" (Figure 20), with slightly under half of the sample sites having "good" stream quality while just over half of the sites had "fair" or "poor" stream quality. Low ratings in the headwaters resulted primarily from poor trophic composition and a lack of indicator species such as brook trout. Low ratings found in the lower sections of the system were symptomatic of a very high percentage of Rhinichthys species and a lack of specialized feeders. Of note is the decrease of the IBI score in Reesor Creek at its' second sampling site located downstream of its confluence with Stouffville Creek. This lower score may reflect decreased water quality due to the sewage treatment plant located on Stouffville Creek.

The difference between expected and actual species richness varies throughout the subwatershed, with the largest discrepancies found in the lower third of the subwatershed. Species richness was lower in areas that lacked riparian vegetation or adjacent to urbanized areas, or both. This is seen in Stouffville and Major creeks, and to a larger extent, in the lower sections of West Duffins Creek.

Analysis of current benthic invertebrate data suggests that the majority of sample stations are in relatively good condition, with a few sites showing signs of degradation (Table 29). Some stations in Major Creek, Stouffville Creek and the headwaters of the West Duffins Creek reflect a community imbalance, with tolerant taxa such as Chironomids dominating the sample. These stations also received poor scores for EPT and for Hilsenhoff's Family Biotic Index. BI scores indicate that there is likely very substantial organic pollution present. Shannon-Weaver Index scores were also relatively low compared to other sites. Stations MAJ01, WDU01, and WDU03 stand out as having the highest level of degradation. However, these sites received "fair" to "good" IBI ratings for fish community health, suggesting that the disturbance could be a relatively recent occurrence that the fish community hasn't yet responded to. Conversely, sites located in the lower sections of the subwatershed received relatively good benthic scores, while fish community metrics indicate poor condition. The data suggests that disturbances, perhaps related to flow or water quality, or both, are occurring periodically, giving the benthic community time to recover but only tolerant fish communities can adapt. Benthic invertebrate data collected from the lower end of the subwatershed suggests eutrophic conditions and high sediment deposition.

When comparing subwatersheds in the Duffins Creek system, or between watersheds in the GTA, the West Duffins Creek subwatershed is only moderately degraded, although more so than the East Duffins Creek. Unstable water temperatures, compromised water quality and patchy riparian vegetation in areas are all impacting ecosystem health.

4.2.3 MANAGEMENT OBJECTIVES AND TARGETS

Table 30. Aquatic management components and targets for the West Duffins Creek subwatershed.

Management Component	Management Target	Existing Conditions by Habitat Category		
		Small Riverine Coldwater	Small Riverine Warmwater	Intermediate Riverine Coldwater
Baseflow	Protect existing baseflow. Maintain baseflow to average annual flow ratio of at least 25 per cent.	Nearly all sub-catchment areas have a baseflow ratio that is suitable for the production of salmon and trout species. Modeling results suggest that if current development projections are met this ratio will not drastically change. Further urban expansion may reduce this ratio.		
Water Extraction	Allocate so that there are no conflicts with aquatic habitat and species.	Active water takings in Reesor Creek could remove up to 30% of the total baseflow volume on a seasonal basis.		
Water Quality and Nutrients	PWQO or better	Water quality, in terms of nutrients, is generally good with the exception of Stouffville Creek and sections of the lower West Duffins Creek. The 2003/04 "Guide to Eating Ontario Sport Fish" shows one location in West Duffins Creek. Smaller tributaries are not listed.		
Instream Barriers and Ponds	Remove or mitigate barriers except where integral to fisheries management (e.g. Whitevale dam)	- Four in West Duffins Creek - Four in Reesor Creek - Three in Wixon Creek	- Four in Stouffville Creek - One in West Duffins Creek	- Seven in West Duffins Creek - One in Stouffville Creek - One in Wixon Creek
Riparian Vegetation	a) 100 per cent stream length naturally vegetated b) 75 per cent of stream length with woody vegetation	a) 74 per cent naturally vegetated. b) 45 per cent of stream length with woody vegetation.		
Altered Watercourses	Natural channel principles used when alterations are necessary or improvements proposed.	- Stouffville Creek is channelized and lined with gabion baskets in the Town of Stouffville		
Wetland	a) > 10 per cent of watershed b) > Six per cent (474 ha) of subwatershed	a) Two per cent for Duffins Creek watershed b) Two-point-five per cent for West Duffins Creek subwatershed		
IBI	Minimum of "Good"	"Good"	Not sampled	"Poor" to "Good"
Target Species	**Small Riverine Coldwater** – brook trout and Atlantic salmon **Small Riverine Warm water** – redside dace and darter species **Intermediate Riverine Coldwater** – brook trout & Atlantic salmon north of Whitevale dam; rainbow trout & redside dace south of Whitevale dam	Atlantic salmon currently not present; OMNR co-ordinating Atlantic salmon Recovery Program; will need to be stocked. Brook trout currently found, although to a limited extend in the headwaters of West Duffins Creek	Redside dace not found in 2000; may be a function of number of sampling stations. Darter species currently found.	need to be stocked. Brook trout currently found.Redside dace not found in 2000; may be a function of number of sampling stations.

4.2.4 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS.

In order to achieve and/or maintain the management objectives and targets, conservation and restoration efforts are required. Table 31 lists recommended management activities required to protect and enhance the aquatic community while Figure 22 shows the location of recommended activities.

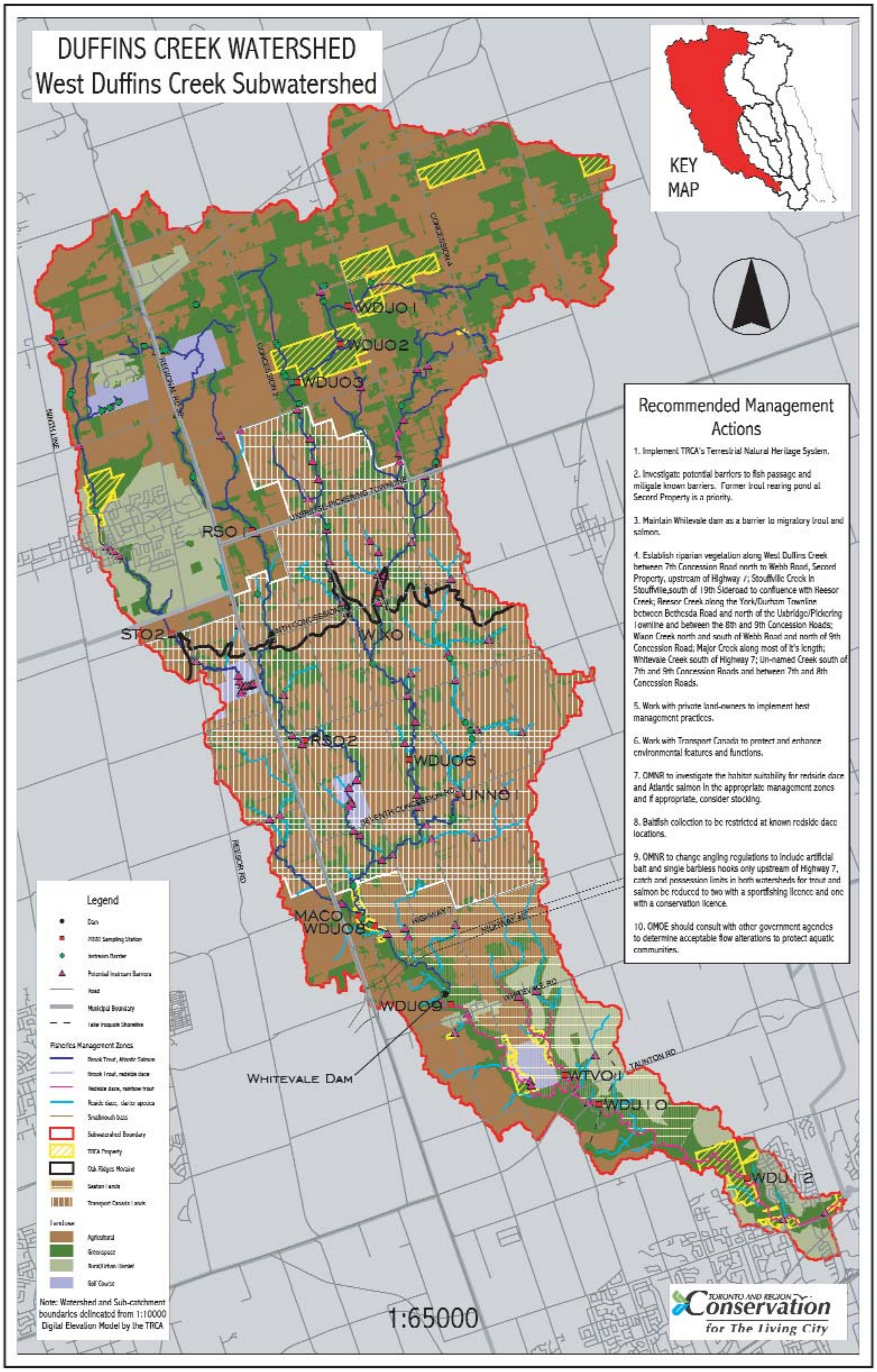
Table 31. Recommended management activities for the West Duffins Creek subwatershed

Management Component	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur (e.g. federal airport and Seaton Lands). ♦ Implement TRCA's Terrestrial Natural Heritage System Strategy. ♦ Protect areas of recharge and discharge. ♦ Assess the impacts of existing water takings in Reesor Creek. ♦ Precise volume limits and timing of water extraction need to be determined to ensure sufficient baseflow requirements for the aquatic community.
Monitoring	♦ Investigate the federal airport lands to determine presence of redside dace and salmonid spawning areas. ♦ Add sample stations in Whitevale, Wixon and Unnamed creeks and small riverine warm-water habitat.
Baitfish Harvest	♦ Baitfish collection to be restricted at known redside dace locations.
Altered Watercourses	♦ Rehabilitate Stouffville Creek in the Town of Stouffville as part of a Community Action Site. ♦ Natural channel principles to be used when alterations or improvements proposed.
Public Land	♦ Development should be conducted on an environment first basis and should include a setback of at least 30 m from top of bank. ♦ Additional aquatic surveys including electrofishing and spawning surveys should be conducted on the Federal Airport Lands. ♦ Explore the concept of establishing a fishing club at TRCA's Secord Property. ♦ Conservation lands should provide specific areas/nodes for angler access and should promote catch and release angling and the use of barbless hooks. ♦ Implement TRCA's approved Conservation Land Management Plans.

Riparian Vegetation	♦ Maintain and protect existing riparian vegetation.
	♦ Woody riparian vegetation should be established in the following areas:
	  ♦ Stouffville Creek in the Town of Stouffville; and south of 19th Sideroad to the confluence with Reesor Creek;
	  ♦ Reesor Creek along the York/Durham Townline between Bethesda Sideroad and north of the Uxbridge/Pickering Townline, and between the 8th and 9th Concession Road;

Management Component	Recommended Activity
	High Priority
Riparian Vegetation	♦ Woody riparian vegetation should be established in the following areas (cont'd): ♦ West Duffins Creek between 7th Concession Road north to Webb Road; Secord Property; and one kilometre north and south of Highway 7; ♦ Wixon Creek north and south of Webb Road and along two warm-water tributaries north of the 9th Concession Road; ♦ Major Creek requires plantings almost everywhere except for an area straddling 16th Avenue;$Whitevale Creek on both branches, south of Highway 7; ♦ Unnamed Creek south of 7th and 9th Concession Roads, and areas between 7th and 8th Concession Roads. ♦ A minimum setback of 30 m should be maintained as a riparian zone, including future development of federal airport lands. ♦ Golf course and agricultural operations are encouraged to allow woody vegetation to grow adjacent to watercourses and to stop mowing right to top of bank.
Instream Barriers and Ponds	♦ Barriers and on-line ponds in the headwaters of West Duffins Creek, Reesor Creek and Stouffville Creek should be removed and/or mitigated. Where barrier removal is not an option, outlets should be converted to bottom draw structures. ♦ Whitevale dam must remain in place for fisheries management purposes. ♦ Potential barriers caused by water crossings or perched culverts and known barriers should be assessed for fish passage.
	Medium Priority
Wetland Creation and Restoration	♦ Existing wetlands must receive full protection. ♦ Opportunities to create additional wetlands in headwater and mid reach areas should be explored. Where possible, historic wetlands should be recreated.
Water Quality	♦ Decommission the Stouffville STP. ♦ Investigate potential locations in Major Creek, Unnamed Creek and smaller tributaries of West Duffins Creek where cattle have access to the watercourse.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Short term – artificial bait and single barbless hooks on TRCA properties upstream of Highway 7 only; trout and salmon catch-and-possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence. ♦ Long term – artificial bait and single barbless hooks only upstream of Highway 7, catch-and-possession limits for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.
Stocking	♦ No stocking of non-native species for put-and-take fishery in riverine systems. ♦ OMNR to conduct genetic analysis to assess the presence and extent of the historic brook trout population. ♦ OMNR to investigate the habitat suitability for redside dace and Atlantic salmon in the appropriate management zones and if appropriate, consider stocking.
Instream Habitat	♦ Assessments required to evaluate the need for instream habitat works.
Stormwater Retrofits	♦ Complete the development of a stormwater retrofit strategy.

Figure 22. Recommended Implementation Strategies in the West Duffins Creek Subwatershed.



4.3 GANATSEKIAGON CREEK SUBWATERSHED

4.3.1 INTRODUCTION

Ganatsekiagon Creek originates in the lower half of the Duffins Creek watershed southeast of the Village of Green River and joins the East Duffins Creek south of Rossland Road and west of Riverside Drive in the Village of Pickering. This subwatershed covers approximately 13.1 km^2 and contains approximately 22.1 kilometres of 1st to 3rd order watercourses (Figure 23).

Setting

Land cover in the watershed is comprised of 58 per cent agricultural lands, two per cent urban land use and 40 per cent is natural cover, including forest, meadow and/or wetland.

Underlying this subwatershed is the Halton Till to the north and the Lake Iroquois shoreline to the south. Approximately 50 - 60 per cent of the surface water in the creek originates from within this subwatershed, making the development of the Seaton and Transport Canada lands biggest issue facing this subwatershed. It is anticipated that the future development of this land will increase the extent of urban area in the subwatershed from approximately two-point-five per cent to 43.2 per cent. Modeling suggests that the increase in urbanization will result in a reduction of the ratio of baseflow to average annual flow by up to approximately 28 per cent in the lower portion of the subwatershed and up to approximately 15 per cent in the upper portion of the subwatershed (TRCA, 2003). This change in flow regime may impact instream habitat and streambanks, and ultimately, the health of the cold-water aquatic community.

The Ganatsekiagon Creek subwatershed contains 10 km of small riverine cold-water habitat (45 per cent of length) and 12 km of small riverine warm-water habitat (55 per cent of length).

4.3.2 AQUATIC COMMUNITY

A total of 17 species have been documented over the last 50 years, of which six were found in 2000 (Table 32). Only one introduced fish species, rainbow trout, has historically been found, however, it is believed that chinook salmon also use this creek during their fall spawning runs. A visual survey in 2002 found numerous rainbow trout parr in the lower portion of the subwatershed, indicating successful spawning of this species. It has been estimated that Ganatsekiagon Creek contains more rainbow trout than the West Duffins Creek (Jones and Guy, 1997), which indicates it's importance as a rainbow trout production area.

Table 32. Fish species found historically and in 2000 in the Ganatsekiagon Creek subwatershed

Common Name	Historic	2000*	Common Name	Historic	2000*
American brook lamprey	♦	♦	blacknose dace	♦	♦
rainbow trout[1]	♦	♦	longnose dace	♦	♦
brook trout	♦		creek chub	♦	♦
white sucker	♦		brook stickleback	♦	
northern redbelly dace[4]	♦		largemouth bass	♦	
redside dace[3,6]	♦		rainbow darter[4]	♦	
brassy minnow[4]	♦		johnny darter	♦	
bluntnose minnow	♦		mottled sculpin	♦	♦
fathead minnow	♦				

* – *Other species, such as white sucker, northern redbelly dace, bluntnose minnow, fathead minnow, brook stickleback, rainbow darter and johnny darter are expected to be present. The status of brook trout, redside dace, brassy minnow and largemouth bass is unknown*

[1] - *Introduced species*
[2] - *Extirpated species*
[3] - *COSEWIC - Species of Special Concern*
[4] - *COSEWIC - Group 2, Intermediate Priority*
[5] - *COSEWIC - Group 3, Lower Priority*
[6] - *COSSARO - Threatened*

The benthic invertebrate data for the station sampled in 2000 was not found so no analysis of the current invertebrate community is possible.

Aquatic Ecosystem Health

It is possible that due to the limited number of stations and timing of the 2000 assessments that the true number of species currently inhabiting the subwatershed is higher than that shown in Table 31. The historical dataset was, therefore, expanded to include data from 1995 to the present. This adds seven species, including brook trout, white sucker, northern redbelly dace, redside dace, brassy minnow, fathead minnow and largemouth bass to the number of species found between 1995 - 2000. It is interesting to note that the account of redside dace on the Provincial Seaton Lands is the only one for the Duffins Creek watershed over the past five years.

The IBI score for the one station sampled in 2000 resulted in a score of 19 or "poor" stream quality. The site received a low score due to a combination of a low catch per unit effort, no brook trout, no piscivores and a high percentage of Rhinichthys species. Species richness was six and not far from the expected value of eight.

Analysis of benthic data from a previous OMNR study conducted in 1996 suggests that the aquatic community is degraded in an area south of 5th Concession Road and an area south of Taunton Road. These areas scored poorly for EPT taxa and for Hilsenhoff's FBI, indicating a high level of organic pollution. The existing extent of riparian vegetation is good, water temperatures are moderately stable and compared to other watersheds in the GTA, Ganatsekiagon

Creek is only mildly impaired. The current level of impairment is likely due to adjacent land use and Highway 7. The unique distribution and extent of recharge and discharge functions renders this subwatershed particularly susceptible to land use alterations, making protection of the recharge and discharge zones during any development of the Seaton and airport lands.

4.3.3 MANAGEMENT TARGETS.

Table 33 summarizes the aquatic management components and targets for the Ganatsekiagon Creek subwatershed.

Table 33. Aquatic management components and targets for the Ganatsekiagon Creek subwatershed

Management Component	Management Target	Existing Conditions by Habitat Category	
		Small Riverine Coldwater Habitat	Small Riverine Habitat Warmwater
Water Balance	Protect existing baseflow. Maintain a baseflow to average annual flow ratio of at least 25 per cent	Both sub-basins currently have a baseflow ratio that is suitable for the production of salmonids. Modeling results suggest that if current development projections are met, ratios may decrease by up to 28 per cent	
Water Extraction	Resource allocation so that there are no conflicts with aquatic habitat and species.	No active water taking permits found.	
Water Quality and Nutrients	PWQO or better	Generally good overall, although south of 5th Concession and Taunton Road appear to be impacted due to eutrophication. Not listed in OMOE's "Guide to Eating Ontario Sport Fish"	
Instream Barriers and Ponds	No instream barriers	Road crossings only	
Riparian Vegetation	a) 100 per cent stream length naturally vegetated b) 75 per cent of stream length with woody vegetation	a) 93 per cent naturally vegetated b) 72 per centof stream length with woody vegetation	
Altered Watercourses	Natural channel principles used when alterations or improvements proposed	Assessment required	
Wetland	a) > 10 per cent of watershed b) > Six per cent (474 ha) of subwatershed	a) Two per cent for Duffins Creek watershed b) Two-point-five per cent for West Duffins Creek subwatershed	
IBI	Minimum of "Good"	"Poor"	Not sampled
Target Species	**Small Riverine Coldwater** – redside dace and rainbow trout **Small Riverine Warmwater** – redside dace and darter species	Redside dace not found in 2000 survey but present in 1996. Rainbow trout found in 2000; young of the year observed in 2002.	Not sampled in 2000 but redside dace present in 1996. Darter species likely still present.

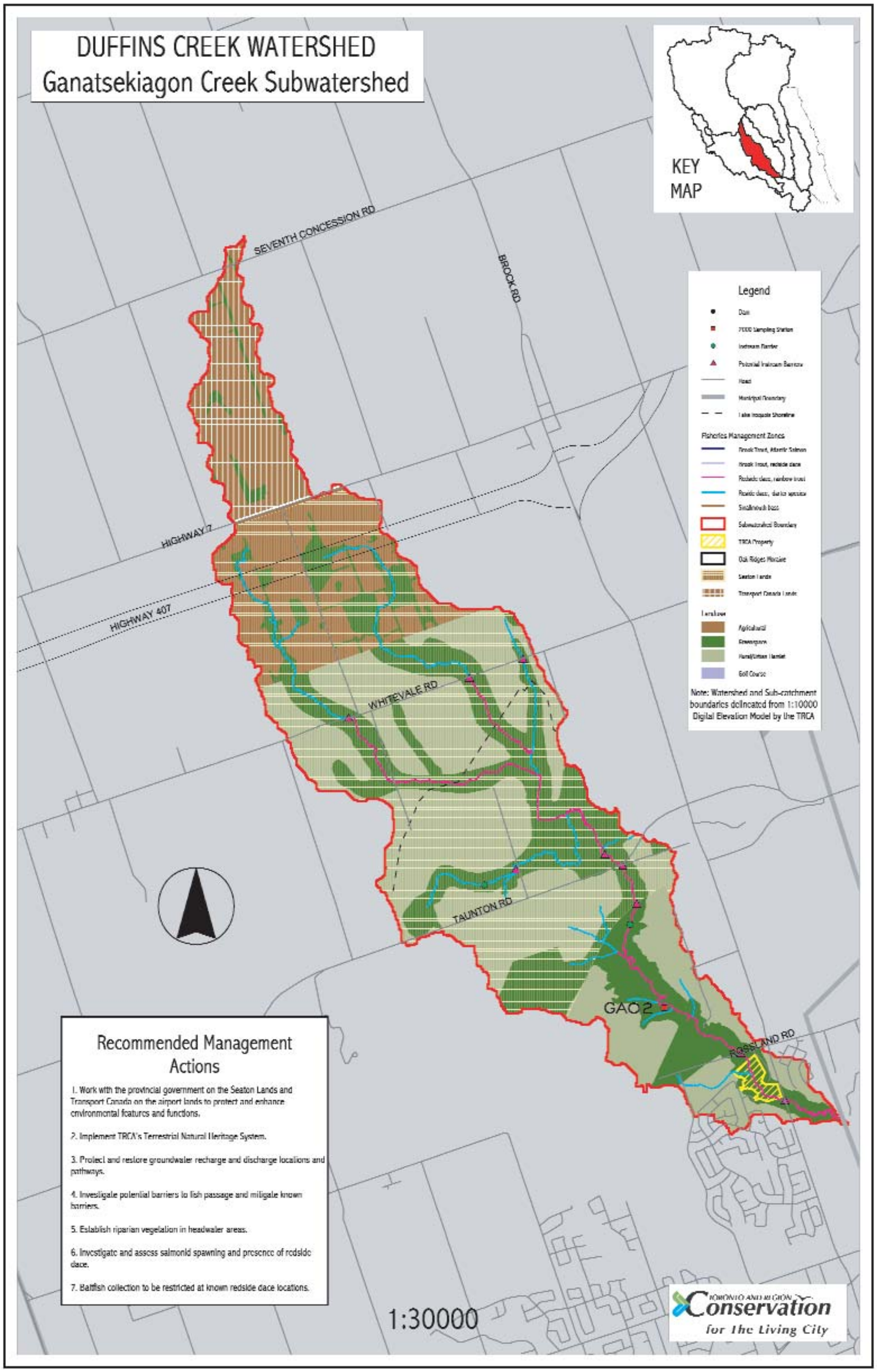
4.3.4 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS

Table 34 lists recommended management activities required to protect and enhance the aquatic habitat and species while Figure 23 shows the location of recommended activities

Table 34. Management recommendations for the Ganatsekiagon Creek subwatershed

Management Component	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur (e.g. Seaton and federal airport lands). ♦ Implement TRCA's Terrestrial Natural Heritage System Strategy. ♦ Protect areas of recharge and discharge.
Monitoring	♦ Investigate Seaton and federal airport lands for salmonid spawning areas and presence of redside dace. ♦ Add one station north of Steeles Ave. and at least one other in small riverine warm-water habitat.
Baitfish Harvest	♦ Baitfish collection to be restricted at known redside dace locations.
Public Land	♦ Development of the Seaton and federal airport lands must protect or enhance existing water balance ♦ TRCA and other organizations should consider purchasing or obtaining additional conservation lands.
Instream Barriers and Ponds	♦ Conduct fish passage assessment for each known and potential barrier.
	Medium Priority
Riparian Vegetation	♦ Maintain and protect existing riparian vegetation. ♦ Establish in headwater areas, particularly to the south of Whitevale Road.
Wetland Creation and Restoration	♦ Existing wetlands must receive maximum protection. ♦ Create additional wetlands.
Instream Habitat	♦ Assessment is required to evaluate need for instream habitat work.
Water Quality	♦ Install cattle fencing to exclude access to watercourse.
Stocking	♦ OMNR to investigate the habitat suitability for redside dace in the appropriate management zones and, if appropriate, consider stocking.
Water Taking	♦ Confirm unpermitted water takings are not occurring. ♦ Precise volume limits and timing of water extraction need to be determined to ensure sufficient baseflow requirements for the aquatic community.
Stormwater Retrofits	♦ None recommended at this time.
Altered Watercourses	♦ Assessments required. ♦ Natural channel principles be used when alterations or improvements proposed.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Short term – trout and salmon catch and possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence. ♦ Long term – catch-and-possession limits for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.

Figure 23. Recommended Implementation Strategies in the Ganatsekiagon Creek Subwatershed.



4.4 URFE CREEK SUBWATERSHED

4.4.1 INTRODUCTION

Urfe Creek is located in the lower half of the Duffins Creek watershed just northwest of the Village of Brougham and covers 14.4 km2 (Figure 24). The subwatershed drains approximately 1,437 hectares of land and contains approximately 30 kilometres of 1st to 3rd order watercourses. Urfe Creek flows in a southerly direction and joins Ganatsekiagon Creek south of Rossland Road and west of Riverside Drive in the Village of Pickering before joining with the East Duffins Creek.

Setting

Land cover in the subwatershed is 52 per cent agricultural, 44 per cent natural area in the form of forest, meadow and/or wetland, three per cent is golf course and one per cent urbanized. Future growth in this subwatershed is expected to be significant over the next few years, particularly in the upper portion of the subwatershed on the Seaton Lands.

The future development of the Seaton Lands is the biggest issue facing this subwatershed. These lands contribute an estimated 50-60 per cent of the groundwater for Urfe Creek (Eyles at al., 1997). It is anticipated that future development will increase urban areas from the existing one per cent to almost 32 per cent. Modeled data reflects that this in turn will result in a reduction in the ratio of baseflow to annual flow by up to almost 24 per cent in the lower portion of the subwatershed and up to five per cent in the upper portion of the subwatershed (TRCA, 2003). This change in flow regime will ultimately affect the health of the aquatic community.

The Urfe Creek subwatershed contains small riverine cold-water habitat (seven km or 24 per cent by length) and small riverine warm-water habitat (22 km or 76 per cent by length).

4.4.2 AQUATIC COMMUNITY

A total of 20 species have been documented over the last 50 years, of which five were found at the single sampling station in the 2000 survey (Table 35). It is not known if Atlantic salmon, once very common in Duffins Creek, spawned in Urfe Creek. Rainbow trout is the only introduced species on the historical list, and was not documented in the 2000 survey. It is highly likely, however, that migratory rainbow trout spawn successfully in Urfe Creek. The status of chinook salmon is also currently unknown, but they too likely spawn in the creek.

Table 35. Fish species found historically and in 2000 in the Urfe Creek subwatershed

Common Name	Historic	2000*	Common Name	Historic	2000*
rainbow trout1	♦		fathead minnow	♦	♦
brook trout	♦		blacknose dace	♦	♦
white sucker	♦		longnose dace	♦	
northern redbelly dace4	♦	♦	creek chub	♦	♦
redside dace[3,6]	♦		brown bullhead	♦	
brassy minnow[4]	♦		brook stickleback	♦	
golden shiner	♦		pumpkinseed	♦	
common shiner	♦		rainbow darter4	♦	
spottail shiner[5]	♦		johnny darter	♦	
bluntnose minnow	♦		mottled sculpin	♦	♦

** – Species such as rainbow trout, white sucker, common shiner, bluntnose minnow, longnose dace, brook stickleback, rainbow darter and johnny darter are expected to be present. The status of brook trout, redside dace, brassy minnow, golden shiner, spottail shiner, brown bullhead and pumpkinseed is unknown.*

[1] - *Introduced species*
[2] - *Extirpated species*
[3] - *COSEWIC - Species of Special Concern*
[4] - *COSEWIC - Group 2, Intermediate Priority*
[5] - *COSEWIC - Group 3, Lower Priority*
[6] - *COSSARO - Threatened*

The general results of the 2000 invertebrate survey are listed in Table 36.

Table 36. Summary of 2000 benthic invertebrate analysis for the Urfe Creek subwatershed

Station	Total No. of Taxa	Most Common Taxa	% Of Total Sample	Next Most Common Taxa	% of Total Sample	EPT	Hilsenhoff's Family Biotic Index /Rating	Shannon Weaver Diversity Index
URFO1	26	Chironomidae (midges)	37	Ephemeroptera (mayflies)	19	5	5.27/ Fair	3.75

Aquatic Ecosystem Health

It is possible that due to the limited number of stations and timing of the 2000 assessments that the true number of species currently inhabiting the subwatershed is higher than that shown in Table 35. The historical dataset was, therefore, expanded to included data from 1995. This adds 10 species, including rainbow trout, brook trout, brassy minnow, common shiner, spottail shiner, bluntnose minnow, fathead minnow, longnose dace, brook stickleback, pumpkinseed and johnny darter to the total number of species found in Urfe Creek between 1995-2000. Given that the habitat requirements of these species are likely still present in the Urfe system, it is probable that these species still inhabit the subwatershed.

The one station sampled in 2000 had an IBI score of 25, or "fair" stream quality. The site received a relatively low score due to a combination of a low species richness, an absence of brook trout, no piscivores, and a high percentage of Rhinichthys species. The low species richness is likely due to the low sampling effort rather than a highly impacted subwatershed.

Analysis of benthic invertebrate data shows a low EPT score, a relatively low number of taxa, a higher than desirable Biotic Index rating and a moderate to high percentage of Chironomids in the sample, suggesting some degradation. A Hilsenhoff Family Biotic Index of 5.27 indicates that there is likely a fairly substantial amount of organic pollution present. The Shannon Weaver Diversity Index of 3.75 suggests that the benthic community, although showing some impairment, is relatively balanced. Water quality, dissolved oxygen, and substrate are likely some of the limiting factors affecting the benthic community.

OMNR benthic data collected in 1996 points to degraded water quality in the area south of 5th Concession Road (Jones and Guy, 1997). Both of these stations had "fairly poor" Hilsenhoff's FBI scores, indicating the presence of substantial organic pollution. These stations are in the vicinity of a pig farm, downstream of a dump and just upstream of Taunton Road.

When compared to other watersheds in the GTA, the Urfe Creek subwatershed is only mildly impaired. Urfe Creek is, however, more impaired than many of the other subwatersheds in the Duffins Creek watershed. However, the unique distribution and extent of recharge and discharge functions renders this subwatershed particularly susceptible to land use alterations. The potential simultaneous development of both the Seaton and airport lands poses a significant threat to the subwatershed. Protection of these areas is, therefore, crucial to protect this subwatershed.

4.4.3 MANAGEMENT TARGETS

Table 37. Aquatic management components and targets for the Urfe Creek subwatershed

Management Component	Management Target	Existing Conditions by Habitat Category	
		Small Riverine Coldwater Habitat	Small Riverine Habitat Warmwater
Baseflow	Protect existing baseflow. Maintain a baseflow to average annual flow ratio of at least 25 per cent.	Ratio of baseflow to annual average flow is suitable for salmonid production. Modeling suggests that if current development projections are met, ratios may decrease by up to 24 per cent.	
Water Extraction	Resource allocation so that there are no conflicts with fish habitat.	No active permits found.	
Water Quality and Nutrients	PWQO or better	Generally good overall, with a few locations showing high levels of organic nutrients. Not listed in the 2003 - 2004 "Guide to Eating Ontario Sport Fish".	
Instream Barriers and Ponds	No non-natural instream barriers.	None identified	Five
Riparian Vegetation	a) 100 per cent stream length naturally vegetated. b) 75 per cent of stream length with woody vegetation.	a) 89 per cent naturally vegetated. b) 60 per cent of stream length with woody vegetation.	
Altered Watercourses	Natural channel principles used when alterations are necessary or improvements proposed.	Further assessment is required.	
Wetland	a) > 10 per cent of watershed b) > Six per cent (57 ha) of subwatershed	a) Two per cent for Duffins Creek watershed b) Two per cent for Urfe Creek subwatershed.	
IBI	Minimum of "Good"	Fair	Not sampled
Target Species	**Small Riverine Coldwater** – redside dace & rainbow trout **Small Riverine Warmwater** – redside dace & darter species	Redside dace not found in 2000; may be a function of number of sampling stations. Rainbow trout were not found in the 2000, but are likely still using the system.	Redside dace not found in 2000; may be a function of number of sampling stations. Darter species likely still found in habitat category, although not present in 2000.

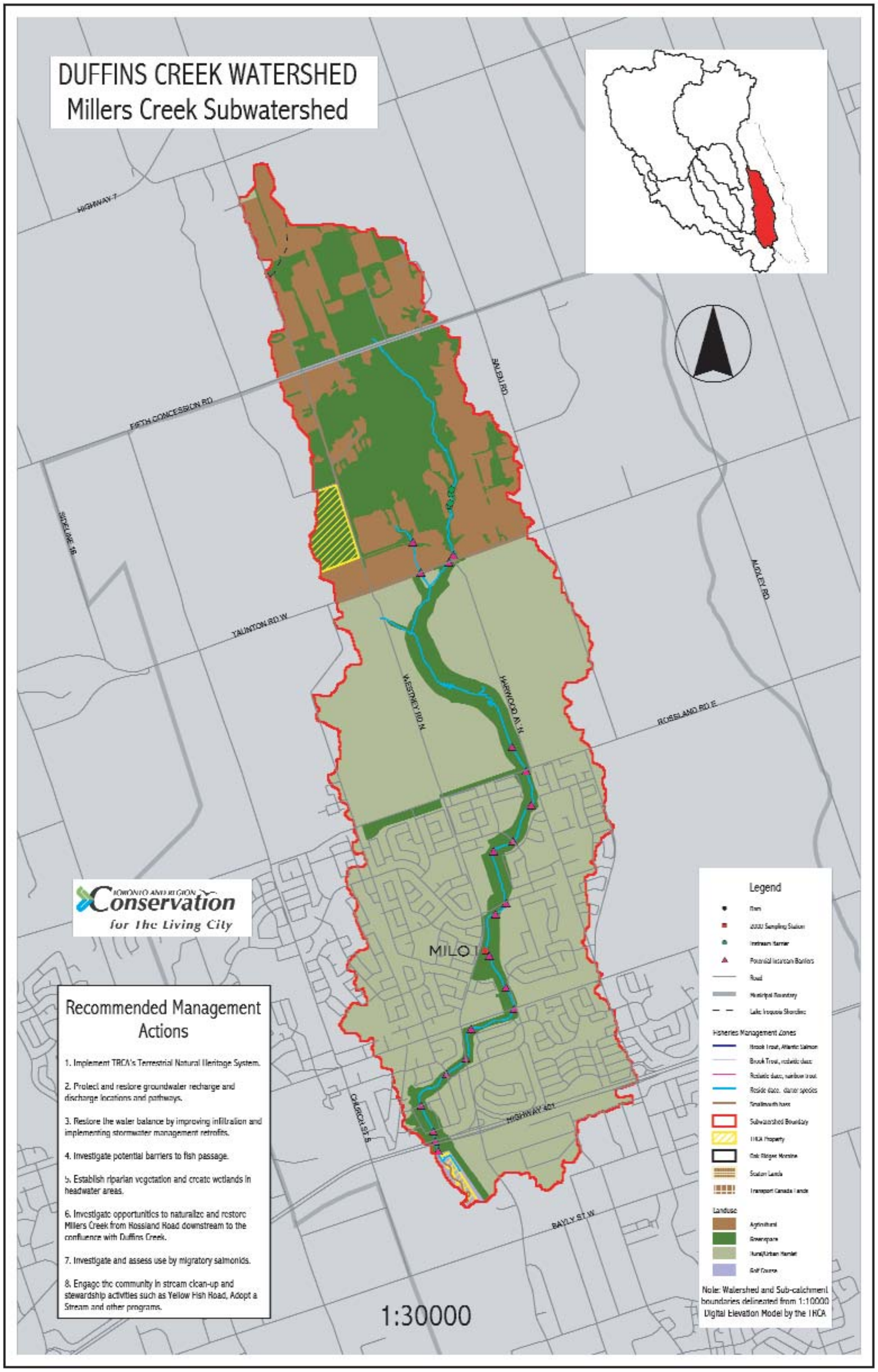
4.4.3 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS.

Table 38 lists recommended management activities required to protect and enhance the aquatic community and Figure 24 shows the location of recommended activities.

Table 38. Management recommendations in the Urfe Creek subwatershed

Management Component	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur (e.g. the Seaton and federal airport lands). ♦ Implement TRCA's Terrestrial Natural Heritage System Strategy. ♦ Protect areas of recharge and discharge functions.
Monitoring	♦ Maintain and protect existing riparian vegetation. ♦ Establish riparian vegetation in headwater areas, particularly on federal airport lands north of Highway 7; at Brock Road south of Whitevale area, and north of Rossland following a line from Riverside Drive. ♦ Maintain a riparian buffer of at least 30 m on each side of the creek.
Baitfish Harvest	♦ Baitfish collection to be restricted at known redside dace locations.
Public Land	♦ Development of Seaton and federal airport lands must be done with an environment-first approach and should include a setback of at least 30 metres from top of bank. ♦ Headwater areas located on federal airport lands located north of Highway 7 require full protection from development and alteration. ♦ TRCA owns lands south of Rossland Road and a section near the confluence with Ganatsekiagon Creek. ♦ TRCA lands should promote catch-and-release angling, and the use of barbless hooks within identified reaches of their property.
Altered Watercourses	♦ Natural channel principles to be used when alterations or improvements proposed.
Instream Barriers and Ponds	♦ Existing wetlands must receive maximum protection.
	Medium Priority
Wetland Creation and Restoration	♦ Existing wetlands must receive full protection ♦ Opportunities to create additional wetlands should be explored.
Instream Habitat	♦ Future work will be required to assess the need.
Water Quality	♦ Protection of source areas will help to protect and improve water quality.
Stocking	♦ OMNR to investigate the habitat suitability for redside dace in the appropriate management zones and, if appropriate, consider stocking.
Water Taking	♦ Precise volume limits and timing of water taking need to be determined to ensure sufficient baseflow requirements for aquatic community.
Stormwater Retrofits	♦ None recommended at this time.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Short term – trout and salmon catch-and-possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence. ♦ Long term – catch-and-possession limits for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.

Figure 24. Recommended Implementation Strategies in the Urfe Creek Subwatershed.



4.5 MILLER'S CREEK SUBWATERSHED

4.5.1 INTRODUCTION

Miller's Creek subwatershed is located in the southeastern portion of the Duffins Creek watershed (Figure 25). Originating at approximately Taunton Road and east of Westney Road, Miller's Creek flows south toward its confluence with the Lower Duffins Creek between Bayly Street and Highway 401. The subwatershed covers approximately 1, 698 hectares of land and contains approximately 11.6 kilometres of 1st and 2nd order streams.

Setting

Land cover is predominantly urban or urbanizing, with rural uses limited to the area north of Taunton Road. Presently, approximately 38 per cent of the watershed is urban, 38 per cent is agricultural, and 24 per cent of the watershed is natural cover (Figure 25).

The relatively high degree of urbanization combined with the significant channel alterations between Rossland Road and Highway 401 have negatively impacted the natural flow regime of the system and provide very limited aquatic habitat.

The Miller's Creek subwatershed contains small riverine cold-water habitat (four kilometers or 33 per cent by length), small riverine warm-water habitat (two kilometers or 17 per cent by length) and intermediate riverine cold-water habitat (Six kilometers or 50 per cent by length).

4.5.2 AQUATIC COMMUNITY

A total of 10 species have been documented over the last 50 years, of which only four were found in the 2000 survey (Table 39). None of the historic or current species are introduced. There are, however, anecdotal reports of migratory rainbow trout below Westney Road. No species found either historically or in 2000 have been designated species of concern by COSEWIC or COSSARO. Brassy minnow, which was historically found, has been placed on the Group 2 - Intermediate Priority Candidate List by COSEWIC.

Table 39. Fish species found historically and in 2000 in the Miller's Creek subwatershed

Common Name	Historic	2000*	Common Name	Historic	2000*
white sucker	♦	♦	fathead minnow	♦	
northern redbelly dace		♦	blacknose dace	♦	♦
common shiner	♦	♦	creek chub	♦	♦
brassy minnow[1]	♦		brook stickleback	♦	
bluntnose minnow	♦		johnny darter	♦	

** – Species such as bluntnose and fathead minnow, brook stickleback and johnny darter are expected to be present*

[1] - COSEWIC Group 2 Intermediate Priority Candidate List

The general results of the 2000 invertebrate survey are listed in Table 40.

Table 40. Summary of 2000 benthic invertebrate analysis in the Miller's Creek subwatershed

Station	Total No. of Taxa	Most Common Taxa	% Of Total Sample	Next Most Common Taxa	% of Total Sample	EPT	Hilsenhoff's Family Biotic Index /Rating	Shannon Weaver Diversity Index
MIL01	16	Isopoda (aquatic sowbugs)	85	Chironomidae (midges)	8	0	7.74/Very Poor	1

Aquatic Ecosystem Health

The station sampled in 2000 received an IBI score of 23, or "fair" stream quality. This is due to a low catch per unit effort, a lack of piscivorous species and low diversity. The station also scored low in the Rhinichthys species sub-indices, suggesting a strong effect from urbanization. The trophic structure at this location may also be in the process of reacting to the effects of both recent urban development just upstream and agricultural run-off from north of Taunton Road. Species richness was four, half of that expected by Steedman (1987). This may be due, in part, to the limited number of stations sampled.

The benthic invertebrate sample contained 16 taxa, of which the dominant taxa was Isopoda at 85 per cent abundance. All of the taxa present in the samples are regarded by Hilsenhoff (1987) and Griffiths (1995) as having at least some tolerance to organic pollution, with the vast majority (isopoda and chironomidae at 7 per cent abundance) having considerable tolerance. Isopods of the genera Asellus and chironomids are generally characteristic of areas with high loads of sediment and organic material. The Hilsenhoff Family Biotic Index Score of 7.74 indicates "very poor" water quality with "severe organic pollution likely". A Shannon Weaver Diversity Index of 1 also indicates low community richness and distribution, which suggests habitat impairment. The absence of representative species of Ephemeroptera, Plecoptera, and Trichoptera is noteworthy in that these taxa are generally sensitive to low oxygen conditions and sedimentation effects. Their absence may, therefore, result in negative impacts to the fish community structure.

The reduced diversity of the benthic fauna at this location suggests degradation of habitat and/or water quality. The decline in density and diversity noted at this station may be attributable to a combination of the significant amount of urban development taking place just upstream, in addition to agricultural run-off from the area north of Taunton Road, resulting in sediment loading and suspended sediment in the water. Compared to other subwatersheds in the Duffins system, Miller's Creek is one of the most degraded and has a priority for restoration efforts.

4.5.3 MANAGEMENT TARGETS

Table 41 summarizes the aquatic management components and targets for the Miller's Creek subwatershed.

Table 41. Aquatic management components and targets for the Miller's Creek subwatershed.

Management Component	Management Target	Existing Conditions by Habitat Category		
		Small Riverine Coldwater	Small Riverine Warmwater	Intermediate Riverine Coldwater
Baseflow	Protect existing baseflow. Maintain a ratio of baseflow to average annual flow of 25 per cent.	Ratio suitable for the production of trout. Modeling suggests if current development projections are met, ratio will drop below 25 per cent.		
Water Extraction	Resource allocation so that there are no conflicts with aquatic habitat and species.	No active water taking permits found.		
Water Quality and Nutrients	PWQO or better	Benthic analysis suggests high levels of organic enrichment. Not listed in the 2003 - 2004 "Guide to Eating Ontario Sport Fish".		
Instream Barriers and Ponds	No instream barriers.	No known barriers identified. Transportation crossings may be potential barriers.		
Riparian Vegetation	a) 100 per cent stream length naturally vegetated b) 75 per cent of stream length with woody vegetation	a) 45 per cent naturally vegetated. b) 19 per cent with woody vegetation.		
Altered Watercourses	Natural channel principles used when alterations are necessary or improvements proposed.	Needs further assessment.	Concrete-lined channel upstream of Westney Road.	Concrete-lined channel upstream of Hwy. 401.
Wetland	a) > 10 per cent of watershed b) > Six per cent (101ha) of subwatershed	a) Two per cent for Duffins Creek watershed b) 0.22 per cent for Miller's Creek subwatershed.		
IBI	"Good"	Not sampled	Not sampled	Fair
Target Species	Small Riverine Coldwater – darter species. Small Riverine Warm water – darter species and rainbow trout. Intermediate Riverine Coldwater – darter species.	Darter species not found in 2000; may be a function of limited sampling.	Darter species and rainbow trout not found in 2000; may be a function of limited sampling.	Darter species not found in 2000; may be a function of limited sampling.

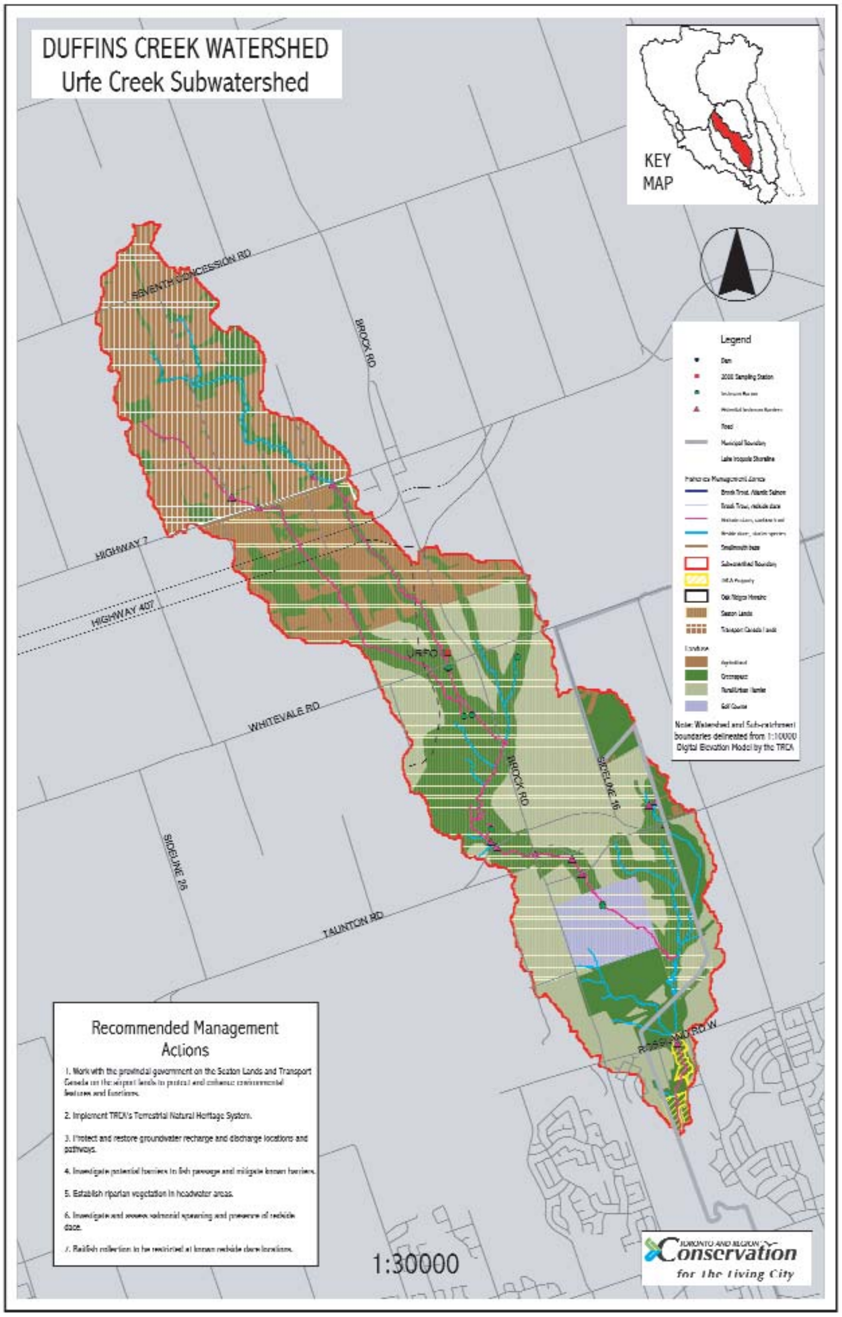
4.5.4 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS.

Table 42 outlines a list of recommended management activities required to preserve and enhance the aquatic community in the Miller's Creek subwatershed. Figure 25 shows the location of recommended activities.

Table 42. Recommended management activities for the Miller's Creek subwatershed

Management Component	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur (e.g. areas south of Taunton Road). ♦ Implement TRCA's Terrestrial Natural Heritage System Strategy. ♦ Protect remaining recharge and discharge functions. ♦ Increase infiltration where possible.
Monitoring	♦ Add at least two sample stations to small riverine cold-water habitat and intermediate riverine cold-water habitat.
Baitfish Harvest	♦ All licenced baitfish collectors must be certified in fish identification (OMNR or ROM fish IDid course).
Altered Watercourses	♦ Natural channel principles to be used when alterations or improvements proposed. ♦ Rehabilitate realigned sections of Miller's Creek (north of Bayly Street). ♦ Restore concrete-lined channel north of Westney Road.
Riparian Vegetation	♦ Maintain and protect existing riparian vegetation. ♦ Woody and herbaceous riparian plantings from Taunton Road to Hwy. 401. ♦ A minimum setback of 30 m should be maintained. ♦ Municipal park operations are encouraged to allow woody vegetation to grow adjacent to watercourses and to stop mowing right to top of bank.
Stormwater Retrofits	♦ Implement retrofit opportunities identified by the Town of Ajax.
	Medium Priority
Wetland Creation and Restoration	♦ Existing wetlands must receive full protection. ♦ Opportunities to create additional headwater wetlands should be explored. Where possible, historic wetlands should be recreated.
Water Taking	♦ Precise limits and timing of water extraction needs to be determined to ensure sufficient baseflow requirements for aquatic community.
Water Quality	♦ Investigate potential locations where cattle have unrestricted access to watercourses. ♦ Opportunities to implement Yellow Fish Road should be investigated.
Public Land	♦ Municipal land along watercourse from Rossland Road south to Jacwin Drive.
Instream Barriers and Ponds	♦ Potential barriers should be assessed for fish passage.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Long term – catch-and-possession limits for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.to ensure sufficient baseflow requirements for the aquatic community.
Instream Habitat	♦ Future work will be required to assess the need for instream habitat works.

Figure 24. Recommended Implementation Strategies in the Miller's Creek Subwatershed.



4.6 LOWER DUFFINS CREEK SUBWATERSHED

4.6.1 INTRODUCTION

The Lower Duffins Creek subwatershed is located in the southern-most section of the Duffins Creek watershed (Figure 26). The subwatershed extends from Lake Ontario to just north of Kingston Road and covers approximately 1,124 hectares of land in the Town of Ajax.

This subwatershed contains a 6th order watercourse 14 kilometres in length which receives the waters of the five larger subwatersheds upstream.

Setting

Land cover in the Lower Duffins Creek subwatershed is nearly evenly split between urban and natural areas. Approximately 45 per cent of the landscape is urbanized, six per cent is golf course and approximately 49 per cent remains as natural areas consisting of meadow, wetland, and or forest.

This subwatershed contains seven km of small riverine warm-water habitat (44 per cent of length), four km of intermediate riverine warm-water habitat (25 per cent of length) and five kilometers of estuarine habitat (31 per cent of length).

Despite the fact that the subwatershed does not directly support the reproduction of salmonid species, rainbow trout and chinook salmon rely on this system as a corridor on their way to annual spawning grounds upstream. As well the coastal marsh and upstream areas also support a good warm-water aquatic community and provides spawning habitat for numerous species such as largemouth bass, northern pike and many minnow species. The coastal marsh is also a popular urban angling destination from the early spring through to the late fall.

4.6.2 AQUATIC COMMUNITY

TRCA conducted fisheries surveys at two stations in the Lower Duffins Creek subwatershed in 2000 while the coastal marsh was surveyed in 2002 using the Durham Region Coastal Wetland Monitoring Project Methodology (CLOCA and EC, 2002).

A total of 37 species have been documented in the Lower Duffins Creek over the last 50 years, of which 26 were found in the 2000 and 2002 sampling events (Table 43). It is possible that due to the limited number of stations and timing of the 2000/2002 assessments, the true number of species currently inhabiting the subwatershed is higher. The historical dataset was, therefore, expanded to include data up to 1995, which adds seven species, including alewife, common carp, spottail shiner, yellow perch, northern pike, and mottled and slimy sculpin. Based on this larger list, the total number of introduced species found historically is five, of which three were found in recent sampling events and include chinook salmon, rainbow trout and brown trout. Alewife and common carp are the two additional introduced species found between 1995 and 2000. Mottled and slimy sculpin and northern pike, have narrow habitat requirements and are considered to be sensitive species. Spottail shiner and yellow perch still likely occur in the watershed but were not found in 2000.

Atlantic salmon, once common in Duffins Creek, are now extirpated from the watershed but would have historically migrated through this subwatershed to access upstream spawning areas.

Table 43. Fish species historically and presently found in the Lower Duffins Creek subwatershed

Common Name	Riverine Habitat		Coastal Marsh		Total Species	
	Historic	2000	Historic	2002	Historic	2000/02
American brook lamprey[4]	♦	♦	♦	♦		♦
alewife[1]	♦		♦			♦
gizzard shad		♦	♦	♦	♦	
chinook salmon[1]	♦	♦			♦	♦
rainbow trout[1]	♦	♦	♦		♦	♦
brown troutv	♦	♦			♦	♦
brook trout	♦	♦			♦	♦
northern pike			♦			♦
common carp[1]			♦			♦
white sucker	♦	♦			♦	♦
emerald shiner[5]			♦			♦
golden shiner			♦			♦
common shiner	♦	♦	♦	♦	♦	♦
spotfin shiner	♦	♦		♦	♦	♦
spottail shiner[5]			♦	♦	♦	♦
sand shiner	♦	♦			♦	♦
bluntnose minnow	♦	♦	♦	♦	♦	♦
fathead minnow	♦	♦	♦		♦	♦
blacknose dace	♦	♦			♦	♦
longnose dace	♦	♦			♦	♦
creek chub	♦	♦	♦		♦	♦
brown bullhead	♦	♦	♦	♦	♦	♦
stonecat[5]	♦				♦	
brook stickleback	♦	♦			♦	♦
white perch[1]	♦			♦		
white bass		♦			♦	
rock bass	♦	♦	♦	♦	♦	♦
pumpkinseed	♦	♦	♦	♦	♦	♦
largemouth bass			♦	♦	♦	♦
smallmouth bass	♦	♦	♦		♦	♦
walleye	♦				♦	
yellow perch	♦		♦	♦	♦	♦
rainbow darter[4]	♦	♦			♦	♦
johnny darter	♦	♦	♦	♦	♦	♦
logperch	♦	♦	♦		♦	♦
mottled sculpin			♦			♦
slimy sculpin		♦			♦	

** – Species such as alewife, northern pike, common carp, emerald shiner and golden shiner are expected to be present. The status of stonecat, white perch, white bass, walleye, mottled sculpin and slimy sculpin is unknown*

[1] - Introduced species [2] - Extirpated species [3] - COSEWIC - Species of Special Concern
[4] - COSEWIC - Group 2, Intermediate Priority [5] - COSEWIC - Group 3, Lower Priority [6] - COSSARO - Threatened

The general results of the 2000 invertebrate survey are listed in Table 44.

Table 44. Summary of 2000 benthic invertebrate analysis in the Lower Duffins Creek subwatershed

Station	Total No. of Taxa	Most Common Taxa	% Of Total Sample	Next Most Common Taxa	% of Total Sample	EPT	Hilsenhoff's Family Biotic Index /Rating	Shannon Weaver Diversity Index
DU01	33	Chironomidae (midges)	35	Ephemeroptera (mayflies)	25	9	5.97/Fairly Poor	4.36
DU02	18	Chironomidae (midges)	79	Ephemeroptera (mayflies)	8	4	6.68/ Poor	3.1

Aquatic Ecosystem Health

Both 2000 sample stations received a relatively low IBI rating of "fair" stream quality due to a low catch per unit effort and poor species and community trophic composition. The community makeup is also deficient in specialized feeders and piscivorous species. Species richness was 13, seven less than that expected by Steedman (1987). The number of species found in the marsh in 2002 was 10, much less than the cumulative historical list of 27.

Analysis of benthic invertebrate data suggests that DU01 has a "fair" condition while DU02, located downstream, is in relatively "poor" condition. Both stations suggest that there is likely substantial organic pollution present. Almost twice the sensitive taxa were found at DU01 compared to DU02, which is located just upstream of Duffins Creek Marsh and is likely in an area of sediment deposition. Further evidence to suggest this is the high percentage of Chironomids to other organisms. Poor water quality, soft and shifting substrates, and perhaps high flows are precluding larger more sensitive organisms such as Megaloptera and Anisoptera from the area.

In 2000 - 2001, the OMOE conducted a sampling program for a number of heavy metals and trace organic contaminants in the Lower Duffins Creek subwatershed. Few traces of organic pollutants were found and of those detected, all occurred in very trace amounts. Metal concentrations were also found to be within the normal range. In the Lower Duffins Creek, there is no particular evidence of water quality conditions being toxic to aquatic or fish communities.

The Lower Duffins Creek subwatershed is considerably urbanized and, therefore, it is not surprising to find that the aquatic community has been affected. Urban land uses are contributing to reduced water infiltration, increased surface run-off, lower water quality and higher total suspended sediments. Streambank hardening has reduced the opportunity for riparian vegetation to grow, particularly within the footprint of Highway 401. The Lower Duffins Creek subwatershed also has a sea lamprey barrier located upstream of Church Street. Although desirable as a means of controlling invasive species, the barrier does inhibit access of non-jumping species and is likely somewhat responsible for the reduced species richness of the subwatershed.

There are a number of issues associated with the coastal marsh including carp access and it's associated impacts on turbidity and aquatic vegetation. For a detailed restoration plan refer to the Duffins Creek Marsh Restoration Plan (TRCAc, 2003).

Compared to the health of other subwatersheds in the Duffins system, this subwatershed ranks second to last behind the Miller's Creek subwatershed. The Lower Duffins Creek subwatershed is not irretrievably impaired, however. Restoration activities can be developed to enhance the aquatic habitat and species in the subwatershed.

4.6.3 MANAGEMENT TARGETS

Table 45 summarizes the aquatic management components and targets for the Lower Duffins Creek subwatershed.

Table 45. Aquatic management components and targets for the Lower Duffins Creek subwatershed.

Management Component	Management Target	Existing Conditions by Habitat Category	
		Large Riverine	Estuarine
Baseflow	Protect current baseflow levels	Existing ratio of 15 - 21 per cent is almost suitable for salmonid production. Regardless, this ratio must be protected to ensure healthy aquatic habitat for both migratory and resident species.	
Water Extraction	Resource allocation so that there are no conflicts with aquatic habitat and species.	No active water taking permits found.	
Water Quality and Nutrients	PWQO or better	Water quality in terms of nutrients is "fair". Coastal marsh listed in the 2003/04 Guide to Eating Ontario Sport Fish.	
Instream Barriers and Ponds	Remove or at minimum mitigate barriers except where they are integral to fisheries management (e.g. sea lamprey barrier).	Lamprey barrier does not allow passage of non-jumping species.	Restrict carp access to lagoons in coastal marsh.
Riparian Vegetation	a) 100 per cent stream length naturally vegetated b) 75 per cent of stream length with woody vegetation	a) 48 per cent naturally vegetated b) 25 per centof stream length with woody vegetation	
Altered Watercourses	Natural channel principles used when alterations are necessary or improvements proposed.	Channelized and lined with concrete under Highway 401.	
Wetland	a) > 10 per cent of watershed b) > Six per cent (23 ha) of subwatershed	a) Two per cent for Duffins Creek watershed b) Four per cent for West Duffins Creek subwatershed	
IBI	Minimum of "Good"	Fair.	N/A.
Target Species	**Large Riverine** – smallmouth bass. **Estuarine**– smallmouth bass.	Currently found, but not all life stages.	Only largemouth bass have recently been found.

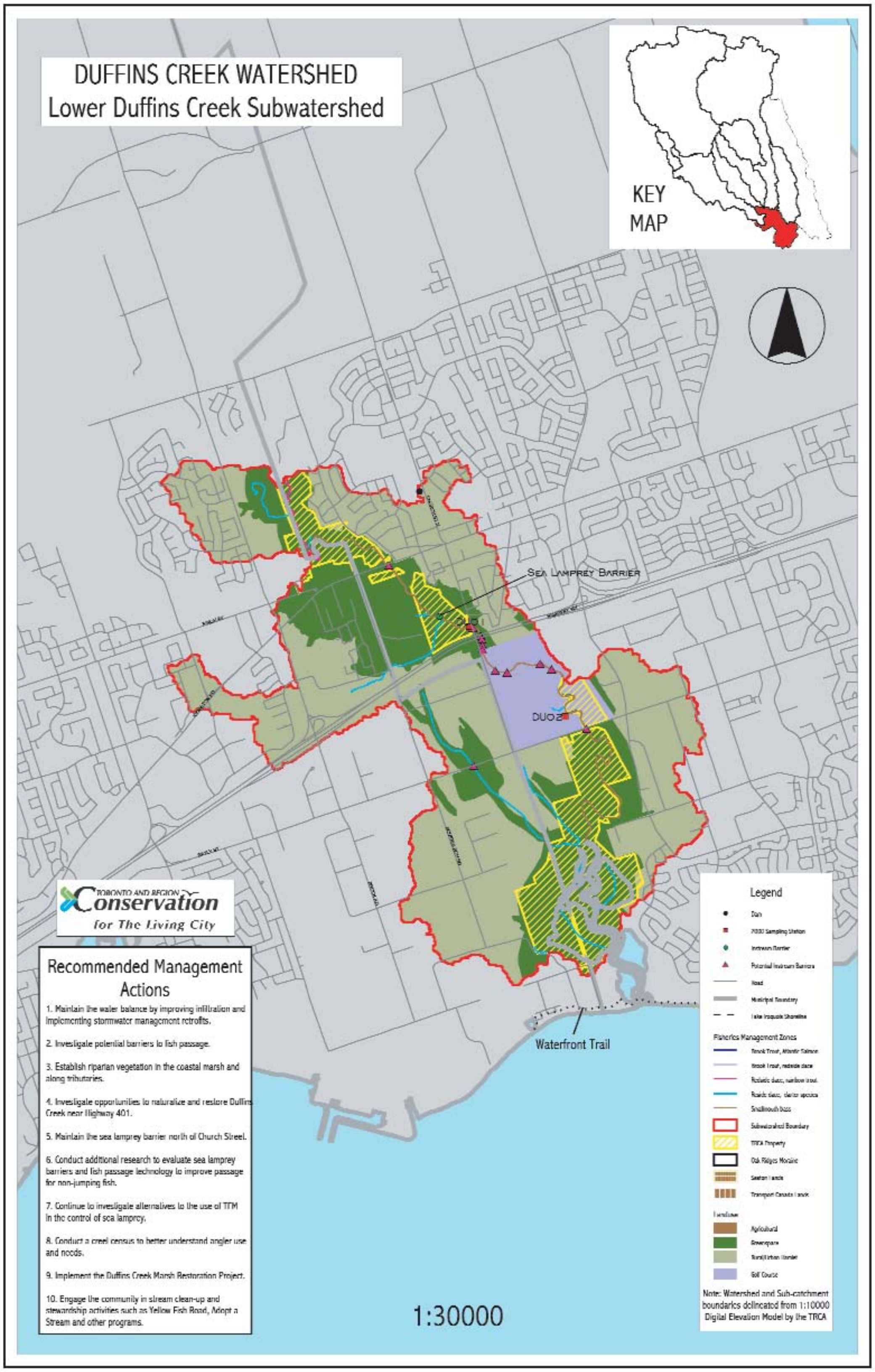
4.6.4 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS

Table 46 lists recommended management activities required to protect and enhance the aquatic community, while Figure 26 shows the location of recommended activities.

Table 46. Recommended management activities for the Lower Duffins Creek subwatershed.

Management Component	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur. This is particularly critical in maintaining the hydrologic regime of Duffins Creek Marsh. ♦ Confirm no active water takings present.
Monitoring	♦ Expand regular monitoring to include at least three sites in Duffins Creek Marsh. ♦ Monitor for sculpin and northern pike. ♦ Assess impacts of sea lamprey barrier on non-jumping fish species. ♦ Assess impacts of lampricide in areas covered by the application. (OMNR or ROM fish IDid course).
Baitfish Harvest	♦ All licenced baitfish collectors must be certified in fish identification (OMNR or ROM fish ID course).
Altered Watercourses	♦ Natural channel principles to be used when alterations or improvements proposed. ♦ Rehabilitate Duffins Creek in the vicinity of Highway 401.
Stormwater Retrofits	♦ Implement retrofit opportunities identified by the Town of Ajax and City of Pickering.
Public Land	♦ Fish viewing opportunities in the marsh and along Duffins Creek should be created. ♦ Additional conservation lands should be secured in the coastal wetland regions. ♦ Work with anglers to foster improved stewardship in heavily used areas.
Riparian Vegetation	♦ Maintain and protect existing riparian vegetation. ♦ Establish woody vegetation from Highway 401 to the northern limits of the marsh. ♦ Golf courses are encouraged to allow woody vegetation to grow adjacent to watercourses and to stop mowing right to top of bank.
Instream Barriers and Ponds	♦ Maintain the sea lamprey barrier north of Church Street. ♦ Potential barriers caused by water crossings and perched culverts to be investigated.
	Medium Priority
Wetland Creation and Restoration	♦ Existing wetlands must receive full protection. ♦ Opportunities to create additional wetlands should be explored. Where possible, historic wetlands should be recreated. ♦ Implement the Duffins Creek Marsh Restoration Plan.
Water Quality	♦ Fulfilling riparian targets will significantly aid in reducing non-point sources of pollution, as well as treatment of stormwater effluent.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Short term - trout and salmon catch and possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence. ♦ Long term - catch-and-possession limits for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.
Stocking	♦ Stocking of non-native species is not recommended.
Instream Habitat	♦ Future work required to assess the need for instream habitat works.

Figure 26. Recommended Implementation Strategies in the Lower Duffins Creek Subwatershed.



4.7 CARRUTHERS CREEK WATERSHED

4.7.1 INTRODUCTION

The Carruthers Creek watershed is located directly to the east of Duffins Creek and flows in a southerly direction to it's confluence with Lake Ontario (Figure 27). The watershed drains approximately 38km2 of land and contains approximately 61 kilometres of 1st to 4th order watercourses.

Setting

As of 1999, land cover in the watershed is 17 per cent urbanized, 49 per cent agriculture, 5 per cent golf course and 29 per cent are natural areas such as forest, meadow and/or wetland. Land cover is changing rapidly with the conversion of agricultural lands to urban use.

The Carruthers Creek watershed contains small riverine cold-water habitat (16 km or 26 per cent by length), small riverine warm-water habitat (31 km or 50 per cent by length), intermediate riverine cold-water habitat (eight kilometers or 13 per cent by length), intermediate riverine warm-water habitat (three kilometers or five per cent by length) and estuarine habitat (four kilometers or six per cent by length).

4.7.2 AQUATIC COMMUNITY

TRCA conducted fish and benthic invertebrate surveys at six stations in the Carruthers Creek watershed in 2000. The coastal marsh was also surveyed in 2002 using the Durham Region Coastal Wetland Monitoring Project Methodology (CLOCA and EC, 2002).

A total of 41 species have been documented in the Carruthers system over the last 50 years, of which 18 were found in the combined 2000 and 2002 sampling events (Table 47). The introduced species found historically are rainbow trout, common carp and alewife.

Table 47. Fish species historically and presently found in the Carruthers Creek watershed

Common Name	Riverine Habitat		Coastal Marsh		Total Species	
	Historic	2000	Historic	2002	Historic	2000/02
American brook lamprey[4]	♦				♦	
alewife[1]			♦		♦	
gizzard shad			♦	♦	♦	♦
rainbow trout[1]	♦	♦			♦	♦
brook trout	♦				♦	
northern pike	♦		♦	**	♦	
white sucker	♦	♦	♦		♦	♦
common carp[1]	♦		♦	♦	♦	♦
sand shiner	♦				♦	
spottail shiner[5]			♦		♦	
spotfin shiner	♦				♦	
rosyface shiner	♦				♦	
emerald shiner[5]	♦			♦		♦
golden shiner			♦		♦	
common shiner	♦		♦	♦	♦	♦
brassy minnow[4]	♦				♦	
bluntnose minnow	♦		♦	♦	♦	♦
fathead minnow	♦		♦		♦	
northern redbelly dace[4]	♦	♦		♦	♦	
redside dace[3,6]	♦				♦	
blacknose dace	♦		♦		♦	♦
longnose dace	♦				♦	
creek chub	♦	♦	♦		♦	♦
central mud minnow	♦		♦		♦	
stonecat[5]	♦				♦	
brown bullhead	♦	♦	♦	♦	♦	♦
banded killifish	♦				♦	
brook stickleback	♦				♦	
three-spine stickleback	♦				♦	
white perch[1]	♦		♦		♦	
white bass	♦		♦		♦	
rock bass	♦		♦		♦	
pumpkinseed	♦	♦	♦	♦	♦	♦
largemouth bass	♦	♦	♦		♦	♦
smallmouth bass	♦		♦	♦	♦	♦
black crappie			♦	♦	♦	♦
walleye						
yellow perch	♦		♦	♦	♦	♦
rainbow darter[4]	♦				♦	
johnny darter	♦	♦	♦	♦		♦
logperch	♦	♦	♦	♦		♦
mottled sculpin	♦	♦			♦	♦

** – Species such as alewife, northern pike, spottail shiner, emerald shiner, golden shiner, fathead minnow, longnose dace, brook stickleback, threespine stickleback, rock bass and rainbow darter are expected to be present. The status of American brook lamprey, brook trout, sand shiner, spotfin shiner, rosyface shiner, brassy minnow, redside dace, central mud minnow, stonecat, banded killifish, white perch, white bass and walleye is unknown*

*** - Anecdotal sighting by TRCA staff*

[1] - Introduced species
[2] - Extirpated species
[3] - COSEWIC -Species of Special Concern
[4] - COSEWIC - Group 2, Intermediate Priority
[5] - COSEWIC- Group 3, Lower Priority
[6] - COSSARO - Threatened

It is likely that due to the limited number of stations and timing of the 2000/2002 assessments, the true number of species currently inhabiting the watershed is higher than that shown in Table 47. The historical dataset was, therefore, expanded to include data from 1995. An additional six species were found and include redside dace, brassy minnow, fathead minnow, longnose dace, brook stickleback and three-spine stickleback. Of these six species, redside dace and brassy minnow are considered to be sensitive and "relatively" sensitive, respectively. Redside dace is a Species of Concern and TRCA has recent anecdotal capture of redside dace in Carruthers Creek, and it is likely that this species still resides in the watershed, but is very sparsely distributed. The remaining four species are not as specialized and were, therefore, likely missed in the recent sampling event rather than being extirpated from the watershed.

The general results of the 2000 invertebrate survey are listed in Table 48.

Table 48. Summary of the 2000 benthic invertebrate analysis in the Carruthers Creek watershed

Station	Total No. of Taxa	Most Common Taxa	% Of Total Sample	Next Most Common Taxa	% of Total Sample	EPT	Hilsenhoff's Family Biotic Index /Rating	Shannon Weaver Diversity Index
CC01	31	Coleoptera (beetles)	39	Trichoptera (caddisfly)	21	7	4.82/Good	3.85
CC02	15	Oligocheata (segmented worms)	43	Isopoda (sowbugs)	40	1	7.73/Very Poor	1.89
CC03	32	Amphipoda (scuds)	23	Trichoptera (caddisfly)	22	9	5.43/Fair	3.47
CC04	18	Chironomidae (midges)	51	Amphipoda (scuds)	18	1	5.98/Fairly Poor	3.4
CC05	28	Amphipoda (scuds)	76	Oligocheata (segmented worms)	18	1	6.33/Fairly Poor	2.55
CC06	12	Isopoda (sowbugs)	48	Amphipoda (scuds)	44	0	6.91/Poor	1.49

Aquatic Ecosystem Health

IBI ratings ranged between "fair" and "good" stream quality. It is curious to note that CC02 which received the best IBI rating, is located where nutrient levels were found to be worst. This site scored well in the IBI rating due to a good catch per unit effort and due to a lack of Rhinichthys species. It is likely that the cold-water environment found in this area is helping to maintain oxygen levels that otherwise would be depleted due to high primary productivity and organic decay. Overall, the fisheries data reflects that all stations have unbalanced fish communities where top predators and specialized feeding groups are lacking. Actual species richness falls well below expected values, likely due to habitat degradation.

Analysis of benthic invertebrate data suggests that the majority of stations are in either "fair" or "poor" condition. Stations CC02, CC04 and CC05, all with poor EPT and Hilsenhoff scores, reflect the highest level of degradation. Low EPT scores indicate that there are few, if any, sensitive taxa and poor Hilsenhoff scores indicate that there is likely substantial organic pollution present.

When comparing the Carruthers Creek watershed to subwatersheds of Duffins Creek, Carruthers Creek is healthier than Miller's Creek and sections of the Lower Duffins Creek.

4.7.3 MANAGEMENT TARGETS

Table 49 summarizes the aquatic management components and targets for the Carruthers Creek watershed.

Table 49. Aquatic management components and targets for the Carruthers Creek watershed

Management Component	Management Target	Existing Conditions by Habitat Category			
		Small Riverine Coldwater	Small Riverine Warmwater	Intermediate Riverine Coldwater	Estuarine
Baseflow	Protect existing baseflow. Maintain a ratio of baseflow to average annual flow of 25 per cent.	Ratio of baseflow to average annual flow is 19 to 25 per cent. As urban expansion occurs, this ratio may be reduced. No active water taking permits found.			
Water Extraction	Resource allocation so that there are no conflicts with aquatic habitat and species.	Existing water taking permits have the potential to exceed the total yearly or daily baseflow.			
Water Quality and Nutrients	PWQO or better	Generally good overall; organic enrichment in places. No locations listed in the 2003/04 "Guide to Eating Ontario Sport Fish".			
Instream Barriers and Ponds	Remove or at minimum mitigate barriers, except where they are integral to fisheries management.	One	Eight	None	None
Riparian Vegetation	a) 100 per cent stream length naturally vegetated b) 75 per cent of stream length with woody vegetation	a) 75 per cent naturally vegetated. b) 42 per cent of stream length with woody vegetation.			
Altered Watercourses	Natural channel principles used when alterations are necessary or improvements proposed.	Needs further assessment.			
Wetland	> 10 per cent (305 ha) of watershed.	Two-point-three per cent of watershed.			
IBI	"Good"	"Good"	Not sampled	Poor - good	N/A
Target Species	**Small Riverine Coldwater** – brook trout. **Small Riverine Warm water** – redside dace and darter species. **Intermediate Riverine Coldwater** – rainbow trout and redside dace. **Estuarine** – northern pike and largemouth bass.	Not found in 2000.	Only darter species found in 2000.	Small rainbow trout runs have been spotted up to Kingston Rd.Anecdotal report of red-side dace in the vicinity of CC04 in 2000.	Anecdotal report by OMNR and TRCA of young of the year pike in 2000. Largemouth bass present.

4.7.4 IMPLEMENTATION STRATEGIES FOR MANAGEMENT ACTIVITIES AND TARGETS

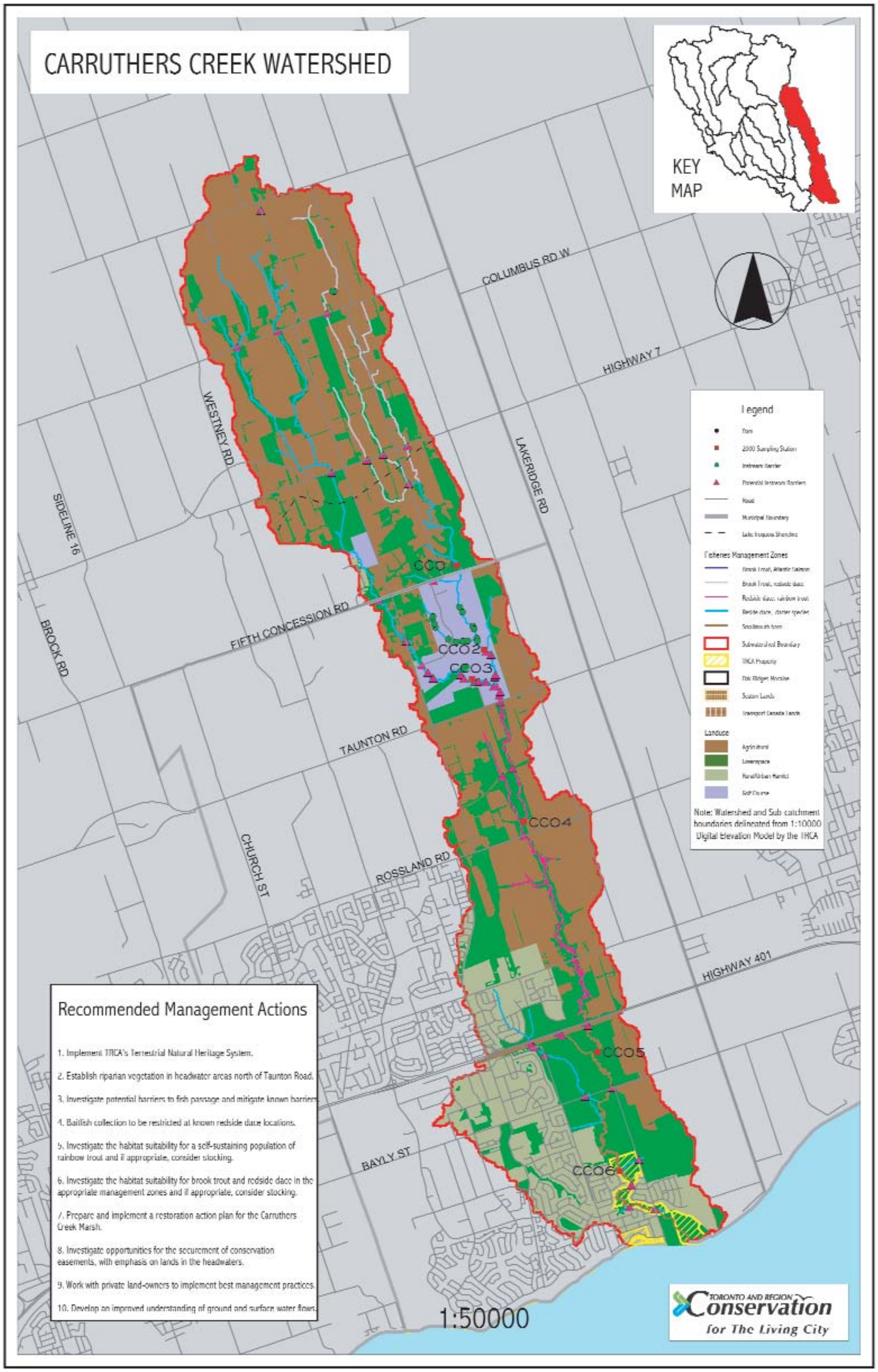
Table 50 lists recommended management activities required to protect and enhance the aquatic community while Figure 27 shows the location of recommended activities.

Table 50. Recommended management activities in the Carruthers Creek watershed Management Component

Management Component	Recommended Activity
	High Priority
Water Balance	♦ Ensure existing water balance is maintained in areas where development is to occur. ♦ Implement TRCA's Terrestrial Natural Heritage System Strategy. ♦ Protect areas of recharge and discharge. ♦ OMOE should consult with other government agencies to determine acceptable flow alterations to protect aquatic communities.
Monitoring	♦ Expand monitoring to include small riverine warmwater habitat
Baitfish Harvest	♦ All licenced baitfish collectors must be certified in fish identification (OMNR or ROM fish ID course)
Altered Watercourses	♦ Natural channel principles to be used when alterations or improvements proposed.
Public Land	♦ TRCA owns a small portion of land south of Bayly Street and west of Shoal Point Road. ♦ TRCA properties should provide specific areas/access nodes for anglers. ♦ TRCA properties should promote catch-and-release angling, and the use of barbless hooks within identified reaches.
Riparian Vegetation	♦ Woody riparian vegetation should be established in the following areas: ♦ headwater areas above Taunton Road. ♦ A minimum setback of 30 m should be maintained as a protective riparian zone. ♦ Municipalities, golf course and agricultural operations are encouraged to allow woody vegetation to grow adjacent to watercourses and to stop mowing to top of bank.
Instream Barriers and Ponds	♦ Opportunities to off-line ponds north of Taunton Road should be investigated. Other alternatives include providing fish passage and/or conversion to bottom draw. ♦ Conduct fish passage assessments for each known and potential barrier. ♦ Opportunities to restrict carp access into the marsh should be explored. ♦ The need for a sea lamprey barrier should be investigated.

Management Component	Recommended Activity
	Medium Priority
Stormwater Retrofits	♦ Existing wetlands must receive full protection. ♦ Opportunities to create additional wetlands should be explored. Where possible, historic wetlands should be recreated.
Water Taking	♦ Precise limits and timing of water extraction need to be determined to meet sufficient baseflow requirements of the aquatic community.
Water Quality	♦ Investigate potential locations where cattle have unrestricted access to watercourses.
Angling Regulations	♦ Conduct creel surveys to determine angling pressure. ♦ Short term – trout and salmon catch-and-possession limit on all TRCA properties only to be changed to five in one day, but not more than one from among brook and brown trout for a sportfishing licence and two in one day, but not more than one from among brook and brown trout for a conservation licence. ♦ Long term – catch-and-possession limits for trout and salmon be reduced to two with a sportfishing licence and one with a conservation licence.
Stocking	♦ Stocking of non-native species in riverine systems should be investigated.$ OMNR to investigate the habitat suitability for redside dace in the appropriate management zones and, if appropriate, consider stocking.
Instream Habitat	♦ Future work required to assess need.
Stormwater Retrofits	♦ None recommended at this time.

Figure 27. Recommended Implementation Strategies in the Carruthers Creek Watershed.



CHAPTER

5

5.0 MONITORING AND SURVEYS.

Watershed wide inventories of the Duffins and Carruthers and creeks watersheds have, in the past, occurred periodically. However, they were often many years apart and only examined the fish and/or benthic invertebrate communities. To provide a regular picture of the health of the nine watersheds in the TRCA's jurisdiction, the Regional Watershed Monitoring Program (RWMP) was implemented in 2001. A total of 150 stations were selected, with 21 of those in the Duffins Creek watershed and three of those in the Carruthers creek Watershed. Each of these stations is sampled annually for benthic invertebrates, while every third year, the suite of data collected is expanded to include benthics, fish community, aquatic habitat, algae and stream temperature. Intensive sampling was completed in 2003 for the Duffins and Carruthers watersheds, with the next complete data collection scheduled for 2006.

While the RWMP provides an excellent snapshot of regional conditions, it is focused on larger stream reaches and does not provide the level of detail required for a complete watershed-wide aquatic ecosystem inventory. It is recommended that when the intensive sampling is again scheduled, additional stations be added in the following locations:

i) **East Duffins Creek** – add sample stations in Brougham, Mitchell and Spring creeks and small riverine warm-water habitat;
ii) **West Duffins Creek** – add sample stations in Whitevale, Wixon and Unnamed creeks and small riverine warm-water habitat;
iii) **Ganatsekiagon Creek** – add one station north of Steeles Avenue, one other station in small riverine warm-water habitat; assess use by chinook salmon and presence of redside dace
iv) **Urfe Creek** – add a monitoring station at Rossland Road and in small riverine warm-water habitat; assess use by chinook salmon and determine presence of redside dace;
v) **Miller's Creek** - add at least two sample stations to cover small riverine cold-water habitat and intermediate riverine cold-water habitat;

v) **Lower Duffins Creek –** expand regular monitoring to include at least three sites in the coastal marsh; monitor for sculpin and northern pike; assess impacts of sea lamprey barrier on non-jumping fish species; assess impacts of lampricide in areas covered by the application, and;

vi) **Carruthers Creek –** expand monitoring to include small riverine warm-water habitat.

It is also recommended that a community monitoring program be initiated in these watersheds. Initial projects being examined by the TRCA include benthic invertebrate and aesthetic monitoring. Other projects could include creel, migratory fish or fish spawning surveys. Local rod and gun clubs, schools or non-government organizations would be potential implementation groups.

Finally, it should be noted that surveys relating to project implementation, watershed issues, species of concern etc., should also be conducted. These surveys are relatively short term and are done to assess specific concerns. Priority surveys include aquatic sampling, presence of redside dace and salmonid spawning surveys on the Transport Canada property, the status of redside dace and smallmouth bass in the appropriate management zones and salmonid spawning locations in Carrurthers, Urfe and Ganatsekiagon creeks.

CHAPTER

6

6.0 NEXT STEPS

The intent of the FMP is to be a living document and one that gets used regularly. It is anticipated that the Plan will provide guidance to those looking to implement stream restoration projects, landowners taking ponds off-line or municipalities replacing culverts. This means that the Plan will need regular updating to stay current and provide the best management direction. It will also require a method for the incorporation of new data and research. Finally, there needs to be a way for the public to be able to provide input into the future management of the aquatic system in both the Duffins Creek and Carruthers Creek watersheds.

To that end, it is recommended that in 2012, the Fisheries Management Plan be reviewed and updated where necessary. This will allow time for the recommendations in this Plan to be developed and implemented and the results of the Regional Watershed Monitoring Program to be analyzed. In the meantime, the Fisheries Management Plan will continue to be a living document that changes as new information is gathered and projects are implemented.

Implementation of the FMP will require the help of federal, provincial and municipal governments, non-governmental organizations, rod and gun clubs, industry, agriculture, golf courses and private citizens. Table 51 outlines some of major roles and responsibilities of management agencies and the public at various stages of project implementation.

Table 51. Implementation stages, and roles and responsibilities

Project Component	Group(s) Responsible
Concept	Everyone
Funding	DFO, OMNR, OMOE, TRCA, municipalities, private sources
Design	Consultants, OMNR, TRCA, municipalities, public
Approvals	DFO – Habitat Management, Transport Canada, OMNR, OMOE, TRCA, municipalities
Implementation	Public, consultants, TRCA, OMNR, DFO

7.0 GLOSSARY

Anoxic
A deficiency of oxygen.

Aquifer
A subsurface body of sediment (or rock) that contains sufficient saturated permeable material to conduct groundwater and yield economically significant quantities of potable water to wells and springs.

Average annual flow
The sum of the total amount of water discharged past a certain point on a watercourse on a yearly basis divided by the number of years for which records exist.

Baseflow
The volume of flow in a stream channel that is derived primarily from groundwater discharge.

Benthic invertebrate
Includes all the organisms without a backbone that are found along the bottom of a watercourse.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
A federal agency that determines the national status of wild species, subspecies, varieties and nationally significant populations that are considered to be at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO)
A provincial agency that determines the provincial status of wild species, subspecies, varieties and provincially significant populations that are considered to be at risk in Ontario.

Endangered
A species facing imminent extirpation or extinction.

Estuarine
Relating to the mouth of a river opening into the lake.

Eutrophic
Rich in phosphates, nitrates and other nutrients that promote the growth of algae, which deplete the water of oxygen and cause the extinction of other organisms.

Exotic
A species not historically present.

Extirpated
A species no longer existing in the wild in Lake Ontario, but occurring elsewhere.

Groundwater
Subsurface water occurring below the water table in the saturated zone where all pores are filled with water under hydrostatic pressure.

Headwater
The source or main part of a river or stream.

Index of Biotic Integrity (IBI)
A measure of fish community associations that is used to identify the general health of the broader stream ecosystem. It assesses the health of a fish community in terms of species composition, trophic composition and abundance of fish.

Infiltration
The percolation of water from precipitation into soil or rock through pores or fractures and which eventually reaches the ground-water table.

Instream barrier
Any human built structure spanning the entire width of a watercourse that blocks upstream movement of fish species. (eg. dam or weir).

Intermittent stream
A stream or stream portion that flows in direct response to precipitation and may be periodically dry.

Introduced
Any species that is not indigenous to the Humber River watershed. Introductions can be deliberate or accidental, and can include exotic species, naturalized species and native species which are stocked beyond their natural range.

Lacustrine
Of, pertaining to, or inhabiting lakes or other bodies of water.

Native
Any species that was found in the watershed prior to European settlement.

Naturalized
An introduced species which is now self-sustaining.

Omnivore
An organism that eats both animal and vegetable food.

Permeability
The capacity of a porous medium to transmit a liquid or gas subjected to an energy gradient. Permeability is the result of the species in situ properties of the sediment or rock such as grain size, grain sphericity, roundness and packing, presence or absence of fractures, etc.

Piscivore
Feeding solely or chiefly on fish; fish eating.

Pool
A deep area in a watercourse having slow-flowing water and a smooth surface, often found at bends in the river.

Recharge
The downward movement of surface precipitation (ie., rain, snow melt) to the water table and underlying saturated zone. Essentially the process by which surface water becomes groundwater.

Recharge area
The portion of the drainage basin in which the net flow of groundwater is directed downward, away from the water table.

Riffle
Shallow water with rapid current and with surface flow broken by sub-surface substrates.

Riparian vegetation
Streamside vegetation which provides temperature control (shading), habitat diversity, bank stability, food and shelter to aquatic organisms and their habitats.

Riverine
Of, or having to do with a watercourse.

Salmonid
A fish of the salmon or trout family.

Sinuosity
A measure of the degree of meandering or bending of a watercourse. The ratio of channel length to direct down valley distance.

Stream order
A classification system that numbers the tributaries of a river beginning with headwater tributaries and increasing the order number as lower order tributaries join the mainstream. Any single, unbranched tributary is considered a first order stream. Two first order streams join to form a second order stream, two second order streams join to form a third order stream, etc.

Stream slope
The change in gradient of the stream bed between two points, which can be used to infer characteristics of that watercourse.

Subwatershed
A subunit of a watershed, often defined as the drainage area of a tributary of a watercourse.

Surficial geology
Overburden soils deposited by the most recent glaciation.

Suspended solid
Solids that either float on the surface of, or are in suspension in, water, water or other liquids, and which are largely removable by laboratory filtering.

Threatened
A species likely to become endangered if limiting factors are not reversed.

Tributary
A contributing stream or river; one that runs into another or into a lake.

Vulnerable
A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

Watershed
The land area drained by a river or stream and its tributaries.

Wetland
Areas that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. The four types of wetlands are bogs, fens, marshes and swamps.

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APPENDICES

Appendix A – Documents developed in the Watershed Plan process

Appendix B – Map illustrating IBI scores for 2000 sampling stations

Appendix C – Map illustrating Hilsenhoff scores for 2000 sampling stations

Appendix D – Stocking data for the Duffins and Carruthers watersheds

Appendix A - Documents Developed in the Watershed Plan Process

Prepared by the Toronto and Region Conservation Authority:

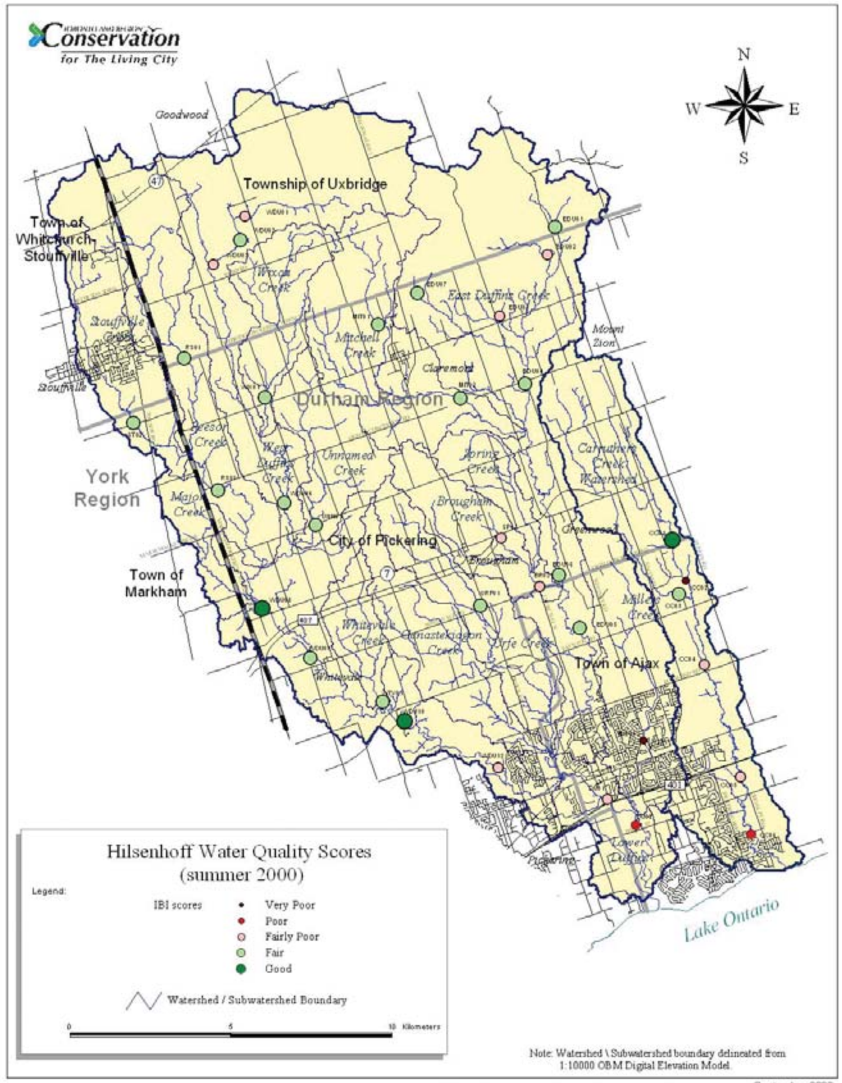
1. A Watershed Plan for Duffins Creek and Carruthers Creek. 2003.
2. Technical Analysis and Integration Process Summary Report – Duffins and Carruthers Creek Watershed Plan. 2003.
3. Agricultural Non?Point Source (AGNPS) Modeling of the Duffins and Carruthers Creek Watersheds.
4. Duffins and Carruthers Creek Low Flow Study and Management Plan. 2002.
5. Ratings Report for the 2003 Duffins and Carruthers Creek Watersheds Report Card.
6. Carruthers Creek State of the Watershed Report. 2002.

Prepared by others:

1. Aquafor Beech Ltd. 2002. Duffins Creek Hydrology Update.
2. Clarifica Inc. 2002. Water Budget in Urbanizing Watersheds: Duffins Creek Watershed.
3. Gerber Geosciences Inc. 2003. Duffins Creek Watershed Hydrogeology and Assessment of Land Use Change on the Groundwater Flow System. Including Appendix on Water Use.
4. Marshall Macklin Monaghan Ltd. 2002. Duffins Creek Watershed Hydraulic Modeling and Floodplain Mapping Project.
5. Stantec Consulting Ltd. and Aquafor Beech Ltd. 2003. Dry and Wet Weather Modeling of Water Quality Under Alternative Land Use Scenarios in the Duffins and Carruthers Creek Watersheds – A Simple Spreadsheet Approach.

Appendix B: IBI scores for 2000 sampling stations

Appendix B



Appendx C: Hilsenhoff Family water quality scores for summer 2000 Benthic Invertebrate Sampling stations

September 2003

Appendix C

Duffin Creek and Tributary Stocking History From 1900 to 2001

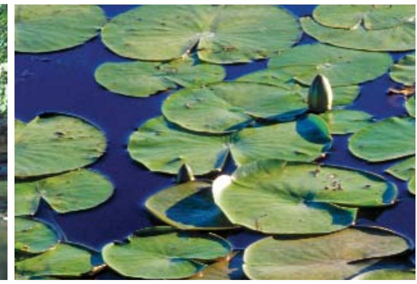
Species	Year	Tributary*	Site	Number Stocked	Month Stocked	Age (Months)	Development Stage	Mean Weight (g)	Clip	Fish Culture Station**	Strain/ Egg Source	Stocking Purpose
Rainbow Trout	1961			4,000	6	12	Yearling					
	1965			1,000	6	12	Yearling					
	1972			10,000	3	12	Yearling	50.39	Right Ventral	Normandale FCS		
	1972			10,000	3	12	Yearling			Normandale FCS		
	1973			10,000	4	12	Yearling		Adipose	Normandale FCS	Normandale	
	1973			10,000	4	12	Yearling		Adipose	Normandale FCS	Normandale	
	1974			5,000	3	11	Yearling		Left Ventral	Normandale FCS	Normandale	
	1974			5,000	6	14	Yearling		No Clip	Codrington FCS	Normandale	
	1976		GREENWOOD	5,000	4	12	Yearling	46.26	Right Ventral	Normandale FCS	Normandale	Rehabilitation
	1976		GREENWOOD	5,000	4	12	Yearling	46.26	Right Ventral	Normandale FCS	Normandale	Rehabilitation
	1977		GREENWOOD	5,000	3	11	Yearling	69.86	Adipose	Normandale FCS	Normandale	Rehabilitation
	1978	Mitchell's Cr.		5,000	6	5	Fingerling	6.00	Adipose	Normandale FCS	Trimborn Lake/Normandale	Introduction/Assessment
	1978	Mitchell's Cr.		5,000	6	5	Fingerling	6.00	Adipose	Normandale FCS	Trimborn Lake/Normandale	Introduction/Assessment
	1978		GREENWOOD	2,730	5	13	Yearling	43.19	Right Ventral	Deer Lake FCS	Normandale	Rehabilitation
	1978		GREENWOOD	5,460	5	13	Yearling	43.19	Right Ventral	Deer Lake FCS	Normandale	Rehabilitation
	1978		8TH CONC PICKERING	2,860	5	13	Yearling	41.24	Right Ventral	Deer Lake FCS	Normandale	Rehabilitation
	1979	Mitchell's Cr.		300	5	16	Yearling	168.00	No Clip	Normandale FCS	Trimborn Lake/Normandale	Put-and-Take
	1979	Mitchell's Cr.		10,000	5	4	Fingerling	4.00	Adipose	Normandale FCS	Trimborn Lake/Normandale	Rehabilitation/Supplemental
	1979		GREENWOOD CON. 8	13,440	4	11	Yearling	18.90	Adipose	Deer Lake FCS	Normandale	Rehabilitation
	1980			10,000	5	3	Fingerling	1.00	No Clip	Normandale FCS	Normandale	Put-Grow-and-Take
	1980			10,000	5	14	Yearling	16.19	Right Ventral	Deer Lake FCS	Normandale	Rehabilitation
	1980			50,000	7	3	Fingerling	2.27	No Clip	Normandale FCS	Normandale	Put-Grow-and-Take
	1983			2,000	4	14	Yearling	37.85	No Clip	Deer Lake FCS	Unknown	Rehabilitation
	1983			5,000	4	14	Yearling	37.85	No Clip	Deer Lake FCS	Unknown	Rehabilitation
	1983			2,240	4	14	Yearling	37.85	No Clip	Deer Lake FCS	Unknown	Rehabilitation
	1985	Mitchell's Cr.		11,200	6	0	Fry		No Clip		Unknown	
	1987			10,000	4	10	Yearling	15.40	Adipose	Normandale FCS	Ganaraska	Rehabilitation
	1987			35,000	5	11	Yearling	5.20	Adipose	Normandale FCS	Ganaraska	Rehabilitation
	1988		WHITEVALE	6,500	5	12	Yearling	44.40	Right Ventral	Normandale FCS	Ganaraska/Normandale	Rehabilitation
	1988			6,500	5	12	Yearling	44.50	Right Ventral	Normandale FCS	Ganaraska/Normandale	Rehabilitation
	1988			7,000	5	12	Yearling	38.00	Right Ventral	Normandale FCS	Ganaraska/Normandale	Rehabilitation
	1988			6,500	5	12	Yearling	38.80	Right Ventral	Normandale FCS	Ganaraska/Normandale	Rehabilitation
	1988			6,500	5	12	Yearling	34.85	Right Ventral	Normandale FCS	Ganaraska/Normandale	Rehabilitation
	1988			7,000	5	12	Yearling	40.00	Right Ventral	Normandale FCS	Ganaraska/Normandale	Rehabilitation
	1988		SOUTH OF WHITEVALE	30,589	9	6	Fingerling	6.45	No Clip	Harwood FCS	Ganaraska/Normandale	Rehabilitation/Supplemental
	1989		WHITEVALE	9,022	4	13	Yearling	13.30	Adipose	Deer Lake FCS	Ganaraska/Normandale	Rehabilitation
	1989		WHITEVALE	18,045	4	13	Yearling	13.30	Adipose	Deer Lake FCS	Ganaraska/Normandale	Rehabilitation
	1989		WHITEVALE	3,383	4	13	Yearling	13.30	Adipose	Deer Lake FCS	Ganaraska/Normandale	Rehabilitation
	1990		WHITEVALE	24,128	4	11	Yearling		Right Ventral	Deer Lake FCS	Ganaraska/Normandale	Rehabilitation
Atlantic Salmon	1946			40,000	6	6	Fingerling					
	1948			80,500	6	6	Fingerling					
	1948			6,500	7	6	Fingerling					
	1948			1,400	8	6	Fingerling					
	1949			24,000	8	6	Fingerling					
	1995		Du6thCon	5,431	4	4	Fry	0.52	No Clip	Ringwood FCS	LaHave/Normandale	Research
	1995		Dufb7thswp	1,931	4	4	Fry	0.52	No Clip	Ringwood FCS	LaHave/Normandale	Research

Ontario Ministry of Natural Resources, Lake Ontario Management Unit, September 2002.

Species	Year	Tributary*	Site	Number Stocked	Month Stocked	Age (Months)	Development Stage	Mean Weight (g)	Clip	Fish Culture Station**	Strain/ Egg Source	Stocking Purpose
	1995		Hwy 7	3,410	4	4	Fry	0.20	No Clip	White Lake FCS	LaHave/Normandale	Research
	1996		DuHwy7	3,300	4	4	Fry	0.45	No Clip	Ringwood FCS	LaHave/Normandale	Research
	1996		Du6thCon	4,500	4	4	Fry	0.17	No Clip	White Lake FCS	LaHave/Normandale	Research
	1997		6th Conc	4,500	4	4	Fry	0.96	No Clip	Ringwood FCS	LaHave/Normandale	Research/Re-Introduction
	1997		Highway 7	3,300	5	5	Fry	0.16	No Clip	White Lake FCS	LaHave/Normandale	Research/Re-Introduction
	1998		6th Conc	4,500	5	4	Fry	0.13	No Clip	White Lake FCS	LaHave/Normandale	Re-Introduction
	1998		Highway 7	3,300	4	4	Fry	0.74	No Clip	Ringwood FCS	LaHave/Normandale	Research
	1999		6th Conc	4,500	4	4	Fry	0.83	No Clip	Ringwood FCS	LaHave/Normandale	Research/Re-Introduction
	1999		Highway 7	3,300	5	4	Fry	0.19	No Clip	Ringwood FCS	LaHave/Normandale	Research/Re-Introduction
Brown Trout	1956			1,000	5	12	Yearling					
	1958			1,500	5	12	Yearling					
	1958			800	6	12	Yearling					
	1959			2,000	6	12	Yearling					
	1960			2,000	5	12	Yearling					
	1961			500	7	12	Yearling					
	1986		@HWY7	20,000	5	16	Yearling	27.10	Adipose	Codrington FCS	Ganaraska	Rehabilitation/Supplemental
	1987		GREENWOOD CA	14,931	4	15	Yearling	50.23	Right Ventral	Chatsworth FCS	Ganaraska/Codrington	Rehabilitation
	1987		GREENWOOD CA	5,069	4	15	Yearling	42.35	Right Ventral	Chatsworth FCS	Ganaraska/Codrington	Rehabilitation
	1988		CHURCH & 401	10,000	3	14	Yearling	29.00	Right Pectoral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1988		WHITEVALE	5,000	4	15	Yearling	43.41	Right Pectoral	Codrington FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1988		GREENWOOD C. A.	10,000	5	16	Yearling	39.55	Right Pectoral	Codrington FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1989		CHURCH ST./401	8,571	3	15	Yearling	35.00	Adipose	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1989		CHURCH ST./401	8,571	3	15	Yearling	35.00	Adipose	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1989		CHURCH ST./401	3,108	3	15	Yearling	34.00	Adipose	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1990		CHURCH ST./401	8,319	3	15	Yearling		Right Ventral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1990		CHURCH ST./401	8,234	3	15	Yearling		Right Ventral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1990		CHURCH ST./401	7,177	3	15	Yearling		Right Ventral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1991		5TH CONC. RD.	6,871	2	15	Yearling		Right Pectoral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1991		5TH CONC. RD.	6,548	3	16	Yearling		Right Pectoral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1991		5TH CONC. RD.	4,650	5	18	Yearling		Right Pectoral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1991		CHURCH ST. /401	10,441	10	10	Yearling		Adipose	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1992			1,639	4	16	Yearling	52.40	Right Ventral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1992			3,572	4	15	Yearling		Right Ventral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1992			4,429	4	16	Yearling	52.40	Right Ventral	Harwood FCS	Ganaraska/Codrington	Rehabilitation/Supplemental
	1994		ROTARY PARK	10,019	3	15	Yearling	31.50	Right Ventral	White Lake FCS	Ganaraska/Normandale	Supplemental
	1995		Rotary Park	12,500	3	15	Yearling	33.60	Right Ventral	White Lake FCS	Ganaraska/Normandale	Supplemental
	1996		Rotary Park	15,921	4	16	Yearling	26.79	Right Ventral	White Lake FCS	Ganaraska/Normandale	Supplemental
	1997		Rotary Pk Ramp	9,123	4	15	Yearling	16.00	Right Ventral	White Lake FCS	Ganaraska/Normandale	Supplemental
	1998		401 Bridge	10,003	5	18	Yearling	48.68	Right Ventral	Harwood FCS	Ganaraska/Normandale	Put-Grow-and-Take
	1999		401 Bridge	9,878	5	18	Yearling	66.04	Right Ventral	Harwood FCS	Ganaraska/Normandale	Put-Grow-and-Take
	2000		401 Bridge	10,018	5	17	Yearling	60.31	Adipose	Harwood FCS	Ganaraska/Normandale	Put-Grow-and-Take
	2001		401 Bridge	10,785	4	18	Yearling	63.25	Right Ventral	Harwood FCS	Ganaraska/Normandale	Put-Grow-and-Take
Brook Trout	1950			2,000	5	12	Yearling					
	1950			400	8	12	Yearling					
	1951			1,800	9	12	Yearling					

Species	Year	Tributary*	Site	Number Stocked	Month Stocked	Age (Months)	Development Stage	Mean Weight (g)	Clip	Fish Culture Station**	Strain/ Egg Source	Stocking Purpose
	1952			5,000	5	12	Yearling					
	1953			5,500	4	12	Yearling					
	1953			1,000	6	12	Yearling					
	1953			2,500	7	12	Yearling					
	1954			5,500	6	12	Yearling					
	1954			1,000	7	12	Yearling					
	1955			5,700	5	12	Yearling					
	1956			1,200	6	12	Yearling					
	1957			600	5	12	Yearling					
	1958			900	5	12	Yearling					
	1964			1,000	4	12	Yearling					
	1966			500	4	12	Yearling					
	1966			2,000	4	12	Yearling					
	1966			2,000	9	36	Juvenile/Adult					
	1969			800	4	13	Yearling		Left Ventral			
	1970			1,500	4	12	Yearling		Left Pectoral	Midhurst FCS		
	1971			1,400	4	12	Yearling		Right Pectoral	Midhurst FCS		
	1972			1,500	4	12	Yearling	56.87	Right Ventral	Midhurst FCS		
	1975	Mitchell's Cr.		500	5	15	Yearling		No Clip	Chatsworth FCS	Hill's Lake	
	1976	Mitchell's Cr.		1,000	5	16	Yearling	7.00	No Clip	White Lake FCS	Hill's Lake	Supplemental
	1983		ALTONA	1,800	4	12	Yearling	9.33	No Clip	Dorion FCS	Lake Nipigon/Dorion Lake	Rehabilitation
	1984		BRIDGE CON8 LOT34	500	4	15	Yearling	4.50	Left Ventral	Deer Lake FCS	Lake Nipigon/Dorion Lake	Supplemental
	1986			500	4	16	Yearling	6.40	Right Pectoral	Skeleton Lake FCS	Lake Nipigon/Dorion Lake	Rehabilitation
	1987		W DUFFIN CREEK	1,000	4	16	Yearling	5.40	Right Ventral	Skeleton Lake FCS	Lake Nipigon/Hill's Lake	Rehabilitation
	1988			500	4	15	Yearling	6.25	Adipose	Skeleton Lake FCS	Lake Nipigon/Hill's Lake	Rehabilitation
	1989			1,000	4	14	Yearling	7.56	Left Ventral	Skeleton Lake FCS	Lake Nipigon/Hill's Lake	Rehabilitation
	1991			1,000	4	15	Yearling		Right Pectoral	Skeleton Lake FCS	Hill's Lake/Lake Nipigon	Rehabilitation



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