

Appendix D. Aquatic Resources

D.1 Purpose

The purpose of the aquatic component of the ONHS was to inventory and evaluate the current conditions of the aquatic ecosystems such as rivers, streams, and drains within Oxford County. Additional rationale for completing an aquatic component of the ONHS was to determine whether current conditions meet their potential, to propose rehabilitation or restoration measures where appropriate, to conserve and protect significant aquatic resources, and to collect baseline data to allow monitoring of ecosystem changes throughout the County.



Coldwater Stream

D.2 Defining Scope of Study

For the purposes of this study, aquatic ecosystems are defined as watercourses which include streams, rivers, creeks, and open drains. Watercourses have been characterized as a depression that has flowing water all or part of the year. A watercourse conveys water and this flowing water carries food, sediment, nutrients, and debris. Many watercourses may be dry or reduced to standing pools of water during dry periods of the year and especially during periods of drought

Watercourses provide habitat for aquatic and semi-aquatic species such as fish, reptiles, amphibians, birds, mammals, plants, and insects. Habitat can take the form of water itself, the river bottom, land surrounding it, in-stream vegetation and overhanging vegetation. This habitat supports all the life stages of aquatic species and some of the stages of semi-aquatic species. Watercourses provide habitat for feeding, cover to escape predation, areas to reproduce, and migration routes. Watercourses also provide travel corridors for many terrestrial species.

Watercourses are complex systems that are influenced by the floodplain (surrounding land), the substrate (rocks, cobble, clay, sand, and silt), the channel itself, water flow, water temperature, and several other factors. All of these factors combined help determine the type of aquatic community that is present. For example, coldwater systems support organisms that require cool temperatures and relatively high dissolved oxygen levels, while warmwater systems support organisms tolerant of higher water temperatures and lower oxygen levels. Generally speaking the more complex and less impacted systems support sensitive or significant species such as federally designated Species at Risk (SAR), and gamefish such as trout, pike, and bass.

D.3 Methodology

In developing the aquatic component of the ONHS, an Aquatic Technical Team (ATT) was formed to guide the direction of the study. It was determined that the ATT would concentrate on open watercourses, compile background information, fill data gaps, report on the current conditions, and provide recommendations to maintain and enhance the aquatic environment.

The ATT decided that standardised protocols would be followed in order to maintain consistency of information across federal and provincial agencies. These protocols included the Ontario Stream Assessment Protocol (OSAP), the Ontario Benthic Biomonitoring Network (OBBN), and the Municipal Drain Classification Project (MDC).

The ATT prepared several documents to assist in developing the OHNS. These include an ONHS ATT Terms of Reference, ONHS ATT Significance Criteria, ONHS ATT Aquatic Ecosystem Background Data Assimilation, Compilation, Current Assessment and Methodology, and the ONHS ATT Categorization of Aquatic Ecosystems. These documents are available from the ATT.

D.3.1 Background Data Collection and Assimilation

Historic and more recent fish and habitat data for Oxford County was collected from the various agencies including conservation authorities, Fisheries and Oceans Canada (DFO) and Ontario Ministry of Natural Resources (MNR) offices. After the information was compiled and assessed, data gaps were identified for further investigation.

D.3.2 Field Investigations

The ATT agreed that field investigations were required to further assess areas where current or recent information was lacking. UTRCA staff completed field surveys which included qualitative habitat assessments and fish sampling.

The Municipal Drain Classification (MDC) protocol was used to assess the current habitat conditions. The Ontario Benthos Biomonitoring Network (OBBN) protocol was followed to collect more detailed habitat information. The Ontario Stream Assessment Protocol (OSAP) guided the fish community sampling.

D.3.3 Data Management and Maintenance

All data gathered was compiled in a Microsoft Access database and transferred to a Geographical Information Systems (GIS) application. Conveniently, the MDC already provided the database and GIS application to house the current data collected in one location

Developing Categories of Aquatic Ecosystems

Initially, the Aquatic Technical Team was following the direction of the Terrestrial Team and formulated eight criteria to determine watercourse significance (see Table D-1). The criteria focused on the many functions and features of an aquatic ecosystem.

However, it was quickly evident that all watercourses met some or all of these criteria, so a different approach was needed for the aquatic component. The team proceeded with collecting information on the aquatic resources of the County and categorizing watercourses in a way that was more tangible and lent itself to structuring remedial work.

Table D.1. Aquatic Significance Criteria

1.	Habitat – Fish habitat, as defined in the Fisheries Act, means spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. The fish habitat definition can be expanded upon to incorporate aquatic and semi-aquatic species habitat. Therefore an inclusive definition of habitat is: Habitat means spawning grounds and nursery, rearing, food supply and migration areas on which aquatic and semi-aquatic species depend directly or indirectly in order to carry out their life processes.
2.	Stream Morphology – fluvial geomorphic processes, hydrologic functions, baseflow contributions, storage capacities, conveyance
3.	Corridors – provide access to spawning grounds and refuge areas; are migration routes
4.	Cold/Cool Water – thermal regime (water temperature), indicator species
5.	Flow Regime – permanent, intermittent or ephemeral
6.	Sensitive Species – do not respond well to habitat alterations, disruptions or destructions (HADDs); include species at risk (SAR), top-level predators, and sportfish, support a fishery
7.	Fish/Aquatic Community – fish have been define in the Fisheries Act to include parts of fish, shellfish, crustaceans, marine animals and any part of shellfish, crustaceans or marine animals; the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and fish habitat.
8.	Hydrology – hydraulics and hydrologic function; influence the hydrograph

The team then identified the need to define a system of categorizing watercourses suited to the purposes of this study. The team agreed they would build upon existing and standardized approaches, but enhance it for the ONHS.

D.3.4 Municipal Drain Classification Project

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The municipal drain classification project (MDC), the Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement and the Fish Habitat Protection Guidelines for Developing Areas provided the basis for categorizing the watercourses in Oxford because they are federal and provincial initiatives and aid in providing consistency between agencies.

The Ontario Ministry of Natural Resources (OMNR) prepared a Natural Heritage Reference Manual in 1999 and the Fish Habitat Protection Guidelines for Developing Areas in 1994. These two documents differentiate between 3 Types of fish habitat and these two documents provided guidance in categorizing watercourses for the OHNS.

The Municipal Drain Classification Project (MDC) provided current watercourse information for much of the County and a framework for organising this information and categorising aquatic ecosystems. The Department of Fisheries and Oceans Canada (DFO) federally funded the MDC, and all Conservation Authorities in Southwestern Ontario have completed this initiative. All data gathered through the MDC is stored and maintained in a standardised database at each CA. The data stored in the MDC database is linked to GIS. Although the MDC was designed specifically for municipal drains, it allows for the incorporation of data on natural or non-municipal drains.

Currently the MDC has six classifications based on permanence of flow, water temperature or thermal regime, fish species, and the time since major drain maintenance had occurred. For this study the classification system was extended beyond municipal drains to include natural watercourses, and the number of categories was reduced to three.

Simply put, more sensitive or complex systems with permanent flow were placed in one category called System Type 1, less sensitive systems with permanent flow were placed in another category called System Type 2, and watercourses with intermittent flow were placed in the final category called System Type 3.

The three categories defined give a general overview of the current aquatic ecosystem conditions found throughout the County. They also allow for the development of general recommendations and management prescriptions for these categories. For example, System Type 1 streams have significant or sensitive features that need to be protected and conserved, while System Type 2 and 3 streams may be targeted for remedial activities.

Several components were used to develop the MDC classifications and were also used to create the categories of watercourses for the ONHS. These components include Species at Risk (SAR), fish community, aquatic and semi aquatic species, habitat, thermal regime/water temperature, permanent flow and the municipal drain classification. Table D-2 summarizes the results of the categorization exercise. The three system types are described by component.

Additional aquatic and semi-aquatic species such as mussels and plants are included in the system types; however, in the future these species may have additional considerations which could alter the category that they are currently found in.

The categories currently do not contain components for threats and issues such as invasive species, and dams or barriers. Water quantity and water quality components were not included as component of the system types. In the future, these will be given further consideration for incorporation into the system types of watercourses for the purpose of Oxford Natural Heritage features. Table D.10 summarizes the results of the categorization exercise. The three system types are described by component.

Table D.2. Aquatic Categories Component Summary

Components	System Type		
	1	2	3
Species at Risk	Schedule 1 Threatened or Endangered (COSEWIC Status)	Other than Schedule 1 Threatened or endangered	NA
Fisheries	Sportfish / top predators / salmonids, sensitive and indicator species, their surrogates/indicator species, and their habitat or spawning areas	With or without fish	With or without fish when inundated with water (may only be seasonally)
Species	Indicator species sensitive to habitat alteration, disruption or destruction, and cold/cool water	Resilient to habitat alteration, disruption or destruction	Ephemeral
Habitat	Identified to support Sportfish / top predators / salmonids, sensitive and indicator species as well as SAR. Complex, natural, or diverse habitat Supports significant areas that provide the life requirements of aquatic species	Supports species not identified in the first category Provides the life requirements of aquatic species	<ul style="list-style-type: none"> - Seasonally supports aquatic and semi-aquatic species when wet. - Provides cover and corridors and food source for terrestrial species - Provides the life requirements of aquatic and semi-aquatic species - Provides corridors for aquatic, semi-aquatic and terrestrial species (i.e.: migratory species, spawning areas)
MDC Classifications	A, B, E , & D	C	F
Thermal Regime	Warm, cold/cool	Warm	NA
Permanency	Permanent, or if intermittent based on spawning areas or critical habitat	Permanent, or Standing/Pooled water	Intermittent or Ephemeral

D.4 Results and Findings

This inventory provided current information on the aquatic systems within Oxford County. The information collected determined the current condition of the aquatic ecosystems to contain very productive and diverse aquatic communities. A significant proportion of southwestern Ontario's trout streams occur in Oxford. The County's watercourses also support many fish and freshwater mussel species at risk. However, there are many watercourses that could benefit from remedial work to make them more productive and thus support a greater diversity of aquatic life.

The ATT developed the criteria for defining the significance of the aquatic ecosystems, conducted field surveys, analyzed the results, and provided general recommendations for managing the aquatic ecosystems.

After the background data was compiled, it was evident that approximately 170 sites in Oxford County required further investigation. Of those, 80 fish community samples were completed. Table D.3 lists the fish species found throughout Oxford County



Central Stoneroller

Table D.3. Fish Species Sampling Summary – Oxford County

Species	Scientific Name	COSEWIC Status
American Brook Lamprey	Lampetra appendix	
Black Bullhead	Ameiurus melas	
Black Redhorse	Moxostoma duquesnei	THR
Blackchin Shiner	Notropis heterodon	
Blacknose Dace	Rhinichthys atratulus	
Blacknose Shiner	Notropis heterolepis	
Blackside Darter	Percina maculata	
Bluegill	Lepomis macrochirus	
Bluntnose Minnow	Pimephales notatus	
Brassy Minnow	Hybognathus hankinsoni	
Brook Stickleback	Culaea inconstans	
Brook Trout	Salvelinus fontinalis	
Brown Bullhead	Ameiurus nebulosus	
Brown Trout	Salmo trutta	
Central Mudminnow	Umbra limi	
Central Stoneroller	Campostoma anomalum	
Common Carp	Cyprinus carpio	
Common Shiner	Luxilus cornutus	
Creek Chub	Semotilus atromaculatus	
Emerald Shiner	Notropis atherinoides	
Fantail Darter	Etheostoma flabellare	
Fathead Minnow	Pimephales promelas	
Golden Redhorse	Moxostoma erythrurum	
Golden Shiner	Notemigonus crysoleucas	
Greater Redhorse	Moxostoma valenciennesi	
Green Sunfish	Lepomis cyanellus	
Greenside Darter	Etheostoma blennioides	SC
Hornyhead Chub	Nocomis biguttatus	
Iowa Darter	Etheostoma exile	
Johnny Darter	Etheostoma nigrum	
Largemouth Bass	Micropterus salmoides	
Least Darter	Etheostoma microperca	
Longear Sunfish	Lepomis megalotis	
Longnose Dace	Rhinichthys cataractae	
Mimic Shiner	Notropis volucellus	
Mottled Sculpin	Cottus bairdi	
Northern Brook Lamprey	Ichthyomyzon fossor	SC
Northern Hog Sucker	Hypentelium nigricans	
Northern Pike	Esox lucius	
Northern Redbelly Dace	Phoxinus eos	
Pearl Dace	Margariscus margarita	
Pumpkinseed	Lepomis gibbosus	
Rainbow Darter	Etheostoma caeruleum	
Rainbow Trout	Oncorhynchus mykiss	
Redfin Shiner	Lythrurus umbratilis	
River Chub	Nocomis micropogon	
Rock Bass	Ambloplites rupestris	
Rosyface Shiner	Notropis rubellus	
Shorthead Redhorse	Moxostoma macrolepidotum	
Silver Shiner	Notropis photogenis	SC
Smallmouth Bass	Micropterus dolomieu	
Spotfin Shiner	Cyprinella spiloptera	
Stonecat	Noturus flavus	
Striped Shiner	Luxilus chrysocephalus	
White Crappie	Pomoxis annularis	
White Sucker	Catostomus commersoni	
Yellow Perch	Perca flavescens	

COSEWIC Status: Status assigned by the Committee on the Status of Endangered Wildlife in Canada.

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

SC Special Concern. A species of special concern because of characteristics that make it particularly sensitive to human activities

D.5 Summary of System Types and Recommended Actions

Table D.4 below summarizes the three system types and their attributes. Table D.5 summarizes the percentage of Oxford's watercourses that fall under each system type. Figure D.1 maps the system types for the County.

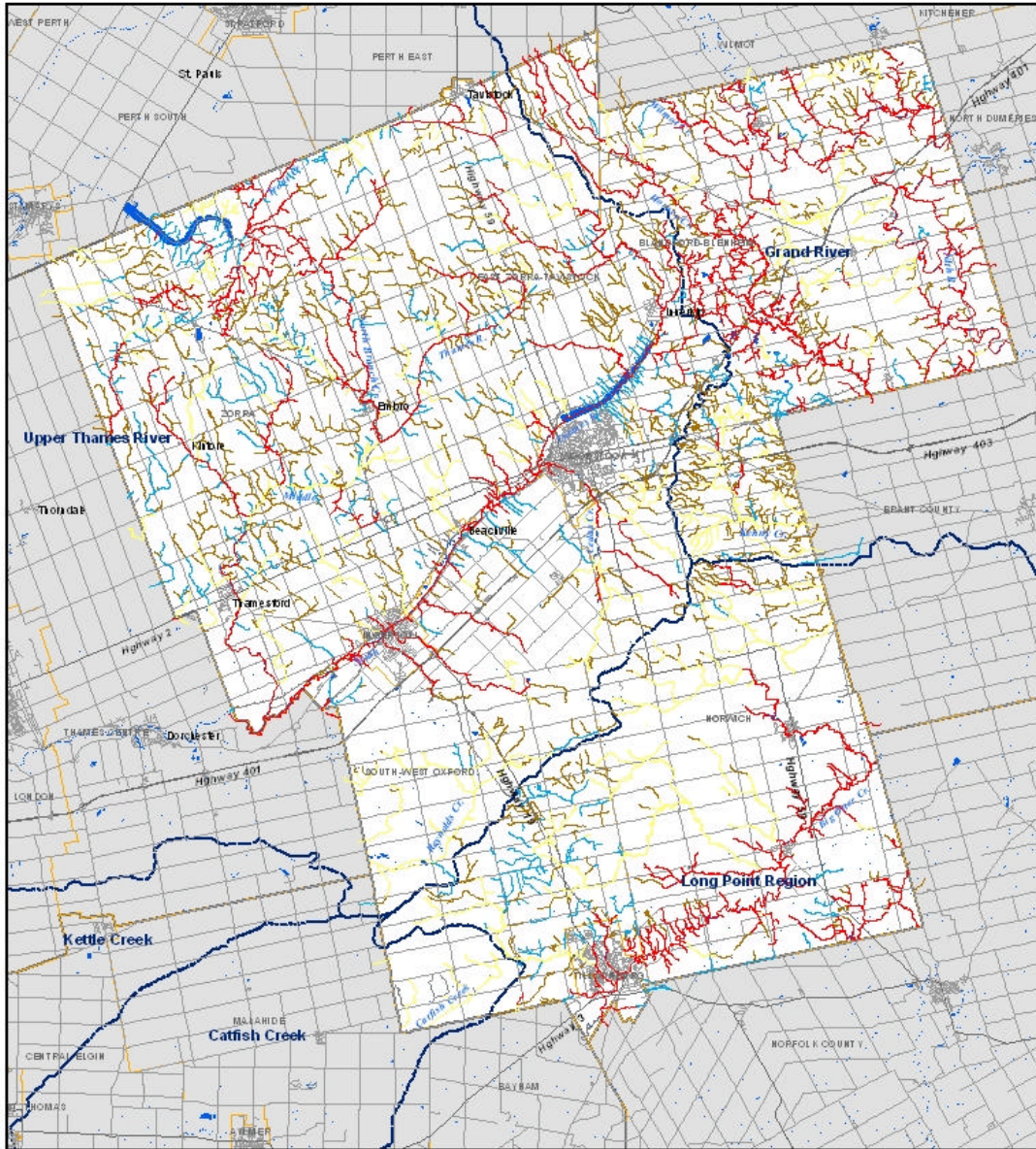
Table D.4. Summary of Categories of Watercourses

System Type	Species Supported	Flow	Temperature	Recommended Action
1	Sensitive or significant species: Species at risk, top level predators, sportfish, sensitive species or the habitat to support these species	Permanent	Warm or cold/cool water	Conserve, Protect, and Enhance
2	Baitfish, species resilient to change	Permanent	Warm water	Conserve, Rehabilitate, Enhance, and Restore
3	Seasonally accessed by aquatic species	Intermittent or ephemeral	Warm water	Conserve, Rehabilitate, Enhance and Restore

Table D.5. Percentage of Watercourses in Oxford under each System Type

System Type	Percent of Watercourses in Oxford
1	50
2	31
3	19

Figure D.1. Aquatic System Types for Oxford County



Water course information provided by UTRCA, GRCA, OCCA, LPRCA. The data varies in age and quality depending on when hydrology section was last updated. This map should be used as an indication of what system type may be present in a given area and not for site specific planning.

Oxford County Natural Heritage Study
Aquatic System Types



D.7.1 System Type 1

Sensitive or significant species such as species at risk, trout, pike, and bass are generally found in this category. These species have very specific habitat requirements, and are easily affected by a change in habitat such as change in temperature, pollution, loss of spawning grounds, and lack of food source.

Generally speaking, system type 1 can be considered to be the most desirable of the three system types. These watercourses should be conserved, protected, and enhanced when possible. Not all watercourses can become this, nor should they be expected to be.

D.7.2 System Type 2

Generally speaking, system type 2 is considered a permanent watercourse either with water flowing in it all year, or with pools of standing water year round. The fish species found in this category are usually referred to as baitfish. Baitfishes include minnows, suckers, darters, and many others. These species can withstand changes in habitat and might be able to spawn in more areas. These species can be found in almost all habitats. All watercourses in this category are warmwater, which means that they have an average temperature of greater than 25°C.

With rehabilitation and restoration efforts some of these systems could become type 1's, although there is not an expectation that they all would. They are often fairly productive and diverse ecosystems.

D.7.3 System Type 3

This category has been presumed to be less important as these watercourses generally carry water only during rain events or after the snowmelt or spring runoff. They are considered to be intermittent or ephemeral systems because they do not have water in them year round.

These systems are very important for transporting sediment and nutrients downstream. Seasonally they provide habitat for fish and other species such as frogs, insects, and other amphibians. There is the potential for species such as pike to migrate to these areas to spawn and reproduce. These also provide food (e.g. frogs, crayfish, and larval insects) for other wildlife such as waterfowl. Many species have adapted to make use of this type of habitat (e.g. some invertebrates migrate downstream to find water or have terrestrial life stages during dry periods).

Several of these watercourses could become type 2 or even type 1 watercourses if rehabilitation or restoration efforts were employed, however it is not expected that they all could.

D.6 Aquatic Technical Guidance

The following points reflect the need to protect and improve the health of Oxford's watercourses and are based on a sound understanding of the conditions, justified through science, considered best management practices, and in consistency with other agencies and organisations.

1. Protect, enhance and restore stream buffers

- *What:* A buffer is a swath of vegetated land on either side of a watercourse, also called a vegetated riparian buffer. A buffer can consist of any permanent vegetation such as trees, shrubs, grasses, wildflowers or forage crops. Current guidance from federal and provincial agencies should be followed when deciding on a minimum size of buffer width. Generally speaking, this recommendation is a minimum width of 15 to 30 metres on both sides of the watercourse (and research indicates that this may increase to 50 m).
- *Benefits:* Vegetated riparian buffers shade and cool water, filter pollutants in runoff, nutrient source, store flood water and allow infiltration into the ground, improve flood connectivity, act as a wildlife travel corridor
- *Examples:* Where natural vegetation along a watercourse does not exist, it can be planted. Appropriate native species should be used. Permanent forage crops can also be planted, as long as they are not tilled. The land can also be retired, allowing wildflowers and grasses to grow up naturally.
- Need an approach to achieve the ultimate goal and decide on timelines for completion.

2. Protect and improve stream habitat

- *What:* Natural habitats usually consist of riffle/pool sequences and have diverse substrates (cobble, rocks, sand, gravel, clay). Streams have natural meander patterns which migrate over time.
- *Benefits:* diverse and productive self-maintaining aquatic communities, provides oxygen to the water.
- *Examples:* Can be achieved through passive means, by leaving the watercourse alone or aggressive means by physically manipulating and adding habitat through the construction of vortex weirs, rocky riffles and stream bank bioengineering.
- Natural channel design: Self maintaining to carry the sediment load

3. Control sediment inputs and siltation

- *What:* Urban and rural sources of nutrients, contaminants and sediment.
- *Benefits:* improved water quality and stream habitat
- *Examples:* conservation tillage, grassed waterways, sediment and erosion control, and storm water management

4. Protect and enhance water quality and quantity

- Reduce pollution sources, protect natural flows, increase water storage capacity and sustain base flow
- *Examples:* storm water management, nutrient and waste management, wetland restoration, barrier mitigation and removal

5. Continuous Monitoring

Continuous monitoring stations are necessary to track and compare results, measure success, monitor trends especially in the long term. There is also a need to monitor for the presence of indicator or sensitive species as these species inform us of the overall health of the system, to fill data gaps and supplement information such as habitat or

geomorphic analysis. This information should be fed back into the system to respond to the results, and be based on current information. This allows for the adjustment of programs and practices as necessary and aids in determining whether goals and objectives have been achieved.

Considerations: monitor areas where implementation activities will be concentrated as a means to measure success

- Monitor benthic, water quality, fish community, habitat, temperature, flow, and additional aquatic components
- Develop a continuous monitoring program that is long term, tracks biodiversity and health to determine whether the goals and objectives of the ONHS are being fulfilled. Long term monitoring is also needed to discount the short term affects of droughts or floods or long term climate changes.

- **6. Apply adaptive management**

- Regularly assess conditions to determine success and effectiveness of projects and adjust programs accordingly
- Due to unpredictable nature of restoration and conservation management strategies and policies, must be flexible and adaptive to accommodate new knowledge and insights

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