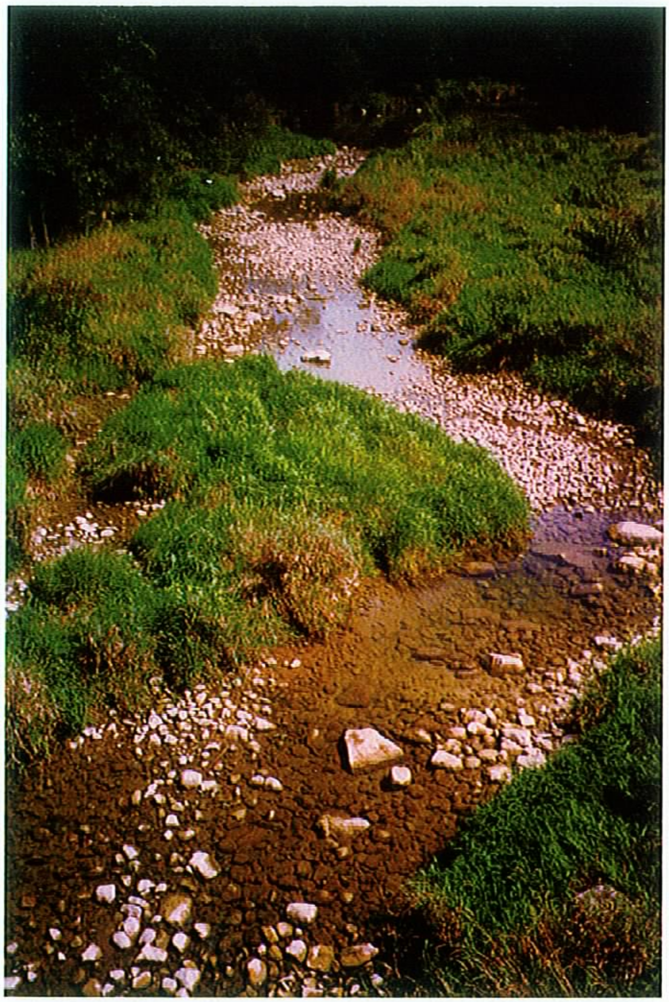
Fish Habitat Management Plan

Ausable Bayfield Conservation Authority



April 2001

Fish Habitat Management Plan

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April 2001

EXECUTIVE SUMMARY

The Fish Habitat Management Plan completed for the Ausable, Bayfield, Parkhill and Gullies watersheds, reviews the current status of fish habitat in the Ausable-Bayfield Conservation Authority (ABCA) area and outlines possible management strategies to improve this aquatic resource. Natural features (i.e., sub-surface geology, wetland, and woodlot information), land use, habitat summaries and priority projects are provided for 14 sub-basins in the ABCA area. Stewardship programs, such as erosion control and forest/wetland improvements, monitoring programs for water quality, benthic invertebrates and fish habitat, and public education programs are recommended to improve aquatic resources. The 14 sub-basins were further prioritized for protection, maintenance and improvement based on: current habitat potential, current land use stress, sensitivity of the resource and fishing level. Additional recommendations to protect fish habitat in the priority sub-basins include: stewardship programs (improvements to riparian land use), further examination of riparian land use, detailed fish habitat studies and updates to specific Municipal Official Plans regarding Environmentally Sensitive Areas.

ACKNOWLEDGEMENTS

Insights into the aquatic resources in the Ausable Bayfield Conservation Authority (ABCA) jurisdiction were gained from ABCA staff (notably Stephen Harburn, Alec Scott and Tom Prout). Staff at the ABCA also provided the maps (John Piraino) and editorial changes (Tom Prout, Judith Parker, Cathy Reeves, Kelly Vader and Erin Jamieson). Ontario Ministry of Natural Resources staff, Mike Malhiot and Harald Schraeder contributed information on past survey work and excellent guidance regarding the Management Plan structure and strategies. Norm Smith and Rick Kiriluk from the Department of Fisheries and Ocean and Warren Yerex from the Grand River Conservation Authority also advised me on the Management Plan structure. Steering Committee Members, Lawrence Craven, John Schwindt and Pat Down contributed invaluable insights on the local fisheries and local land use.

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Acronyms

ABCA	Ausable-Bayfield Conservation Authority
DFO	Fisheries and Oceans, Canada
OMNR	Ontario Ministry of Natural Resources

Terms

base flow	watercourse flow derived from groundwater discharge (not augmented by surface runoff)
cold water	summer water temperatures usually less than 22°C; capable of supporting fish species that cannot withstand temperatures exceeding 20°C for prolonged periods; if other habitat characteristics (i.e., substrate conditions) are favourable these waters should support cold water fish (i.e., brook trout)
dissolved oxygen concentrations	the concentration of oxygen gas dissolved in water
forage community	typically refers to fish of Cyprinidae family, fish that are consumed by game fish
macro-habitat	stream habitats (i.e., pools - deep, slow conditions, riffles - shallow, fast conditions, runs - areas between pools and riffles)
mixed waters	sections of watercourses that have warm and cold temperatures
nitrogen	an element that stimulates vegetative (i.e., plant) growth
phosphorus	an element that stimulates vegetative (i.e., plant) growth
turbidity	suspended matter that reduces the clarity of water
warm waters	summer water temperatures that usually exceed 22°C; capable of supporting fish species tolerant of temperatures exceeding 20°C for prolonged periods
wetlands	areas where land and water meet, these areas are wet for most of the year and they typically provide: filtration of sediment and chemicals, flood and erosion control, ground water supply and habitat for fish and fowl.

1. 0 INTRODUCTION

1.1. Background

1.1.1 Location of the Ausable-Bayfield Conservation Authority (ABCA)

The Ausable-Bayfield Conservation Authority (ABCA) area of jurisdiction is based on watershed boundaries and includes all the lands which drain into the Ausable River, Bayfield River, Parkhill Creek and gullies and streams draining directly to Lake Huron (Figure 1.1.1). The ABCA area lies within the Counties of Perth, Huron, Middlesex and Lambton. The western boundary of the Conservation Authority's jurisdiction is Lake Huron. The area is bounded to the north by the Maitland River watershed. On the east, the jurisdiction's boundary is the Upper Thames River watershed. The southern boundary is the many streams that flow to the St. Clair River.

The total area in the ABCA jurisdiction is 2428 km^2. The Bayfield basin is 497 km^2. The river rises north of Dublin and outlets at the Town of Bayfield. The Bayfield River has one main tributary, the Bannockburn River. Trick's Creek is another important tributary of the Bayfield River, as it increases the low base flow during dry periods.

The Ausable basin is 1142 km^2. The original Ausable river drainage pattern has been likened to a barbed fishing hook (Department of Planning and Development 1949). The Ausable River arises near Staffa and flows south to Ailsa Craig where it makes a wide arc to the west. Prior to 1873, the river traveled north to Grand Bend. Here the river made another sharp turn (approximately 180°) and flowed southwest to its outlet near Port Franks. Between 1873 and 1875 the course of the river was altered by excavating a channel from near the boundary between the wards of McGillivray and West Williams to Port Franks. This "cut" diverted flow from Grand Bend. The current mouth of Ausable River is at Port Franks. Main tributaries of the Ausable River include: Black Creek, the Little Ausable and Nairn Creek.

The old Ausable channel (north of the "Cut") still receives water from Parkhill Creek (also known as Mud Creek). The source of this creek is northeast of Dashwood. The creek flows parallel to the Ausable for most of its length. It joins the old Ausable channel north of Sylvan. In 1892, a channel was cut at Grand Bend and this became the outlet of Parkhill Creek.

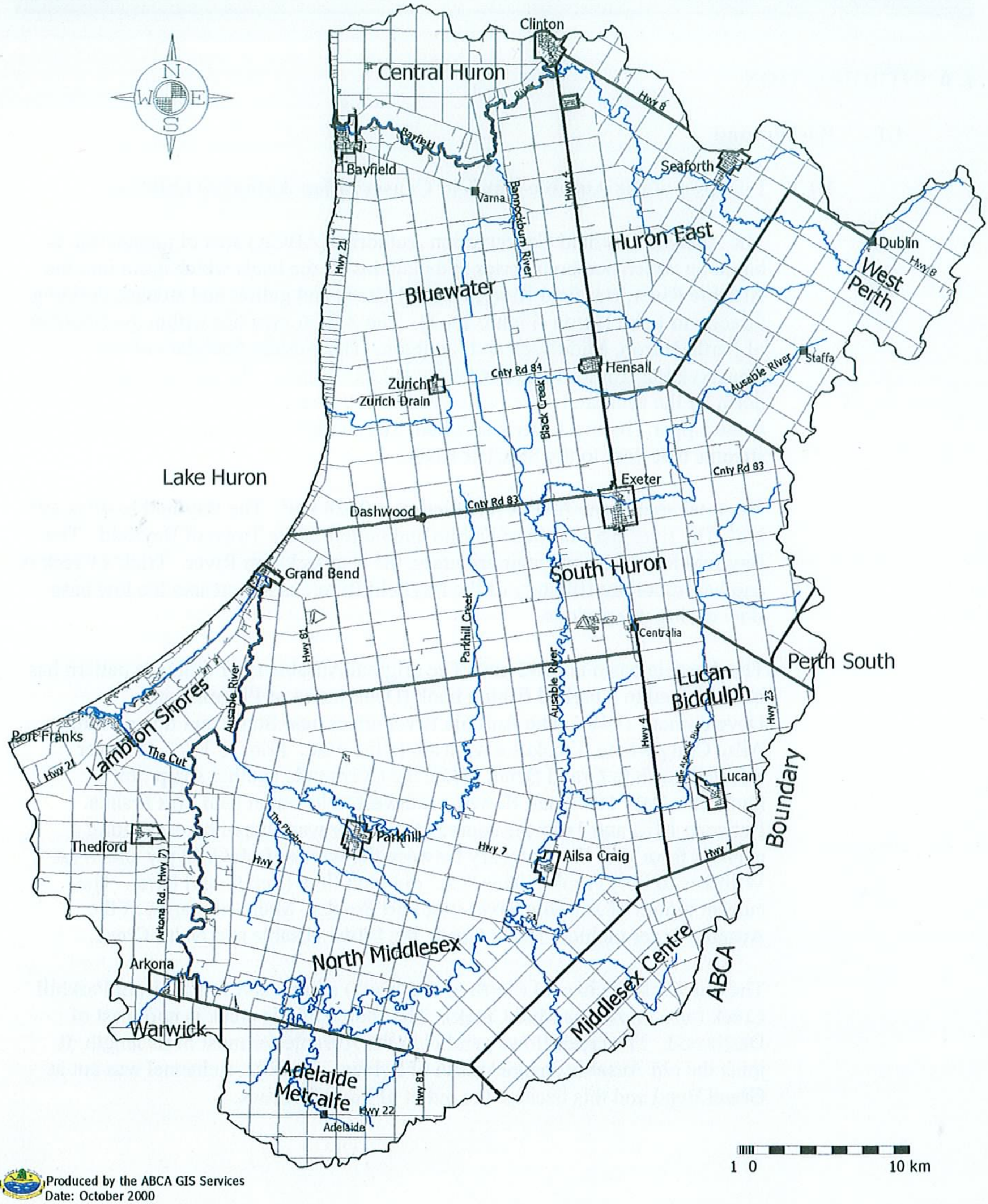


Figure 1.1.1: Location and Political Boundaries in the Ausable-Bayfield Conservation Authority

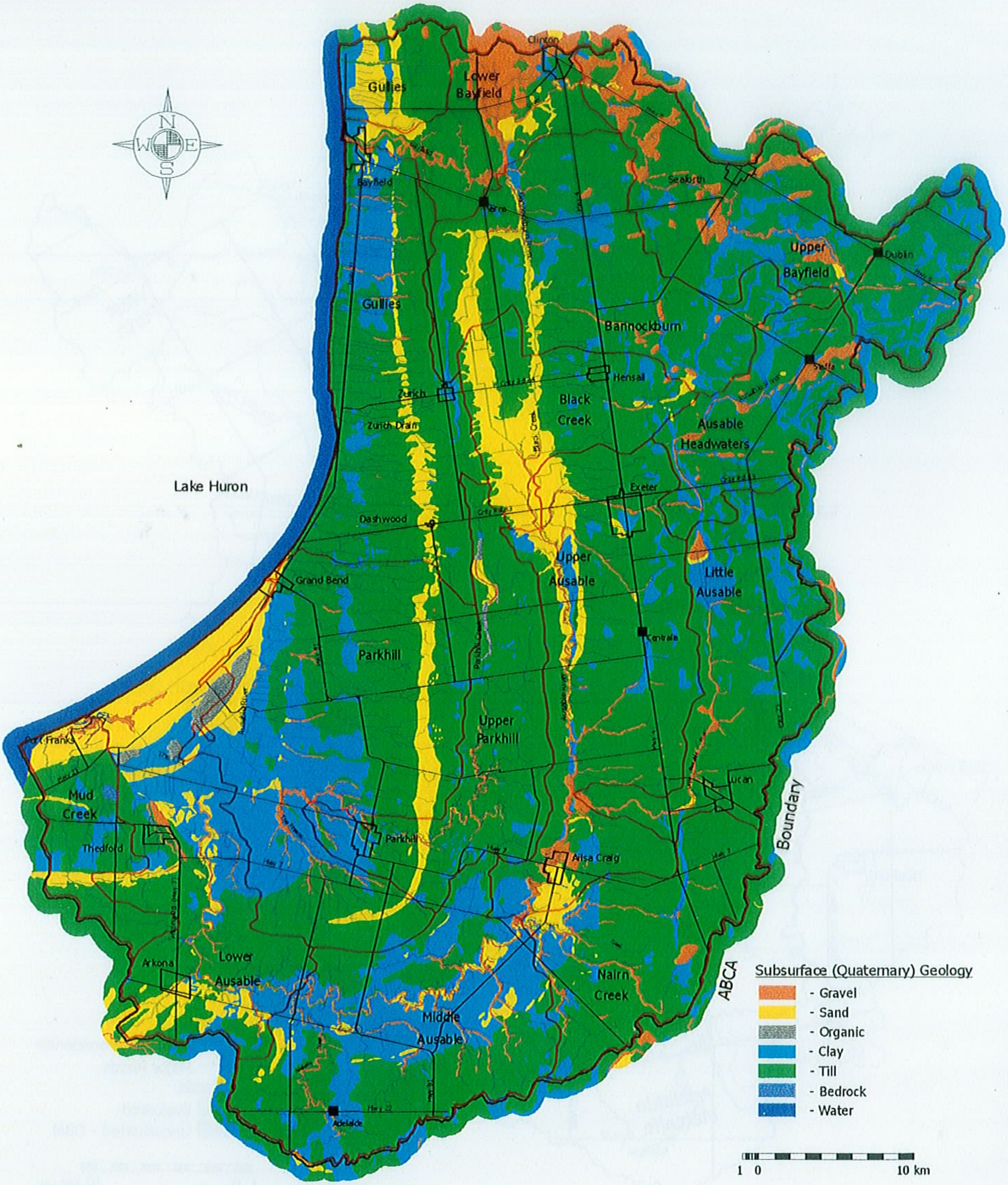
1.1.2 Important Natural Features of the ABCA Watershed

Freshwater habitat potential and limitations can be determined by both natural features and land use. Key natural feature attributes include but are not limited to geology and the amount and location of woodlots and wetlands. Most of the ABCA watersheds consist of clayey to silt/clayey till plains with poor to very poor infiltration (Figure 1.1.2). Watercourses draining areas with poor infiltration typically have little ground water input and as a result, have low to intermittent base flows, flashy runoff, turbid waters and warm temperatures. However, there are areas with coarse moraine deposits (most notably in the northwest area of the ABCA jurisdiction) that provide water, typically cold water, to the river system.

Wetlands and riparian woodlots are well recognized contributors to freshwater habitat. Wetlands help to clear sediment laden waters and reduce nitrogen (N) and phosphorus (P) concentrations. These areas retain water, making water available to downstream areas in periods of low base flow. Furthermore, wetlands provide fish feeding, spawning and nursery areas. In the ABCA jurisdiction, wetland area is limited (Figure 1.1.3); approximately 1.25% of the basin area is wetland.

Riparian woodlots shade streams, preventing excessive aquatic plant growth and moderating temperatures. Leaves, twigs and other woody debris provide food for benthic invertebrates (an important group of animals that are eaten by fish) and structure to streams. Depending on soil conditions, these woodlots may also attenuate the movement of fine soils and N and P concentrations. To date, there has been no attempt to determine riparian cover for the different watercourses in the ABCA watersheds. However, from examination of Drain Classification data and photos, the Watershed Management Strategy (Snell and Cecile Environmental Research and ABCA 1995), and Figure 1.1.4 , it is apparent that the main stem of the rivers (particularly the lower reaches) generally have riparian forests but the headwater tributaries lack cover.

At the landscape level, human settlement patterns are obvious from Figure 1.1.4. Woodlots are typically found at the back of the farm. This has resulted in strips of forest across the ABCA watersheds.



Produced by the ABCA GIS Services - August 2000

Figure 1.1.2: Subsurface Geology in the Ausable-Bayfield Conservation Authority

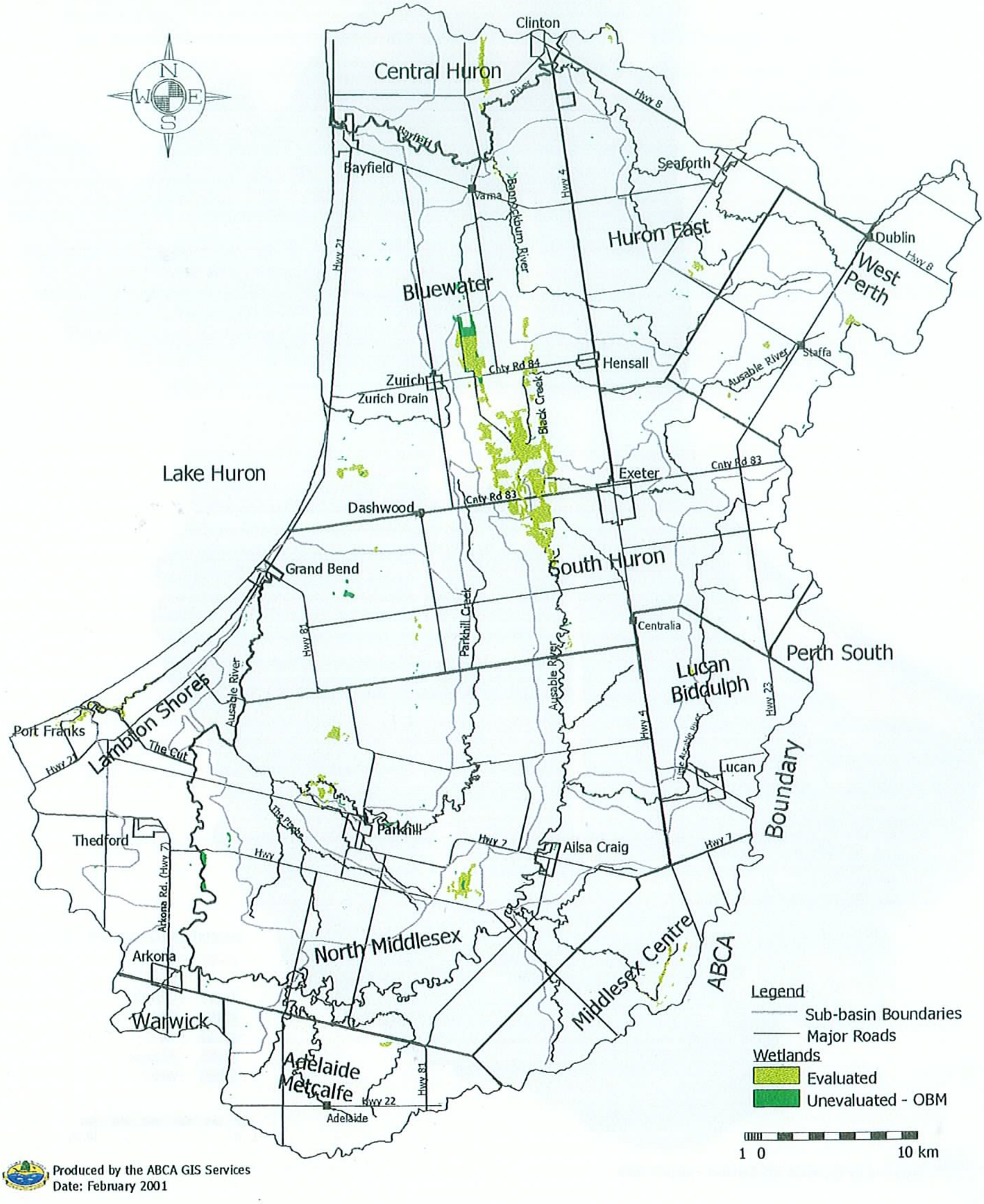


Figure 1.1.3: Wetlands in the Ausable-Bayfield Conservation Authority

Figure 1.1.4: Wetlands and Woodlots in the Ausable-Bayfield Conservation Authority

1.1.3 Land Use and Fish Habitat in the ABCA Area

Natural characteristics such as sub-surface geology and wetland and woodlot distribution and abundance provide the basis for fish habitat. Land use practices, when superimposed on these natural conditions may promote or degrade the aquatic resources. In the ABCA jurisdiction, the dominant land use is agriculture. For example, in Huron County, there are 3,150 farms with over 700 000 acres of farmland. The farms produce $ 450 million in cash receipts, annually (Statistics Canada 1996). Comparable statistics exist for Middlesex, Perth and Lambton counties. The importance of agriculture on the local landscape and economy is clear.

The effects of agriculture on the local aquatic habitats are not as well understood. Firstly, the fish community of the ABCA area is diverse. There are 72 confirmed fish species in the Ausable River basin (see Table 1.1.1). Thus, in this agricultural landscape the diversity of fish species is impressive, although, not uncommon. The Grand River basin, another watershed dominated by agricultural activity, is home to 80 confirmed species (OMNR and GRCA 1998). Similar numbers of fish species are also found for the Upper Thames and the St. Clair Region. However, species diversity at any one site is typically much less than 80. In 1999/2000, ABCA surveyed 40 watercourses in the southern part of the watershed. Most sites (34) had less than 10 species. The low species diversity in most sites may indicate poor habitat conditions. Furthermore, the distribution of some of the more sensitive fish species (i.e., warm water intolerant species, such as salmonids, or sediment intolerant species, such as percids) may be limited by land use practices that affect water quality and the physical stream environment and thus, limit the abundance and distribution of sensitive species.

(The Bayfield list of confirmed fish species, Table 1.1.2, is not as extensive as the Ausable River list. There has been incomplete record keeping of minnow and perch families.)

The *Fisheries Act* defines fish habitat as "spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes". The quality of aquatic habitat depends on: water quantity (i.e., water depth and velocity), water quality (most specifically water temperature and dissolved oxygen concentrations and to some extent turbidity, and N and P concentrations), aquatic plants, in-stream substrate type and structure, and benthic invertebrates, an important fish food source. Agricultural activities that alter these characteristics may potentially alter fish habitat.

Table 1.1.1: Confirmed Fish Species in the Ausable River Basin

Common Name	Scientific Name	Most Recently Collected
Bowfin	*Amia calva*	1947
Gizzard Shad	*Dorosoma cepedianum*	2000
Pink Salmon	*Oncorhynchus gorbuscha*	
Coho Salmon	*Oncorhynchus kisutch*	
Chinook Salmon	*Oncorhynchus tshawytscha*	
Rainbow Trout	*Oncorhynchus mykiss*	1999
Brook Trout	*Salvelinus fontinalis*	1999
Central Mudminnow	*Umbra limi*	2000
Grass Pickerel	*Esox americanus vermiculatum*	1947
Northern Pike	*Esox lucius*	2000
Muskellunge	*Esox masquinongy*	1947
Central Stone Roller	*Campostoma anomalum*	1999
Northern Redbelly Dace	*Phoxinus eos*	1999
Common Carp	*Cyprinus carpio*	1999
Brassy Minnow	*Hybognathus hankinsoni*	1999
Hornyhead Chub	*Nocomis biguttatus*	1999
River Chub	*Nocomis micropogon*	1974
Golden Shiner	*Notemigonus crysoleucas*	1982
Pugnose Shiner*	*Notropis anogenus*	1982
Common Shiner	*Notropis cornutus*	2000
Ghost Shiner	*Notropis buchanani*	1982
Striped Shiner	*Notropis chrysoocephalus*	2000
Blackchin Shiner	*Notropis heterodon*	1982
Blacknose Shiner	*Notrops heterolepis*	1982
Rosyface Shiner	*Notropis rubellus*	1999
Spottail Shiner	*Notropis hudsonius*	1982
Spotfin Shiner	*Cyprinella spiloptera*	1999
Sand Shiner	*Notropis stramineus*	1982
Redfin Shiner	*Lythrurus umbratilis*	1973
Mimic Shiner	*Notropis volucellus*	1982
Blacknose Dace	*Rhinichthys atratulus*	2000
Bluntnose Minnow	*Pimephales notatus*	2000
Fathead Minnow	*Pimephales promelas*	2000
Longnose Dace	*Rhynichthys cataractae*	1947
Creek Chub	*Semotilus atromaculatus*	2000
Quillback	*Carpiodes cyprinus*	1974
White Sucker	*Catostomus commersoni*	2000
Lake Chubsucker*	*Erimyzon sucetta*	1982
Northern Hog Sucker	*Hypentelium nigricans*	2000
River Redhorse*	*Moxostoma carinatum*	1936
Golden Redhorse	*Moxostoma erythrurum*	1982
Shorthead Redhorse	*Moxostoma macrolepidotum*	1982
Greater Redhorse	*Moxostoma valenciennesi*	1982

Table 1.1.1 (continued): Confirmed Fish Species in the Ausable River Basin

Common Name	Scientific Name	Most Recently Collected
Black Bullhead	*Ameiurus melas*	2000
Brown Bullhead	*Ameiurus nebulosus*	1982
Channel Catfish	*Ictalurus punctatus*	1947
Stonecat	*Notorus flavus*	2000
Tadpole Madtom	*Notorus gyrinus*	1982
Banded Killifish	*Fundulus diaphanus*	1929
Brook Stickleback	*Culaea inconstans*	2000
Trout-perch	*Percopsis omiscomaycus*	1982
Rock Bass	*Ambloplites rupestris*	2000
Green Sunfish	*Lepomis cyanellus*	2000
Pumpkinseed	*Lepomis gibbosus*	2000
Bluegill	*Lepomis macrochirus*	1999
Longear Sunfish	*Lepomis megalotis*	1969
Smallmouth Bass	*Micropterus dolomieui*	2000
Black Crappie	*Pomoxis nigromaculatus*	1982
Yellow Perch	*Perca flavescens*	1947
Pickerel/Walleye	*Stizostedion vitreum*	1947
Greenside Darter*	*Ethostoma blennioides*	2000
Rainbow Darter	*Etheostoma caeruleum*	1982
Iowa Darter	*Etheostoma exile*	1982
Fantail Darter	*Etheostoma flabellare*	2000
Least Darter	*Etheostoma microperca*	2000
Johnny Darter	*Etheostoma nigrum*	2000
Logperch	*Percina caprodes*	1999
Blackside Darter	*Percina maculata*	2000
Mottled Sculpin	*Cottus bairdi*	1999

* fish species found on the May 10, 2000 Index list of vulnerable, threatened, endangered, extirpated or extinct species of Ontario (Issued by Ontario Ministry of Natural Resources).

Table 1.1.2: Confirmed Fish Species in the Bayfield River Basin

Common Name	Scientific Name	Most Recently Collected
Northern Brook Lamprey*	*Ichthyomyzon fossor*	
Gizzard Shad	*Dorosoma cepedianum*	1974
Alewife	*Alosa pseudoharengus*	1974
Pink Salmon	*Oncorhynchus gorbuscha*	
Coho Salmon	*Oncorhynchus kisutch*	
Chinook Salmon	*Oncorhynchus tshawytscha*	
Brown Trout	*Salmo trutta*	1974
Rainbow Trout	*Oncorhynchus mykiss*	1974
Brook Trout	*Salvelinus fontinalis*	1974
Atlantic Salmon	*Salmon salar*	1974
Rainbow Smelt	*Osemerus mordax*	1974
Central Mudminnow	*Umbra limi*	1974
Northern Pike	*Esox lucius*	1974
Horny head Chub	*Nocomis biguttatus*	
River Chub	*Nocomis micropogon*	1974
Common Shiner	*Notropis cornutus*	
Emerald Shiner	*Notropis atherinoides*	1974
Spottail Shiner	*Notropis hudsonias*	1974
Redfin Shiner	*Lythrurus umbratilis*	
Longnose Dace	*Rhynichthys cataractae*	
Creek Chub	*Semotilus atromaculatus*	
White Sucker	*Catostomas commerssoni*	1974
Northern Hog Sucker	*Hypentelium nigricans*	1974
Black Redhorse	*Moxostoma duquesnei*	
Catfish		1974
Brook Stickleback	*Culaea inconstans*	1974
Rock Bass	*Ambloplites rupestris*	1974
Smallmouth Bass	*Micropterus dolomieui*	1974
Yellow Perch	*Perca flavescens*	1974
Rainbow Darter	*Etheostoma caeruleum*	1974
Least Darter	*Etheostoma microperca*	1974
Johnny Darter	*Etheostoma nigrum*	1974
Blackside Darter	*Percina maculata*	1974
Mottled Sculpin	*Cottus bairdi*	1974

* fish species found on the May 10, 2000 Index list of vulnerable, threatened, endangered, extirpated or extinct species of Ontario (Issued by Ontario Ministry of Natural Resources).

Water Temperature

Water temperature is a key consideration that determines species abundance (i.e., numbers) and distribution (i.e., location). Although warmer temperatures increase feeding activity and digestion rate for fish, they also raise respiratory rates. For some fish species the energetic costs of high metabolic rates curtail the benefits of increased feeding activity. All fish also have maximal temperatures at which further increases in temperature simply cannot be survived. For example, trout cannot survive in temperatures above 25°C (Allan 1995). The timing of important life cycle activities is also cued to the temperature. For example, spawning for many species occurs at specific temperatures (see Appendix 1). Thus, water temperature regimes help to define conditions that are preferred for different fish species.

Land use activities such as the removal of stream side cover and forest from the basin may increase water temperatures (Barton et al. 1985). In the ABCA area, stream temperature assessments from 1949 compared to 1999/2000 showed a reduced number of cold/cool water streams in the more current survey (Figures 1.1.5 and 1.1.6). However, the water temperatures from areas near Staffa and Hensall need to be re-examined according to protocol detailed by Stoneman and Jones 1996. The increased water temperatures in Nairn Creek (east of Ailsa Craig) in 1999 compared to 1949 are perhaps a result of forest clearing and land use activities in this basin.

Dissolved Oxygen Concentrations

Water temperatures, also in part, determine the concentration of dissolved oxygen (D.O.) in the water (i.e., the solubility of oxygen in water decreases as temperature increases). Oxygen concentration in water is also related to current/ flow and amount of organic matter. While oxygen concentrations are typically adequate in turbulent waters, depressed conditions may exist in standing pools in the summer or in reservoirs, particularly in the winter. Oxygen is critical to all aerobic organisms as it drives metabolic processes. Aquatic organisms differ in their ability to withstand various D.O. concentrations and therefore D.O. concentration also help to define preferred conditions for different aquatic organisms.

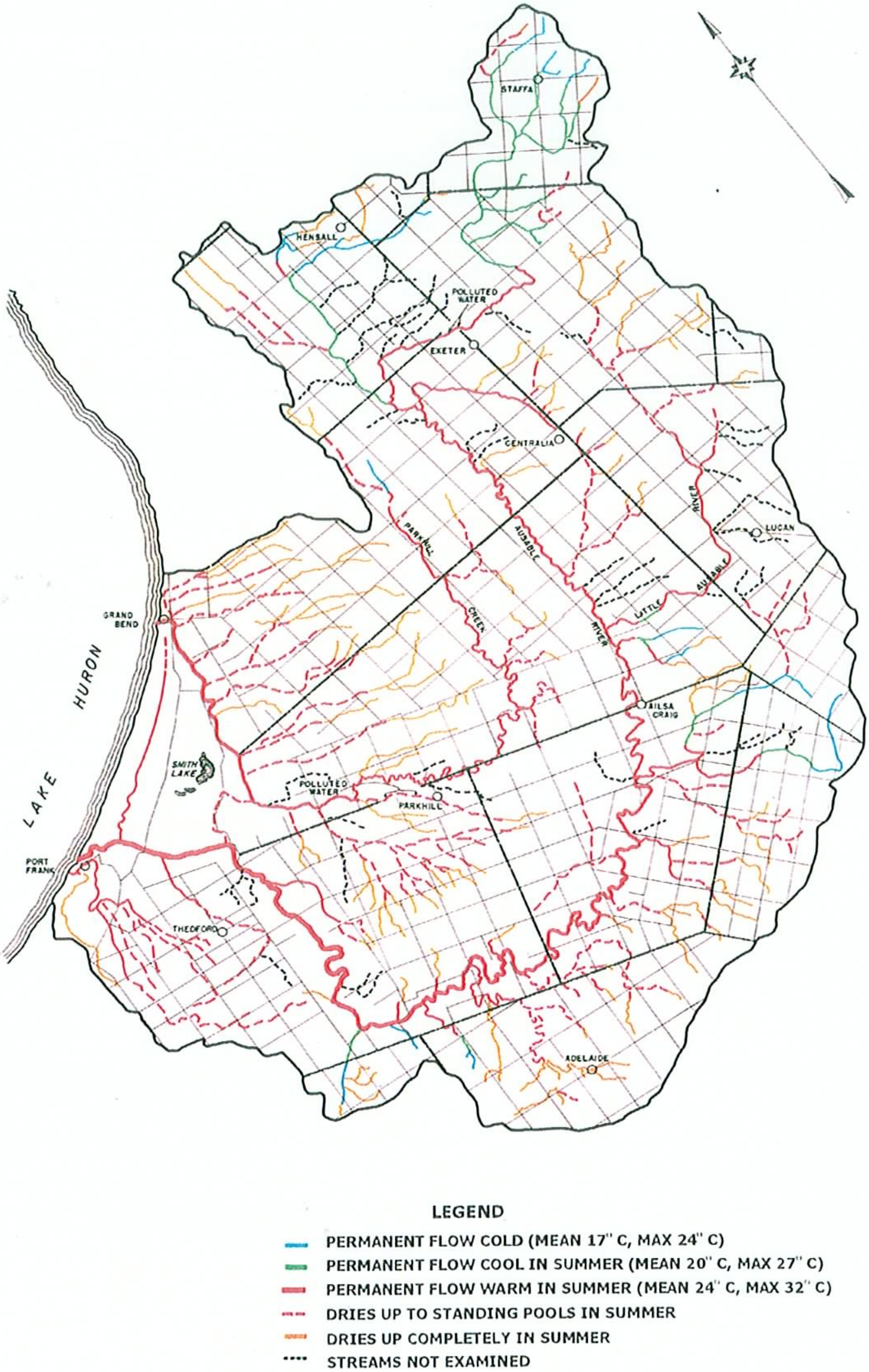


Figure 1.1.5: Stream Temperatures in the Ausable River Basin (1949)

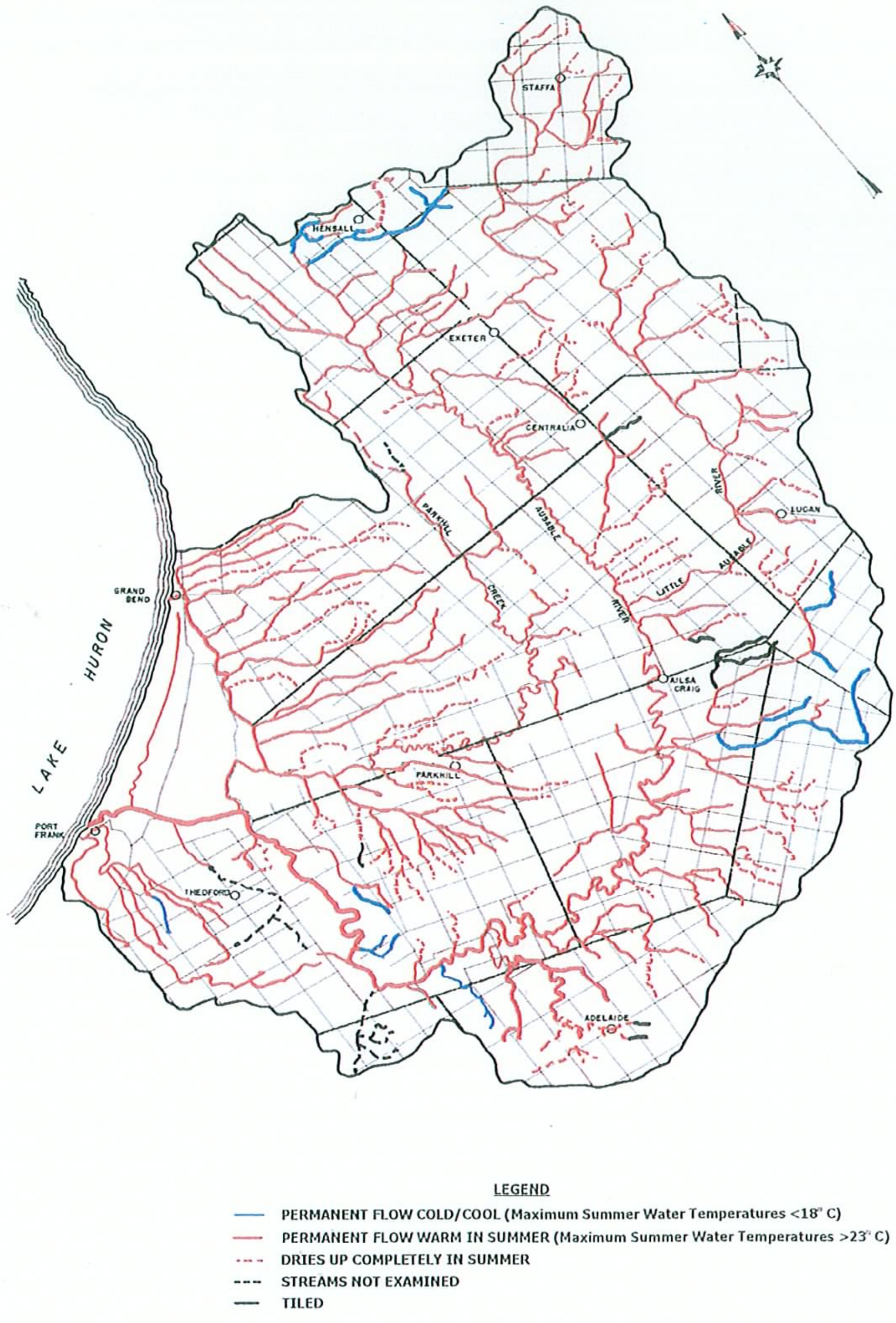


Figure 1.1.6: Stream Temperatures in the Ausable River Basin (1999)

Nitrogen and Phosphorus

Nitrogen and phosphorus are elements that stimulate plant growth. The addition of N and P might enhance plant and algal abundance, which in turn might increase the abundance of benthic invertebrates, an important fish food, and therefore benefit fish production. However, the eventual decay of plant material is also known to result in low D.O. concentrations that might result in fish kills. The optimum concentration of N and P that balances both the stimulation of food production and the potential overproduction of aquatic plant material is typically unknown. Thus, vague water quality guidelines regarding the different forms of N and P exist in Canada. For example, the summary of the Canadian Water Guidelines for the Protection of Aquatic Life (Canadian Council of Resource and Environment Ministers - CCREM 1987) suggested that nitrate concentrations that stimulate weed growth should be avoided. There is no mention of P concentrations in these guidelines. The Interim Provincial Water Quality Objectives (OMOEE 1994) acknowledged that current scientific evidence is insufficient to develop a firm objective with respect to total P however, they do suggest that excessive plant growth in rivers and streams should be eliminated at concentrations less than 30 µg/L. The inputs of N and P in agricultural areas might result from fertilizer application, animal waste run off and soil erosion.

An important form of inorganic N in water is ammonia (NH_3). Ammonia concentrations greater than 20 µg/L may be lethal to fish (Canadian Council of Ministers of the Environment 2000). Excessive ammonia concentrations may result from uncontrolled spills from sewage treatment plants or from untreated animal waste. While, the concentrations of the different forms of N and P may not be as directly influential on fish distribution and abundance as temperature and oxygen concentrations, N and P concentrations should not be overlooked as indicators of the quality of freshwater habitat.

Erosion and Sedimentation

Erosion is a natural process. The displacement of soils is caused by gravity, rainfall, wind and stream movement. However, human activities such as livestock access to streams, cultivation of steep slopes or the edge of stream banks, removal of fence rows, removal of forest cover, municipal drain construction and maintenance, increased hardened surfaces (e.g., asphalt, gravel) and overgrazing may cause accelerated erosion. Erosion and the resulting sedimentation affects the distribution of fish species, which vary in their tolerance for silty conditions.

There are both short-term and long-term effects for fish of increased suspended sediment materials. In the short-term, turbidity makes prey less visible and may damage gill filaments, making the fish more prone to disease and reducing its ability to take oxygen. Over the long-term, deposited fine particles may smother benthic invertebrates, as well as destroy spawning beds. Erosion and resulting sedimentation in streams reduces gravel or rock bottom substrate habitat. Species such as trout and walleye deposit their eggs over a clean cobble and gravel substrate. The interstitial spaces between these coarse particles provide fish eggs with protection from predators, and flowing waters provide oxygen and remove metabolic wastes. Fine sediment eventually settles and may fill these important interstitial spaces. Other fish species, such as northern pike, attach their eggs to emergent vegetation above oxygen-poor sediment. The outside surfaces of the eggs are covered with a sticky substance. Suspended particles may attach to the sticky surface and smother the egg (Adamson 2000).

Hydrology

Agricultural activities may also modify the hydrology of running waters. Impoundments, channelization, and tiled areas affect the hydrology of the landscape and therefore, affect the habitat of watercourses in agricultural areas. Dams are an ubiquitous component of the agricultural landscape. Dams are constructed for irrigation purposes and also help reduce flood damage and produce power. For many people, they also serve aesthetic purposes and their reservoirs provide recreation, including angling opportunities. It should also be recognized that dam creation is not only a human activity since animals such as beavers also build dams.

Dams however, affect aquatic community assemblages and block fish migration. Fish move up and down streams to spawn, feed, find refuge in low flow or from predators, find cooler water or find suitable over-wintering habitat. Fish may therefore, spawn in less suitable habitat downstream or may abandon their run. Eventually, some fish species may be eliminated from portions of the drainage basin. Possible dam failure and the resultant silt release and deposition of silt downstream has serious consequences for fish.

In 1991, the ABCA inventoried dams in their jurisdiction (ABCA 1991). The criteria for the inventory was that the dam had to be a man-made obstruction to a watercourse that had the potential to hold back water and have a spillway to release water. The water flowing into the reservoir had to be an on-stream feature or be fed from springs. The out flow of the water from the dam had to go into a drain, ditch, stream, or river. The reservoir had to be a minimum of 0.1 hectares. Initially, it was thought that there were more than 300 dams in the watershed. However, that number was reduced to 41 by considering the minimum reservoir size and eliminating dug ponds. These 41 dams were characterized with respect to: type, size, purpose, age, general condition, status, head pond and downstream condition, reservoir size, water quality, operation and maintenance issues and potential for power generation. Further information about the 41 dams is found in Dam Inventory and Reservoir Assessment (ABCA 1991). A map of the location of these dams is included in this report (Figure 1.1.7). Nineteen of the 41 dams are located on watercourses that contain relatively sensitive fish species (see in particular, the dams in the Lower Bayfield, Bannockburn, upper Gullies, and Lower Ausable sub-basins). Some dams were identified to be in poor condition. Possible dam failure has important implications for fish and public safety.

The construction and maintenance of channelized watercourses or municipal drains may also alter fish habitat. Municipal drains improve agricultural drainage. They are created by straightening and grading existing stream channels or by excavating new channels. The creation of new watercourses may extend fish habitat. However, certain drain maintenance activities such as the removal of riparian vegetation or coarse substrate and the creation of straighter, wider and shallower channels may disrupt fish habitat (Fisheries and Oceans, Canada 1999). In the ABCA area, municipal drains account for the majority of watercourse types. From the 1999/2000 survey of stream habitat at 766 road crossings in Middlesex and Lambton counties, 466 sites were channelized (61%). Clearly, agricultural drains and their maintenance are important considerations for freshwater habitat in the ABCA basins.

During the 1999/2000 survey, it was also observed that some watercourses were closed. Of the 766 sites (in Middlesex and Lambton counties), 105 sites were closed (13%). Further investigation of air photos from 1975 to 1999 of the Nairn Creek sub-basin suggested that 14 % of open watercourses in this sub-basin had been transformed to closed, tiled drains. For freshwater habitat, the costs and benefits of these closed, tiled systems have not been documented. The closed watercourse is no longer providing freshwater habitat, however, the water inside the tile may be cooler and contain less sediment and may therefore, benefit downstream water quality. The lack of information regarding the potential costs and benefits of closing drains and the extent to which this activity is occurring in the ABCA basins needs to be addressed before the effects of drain closures on fish habitat is understood.

Agricultural drainage through field tiling is also thought to alter headwater hydrology. There is a common perception that flood waters that normally recharge soils are rapidly exported through field drainage tiles, resulting in higher peak flows and reduced summer base flows.

Figure 1.1.7: Location of Dams and Reservoirs in the Ausable-Bayfield Conservation Authority (1991)

However, there is also some evidence that for some soil types, drainage provides better moisture conditions (i.e., the soil has adequate air spaces) to receive water and may therefore, provide a lag period for heavy rains (OMAFRA 2001). The water would be retained in the soils and lost through evapo-transpiration or released more slowly to the drainage system. However, it is recognized that tiling in spring seepage areas may short circuit these particular systems. Soil conditions and precipitation amounts are factors which affect the movement of water to both tiled and surface headwater systems. Low summer base flow is an important issue for aquatic communities in tributaries of the ABCA basin, further examination of field tiling and discharge relationships may be warranted.

The above discussion highlights the relationship between some agricultural practices and fish habitat. The Ausable, Bayfield and Parkhill basins, like many areas in southwestern Ontario, are dominated by agricultural activities. The low fish species diversity at many sites and the limited area for more sensitive species, particularly the cold water salmonid species, suggests that some watercourses in the ABCA jurisdiction have deteriorated fish habitat conditions. Furthermore, as fish habitat is dependent on the larger landscape, the low percentage of wetland area in the jurisdiction may not provide protection to the intensification of agricultural activities; as a result, further degradation of fish habitat conditions may be expected. To ensure that managers are able to quantify further loss or (more hopefully) measure improvements to fish habitat, a summary of existing resources is imperative. From this summary, resources that require protection or improvement may also be identified.

Multiple agencies are responsible for fish. Furthermore, many groups are concerned about fish and about what healthy fish communities means for humans. This document was therefore, created with input from Fisheries and Oceans, Canada, Ontario Ministry of Natural Resources, Angler and Conservationist Clubs, and the Huron County Federation of Agriculture.

1. 2 Objectives

The objectives of this Fish Habitat Management Plan for the ABCA area were to:

1) document the location of the warm and cold water fisheries;
2) identify habitat issues that may contribute to those communities that are not currently meeting their potential;
3) develop strategies that will be implemented by the different partners to improve aquatic habitat conditions;
4) prioritize watersheds for protection, re-mediation and rehabilitation; and
5) promote stewardship and education.

1.3 Plan Format and Methodology

The majority of this document describes the existing information and potential habitat issues for 14 sub-basins (Figure 1.3.1 - Section 2.0). The format for each sub-basin summary is similar. Each summary locates the sub-basin, briefly describes the sub-surface geology, land use and general or historic fish community. The sub-basin was further categorized into fish community segments. These fish community segments typically included the main stem of a river, reservoirs, cold, warm, or mixed-water tributaries. For each segment, the current fish community is identified, fish community potential is provided (i.e., what are the waters capable of producing), fish habitat issues and potential solutions are also provided. Conclusions and recommendations for the ABCA area and for priority sub-basins are detailed in Section 3.0.

The information and basin boundaries for each sub-watershed comes from the ABCA Watershed Management Strategy (Snell and Cecile Environmental Research 1995). Key reports pertaining to water quality include Water Quality and Quantity of the ABCA (ABCA 1982), Bayfield River Drainage Basin Study (Ontario Ministry of Environment and Energy - OMOEE 1980). The Bayfield River Stream Survey (Ontario Ministry of Natural Resources - OMNR 1973) and The Ausable River Stream Survey (OMNR 1974) were the main source of fisheries information. Further access to OMNR files (Clinton and Aylmer District Offices) and information from the ongoing Municipal Drain Classification system supplemented these surveys.

The quaternary geology is derived from Ontario Ministry of Northern Development and Mines (1:50 000) mapping. Wetland and woodlot areas were determined from OMNR information (1985) and OMNR Ontario base mapping (1:10 000) (1985), respectively. These source data may exclude smaller wetland areas and wetlands associated with riparian areas.

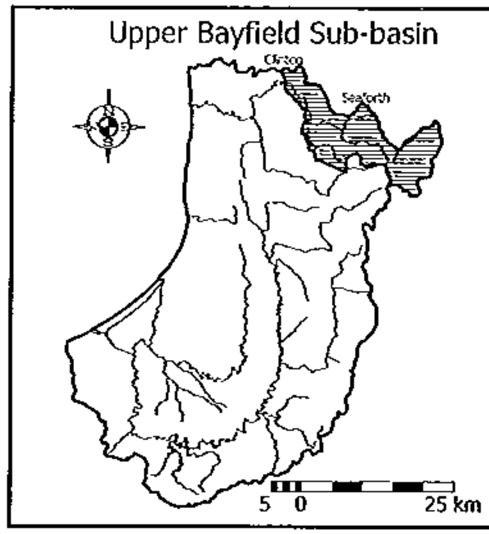
The fisheries/temperature designation of the watercourses in Middlesex and Lambton Counties was determined as a part of the Municipal Drain Classification system. This system was designed to streamline the process of authorizing drain maintenance activities while protecting sensitive fish habitat under the Federal *Fisheries Act.* Watercourses in Huron and Perth Counties were classified in 1994-1995. In 1999 and 2000, the thermal stability in the remaining streams and drains in Middlesex and Lambton Counties were assessed. Information from the Municipal Drain Classification program was imperative to this Plan. The current information from the 1999/2000 surveys provided assessment of fish habitat potential (see Appendix 2). For the most part, fisheries surveys were not conducted during the Plan development (June 2000 - March 2001). However, 40 sites in the Middlesex and Lambton Counties were surveyed as a part of the Drain Classification project. Further fisheries information was gleaned from local anglers.

Figure 1.3.1: Fish Habitat Management Plan Sub-basins in the Ausable-Bayfield Conservation Authority

The transformation from open, surface drains to closed, tiled drains is occurring in the ABCA jurisdiction. However, the extent to which this activity has occurred is unknown. Therefore, drain closures between 1975 and 1999 were examined in one sub-basin, the Nairn Creek sub-basin. The total length of open watercourses in 1975 was determined from the 1975 enlargements (1:5 000) of aerial photographs (1:20 000). The length of closed, tiled drains in 1999 was determined from the 1999 (1: 15 000) aerial photographs. (The length of the watercourse that no longer appeared was assumed to be the amount of the watercourses that was closed and tiled.) The amount of watercourse closed and tiled in 1999 is expressed as a per cent of the total length of open, surface drains (1975). The findings from this preliminary survey suggested that 14 % of open watercourses in this sub-basin had been transformed to closed, tiled drains.

2.0 Fish Habitat Information, Issues and Strategies for 14 Sub-basins of the ABCA

UPPER BAYFIELD - 200 KM²



BACKGROUND

Location: This sub-basin includes the headwaters of the Bayfield River and follows the main stem to Clinton. The headwaters rise near Dublin in Perth County.

Sub-surface Geology: This sub-basin predominantly drains a tightly-bound Rannoch till (Figure 1.1.2). However, there are extensive areas of coarse material deposits, particularly north of the Bayfield River between Seaforth and Clinton.

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 6 % of the sub-watershed and is mostly small riparian and headwater wood-lots.

Fish Community: The sub-basin is dominated by silty-clay tills and has poor infiltration. Tributary runoff is therefore, highly variable with short periods of high discharge and long periods with extremely low base flows. Fish communities are typically limited in these intermittent streams. However, there are some areas with complex sub-surface geology dominated by deposits of sand and gravel that provide opportunity for groundwater discharge. These areas provide an important contribution of water to the main stem during dry periods. There is also potential for these streams to provide cold water fish habitat.

FISH COMMUNITY SEGMENT

Bayfield main stem

Cold water tributaries: Cresswell Creek (Crozier Drain), Gibbings Drain and Helgrammitte Creek

Warm water tributaries: Liffy Drain, Cook Drain, McGrath Drain, Tyndali Creek, Dill Drain, Carter Drain, Nott Drain, Veenstra Drain

Mixed water tributaries: Silver Creek, Broadfoot Drain

Fish Habitat Summary (Upper Bayfield - Bayfield main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
Main Stem warm water fish with top predators (i.e., smallmouth bass)	warm water fish with top predators (particularly smallmouth bass)	**Habitat:** Excessive water temperatures, eutrophication, livestock access, erosion and resulting sedimentation, and low summer base flow limit fish habitat and may limit smallmouth bass distribution.	Encourage practices that reduce nutrient and sediment inputs (i.e., buffer strips and restrict livestock access).
		Intermittent flow maybe particularly problematic, as stable high water flows are preferred for small mouth bass nesting.	Drain maintenance could allow for substrate and flow variability (i.e., riffles and pools). Protect all wetlands.
		Inadequate information on: low summer base flows. Are flows exacerbated by water taking permits, agricultural drainage issues, or lack of wetland? It is important to note that resolving these issues for the tributaries will likely have more appreciable results than if these issues were only addressed for the main stem.	Investigate MOEE water taking permit authorization (i.e., numbers of permits and discharge permitted) in this sub-basin.
		Potential Point Source Pollution: Dublin and Seaforth sewage facilities discharge to the Bayfield.	Continue to monitor water quality near Seaforth. Evaluate trends in nitrogen and phosphorus concentrations.

Fish Habitat Summary (Upper Bayfield - cold and warm water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
cold water tributaries (Helgrammite Creek supports a resident and migratory salmonid population. Creswell Creek and Gibbings Drain are not thought to support a salmonid population.)	cool, cold with resident salmonid population	**Habitat:** Excessive summer water temperatures may limit the potential for resident salmonids in some creeks.	Encourage the development of riparian cover that will shade the streams. Limit further clearing in the headwaters of these creeks.
		Channelization may result in natural habitat loss (i.e., riffle, pool, run sequences).	Drain maintenance could allow for substrate and flow variability (i.e., riffles and pools).
		Inadequate information on: Stream temperatures and fish habitat.	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.
warm water tributaries warm, forage fish	warm, diverse forage communities	**Habitat:** High nutrient concentrations promote excessive aquatic vegetation growth.	Encourage practices that reduce nutrient inputs (i.e., buffer strips and restrict livestock access).
		Channelization may result in natural habitat loss.	Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools).
		Intermittent flow in some streams prevents fish communities from becoming established.	Investigate the reasons for the low summer base flows.
		Inadequate information on: Stream temperatures and fish habitat (particularly for *Nott Drain*, according to subsurface geology it has cold water potential).	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.
		Potential Point Source Pollution: Seaforth sewage discharge to Creswell Creek.	Evaluate trends in the concentrations of inorganic forms of nitrogen and phosphorus.

Fish Habitat Summary (Upper Bayfield - mixed water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
mixed water tributaries (Silver Creek and Broadfoot Drain)	Cold water fish communities where geological characteristics permit, and warm water fish communities in reaches that cannot support cold water communities.	**Habitat:** Excessive summer water temperatures may limit the potential for rainbow trout.	Encourage the development of stream side cover that will shade the streams.
		Channelization may result in natural habitat loss.	Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools).
		Potential impact of on-stream impoundment (*Silver Creek*) on fish movements.	Assess the value of pond/dam to the local community.
		Inadequate information on: stream temperatures and fish habitat (according to subsurface geology there are gravel/sand deposits in both basins, suggesting that there may be cold water potential in these watercourses).	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.

Priority Projects

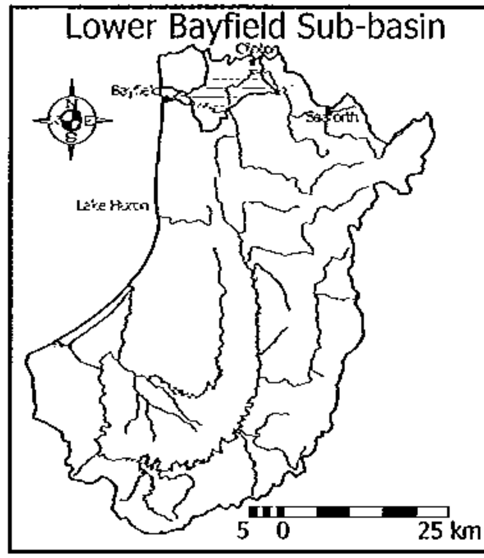
1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin.

2. The sub-surface geology indicates that there are gravel moraine deposits in the Silver Creek, Nott Drain, and Broadfoot Drain basins. These creeks may have potential for cold groundwater discharge. This should be verified by temperature and habitat assessments. However, a lack of riparian cover and other land use activities may result in warm temperatures at these roadside crossings. Stream improvement efforts might be best spent in these creeks.

3. Silver Creek may be an ideal rehabilitation segment. The subsurface geology indicates that there are extensive areas of sand and gravel which may provide ground water discharge. There are cold water segments (based on 1995/1996 efforts) without stream side vegetation. There is an old weir downstream of Highway 8 potentially preventing fish migration and warming waters. Silver Creek is close to a concentrated population and therefore, has good education potential.

4. Protect all wetlands.

LOWER BAYFIELD - 87 KM²



BACKGROUND

Location: This sub-basin includes the main stem of the Bayfield River from Clinton to the mouth at the Town of Bayfield on Lake Huron and all the waters draining into this section of the River, excluding the Bannockburn system.

Sub-surface Geology: Compared to the other sub-basins, this sub-basin has the largest area of gravel deposits (nearly all of Trick's Creek watershed is dominated by gravel). However, tightly bound St. Joseph till, which is common throughout the western part of the ABCA jurisdiction is also extensive in this sub-basin (see Figure 1.1.2). There is a large glaciolacustrine deposit north east of the Town of Bayfield. Close to Lake Huron, this deposit is comprised of fine material, further to the east, coarser sand and gravel dominates.

Land Use: Forest and wetland covers approximately 19 % of the sub-basin including 14 km^2 high ranked areas (1 ANSI and 3 ESAs) and riparian and headwater woodlots.

Fish Community: There is an extensive area with complex subsurface geology dominated by deposits of gravel that provide opportunity for groundwater discharge and provide suitable substrate for trout to spawn. This potential for groundwater discharge combined with extensive forest cover provides for some of the best cold water fish habitat in the ABCA jurisdiction.

FISH COMMUNITY SEGMENT

Bayfield main stem
Cold water tributaries: Brandt Creek, Middletons Creek, Purdue Creek (Steenstra Drain), Trick's Creek, Wiltse Creek (Zwann, Buffinga and O'Brien Drains), Johnston-Howson Drain

Fish Habitat Summary (Lower Bayfield - Bayfield main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
main stem warm water fish with top predators	warm water with top predators (particularly smallmouth bass and rainbow trout and pacific salmon during migration)	**Habitat:** High water temperatures, low base flows and excessive nutrient inputs limit fish habitat.	Encourage practices that reduce nutrient inputs (i.e., buffer strips and restrict livestock access).
		Intermittent flow maybe particularly problematic, as stable high water flows are preferred for smallmouth bass nesting. Adequate flow is also required for migratory trout.	Determine if low summer base flows are accentuated by water taking permits, agricultural drainage issues, or lack of wetlands? It is important to note that resolving these issues for the entire watershed will likely have more appreciable results than if these issues were only addressed for the main stem. Protect all wetlands.
		Dredging at the mouth of the Bayfield may disrupt nursery and feeding areas.	Use *Fisheries Act* to mitigate effects of dredging.
		Inadequate information on: Do pools provide holding and hiding cover for smallmouth bass? Are there stretches of the river that are slow and muddy limiting smallmouth bass reproduction?	Evaluate fish habitat.
		Potential Point Source Pollution: Sewage facilities from the Towns of Clinton, Bayfield and Vanastra and the Huronview Home for the Aged discharge to the Bayfield River.	Continue to monitor water quality at Varna. Evaluate trends in the concentrations of inorganic forms of nitrogen and phosphorus.
		Fish Population: Local anglers feel that fishing pressure on smallmouth bass has recently been drastically increased.	Determine if smallmouth bass are over-harvested.

Fish Habitat Summary (Lower Bayfield - cold water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
cold water tributaries	cool, cold with resident and migratory salmonid population	**Habitat:** Excessive summer water temperatures and low base flow may limit the potential for a resident salmonid fishery in some creeks.	Encourage the development of riparian cover that will shade the streams. Examine artificial drainage characteristics and % riparian cover to help determine which attribute is limiting the cold water potential of these creeks (particularly *Purdue Creek*). Protect all wetlands.
		Channelization may result in natural habitat loss.	Drain maintenance could allow for substrate and flow variability (i.e., riffles and pools).
		Road salt may degrade water quality in more pristine streams.	Evaluate the effects of road salt on aquatic habitats. A literature review on this topic would be the most logical first step.
		Inadequate information on: Stream temperatures and fish habitat, particularly for creeks that meet the main stem at the Bayfield Road North lots 8, 10, 14.	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.
		Potential effects of aggregate activity at potential groundwater recharge/discharge areas.	Monitor streams temperatures at Trick's Creek and Huron County Rd. 13 as aggregate activities may affect groundwater temperatures and amounts.

Priority Projects

1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin.

2. Maintain cool/cold water designation of the tributaries. If there is opportunity to revisit rehabilitation plans for the aggregate activities in this basin, ensure that the plans take into consideration the cold water potential of this area (i.e., shallow and wide water storage areas should be discouraged in favour of deeper reservoirs). Another approach that may provide further protection to this area is to designate cold water streams, as verified by stream assessments conducted in 2001, as **Environmentally Significant Areas** (ESAs). Environmental impact studies would be required of development proposals affecting ESAs. All cold water streams in the Haldimand-Norfolk Region have been designated as ESAs since 1978. Due to topography and geology, there are far fewer creeks in the ABCA jurisdiction that have cold water potential and therefore, these creeks need protection.

   The cold water tributaries of this sub-basin are the most pristine watercourses in the entire watershed. Planning policies need to ensure that wetlands, woodlots, water quality and water quantity are protected in this sub-basin. The increase in water temperatures and low flow conditions in some tributaries indicate that the current level of protection (ESA designation), has not provided sufficient protection for the few tributaries currently designated.

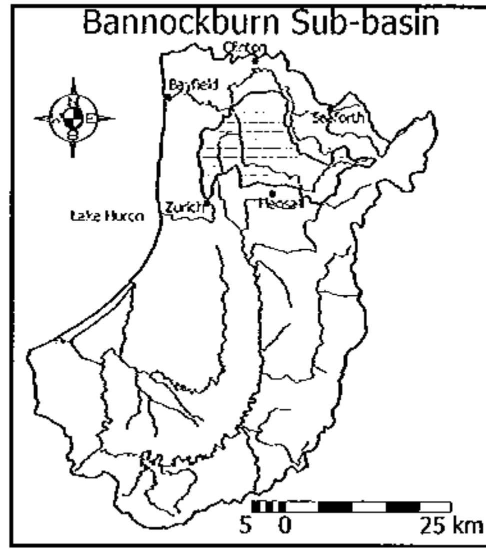
   Should a sensitive areas study be conducted for Huron County, cool/cold water stream attributes should be considered in the proposed study's terms of reference.

3. Creeks that do not qualify as cold water, according to Stoneman and Jones (1996), but have sub-surface geologic features that suggest they are groundwater recharge/discharge areas, are excellent candidates for stream improvement.

4. There are seven dams located within this sub-basin. Further investigation of the function of these dams and other potential fish barriers (such as perched culverts, weirs, and in-line stormwater management ponds) is warranted.

5. Key species in this sub-basin include migratory rainbow trout, brook trout and smallmouth bass. Further investigation of the spawning habitat, spawning success and the success of juveniles in specific habitats might help to promote these attributes throughout the sub-basin.

BANNOCKBURN - 210 KM^2



BACKGROUND

Location: The Bannockburn River is a main tributary of the Bayfield River. The headwaters of the Bannockburn River rise north-west of Chiselhurst in Huron East (formerly Tuckersmith Township) and meets the Bayfield River north of Varna.

Sub-surface Geology: Most of the sub-basin drains tightly bound till (see Figure 1.1.2). However, at the confluence of many tributaries (i.e., Notts, Waldon, Brucefield Drain, Moore Drain and Big Drain) with the Bannockburn there are fluvial gravel deposits. The Bannockburn and Big Drain basins also have extensive portions of sand.

Land Use: Agriculture is the dominant land use. Forest and wetland covers approximately 9 % of the sub-basin including 5 km^2 high ranked areas (7 ESAs) and some small riparian and headwater woodlots.

Fish Community: This sub-basin has provided habitat for adult rainbow trout from the early season migration, brown trout, smallmouth bass and northern pike (MNR 1975). The main stem appears to have good riparian vegetation (observations from the Bannockburn Line). In contrast, many of the tributaries have little cover (observations from Highway 4). There are some areas with complex subsurface geology dominated by deposits of sand and gravel that provide opportunity for groundwater discharge and provide suitable substrate for trout to spawn. Some tributaries have short periods of high flows and longer periods of extremely low flows. The high flows may displace gravel and sand beds. The low flows may strand fish.

FISH COMMUNITY SEGMENT

Bannockburn main stem

Cold water tributaries: Notts Creek (Rehorst and Horton Drains), Waldon Creek (Turner Creek or Watson Drain), Brucefield Drain, Moore Drain, Henderson Drain, Hood Drain Extension, Forrest- Thompson and Datars-Logan Drains

Warm water tributaries: McCullie Drain

Mixed water tributaries: Big Drain

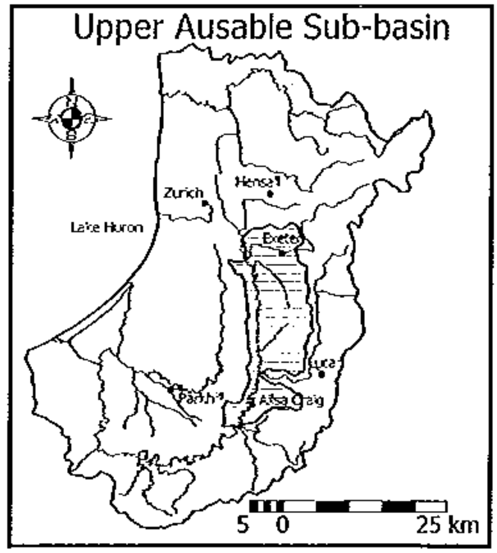
Priority Projects

1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin.

2. The sub-surface geology indicates there are gravel moraine deposits in the Staffa Drain basin. This creek may have potential for cold groundwater discharge. Temperature and habitat assessments are necessary to verify this possibility. However, it is possible that warm temperatures may be recorded at these roadside crossings due to land use activities.

3. To improve the smallmouth bass fishery in the Ausable headwaters, drain maintenance could allow for variability in macro-habitat regimes and substrate composition.

UPPER AUSABLE - 241 KM^2



BACKGROUND

Location: The Upper Ausable sub-basin includes the Ausable River from below the Morrison Dam to just above its confluence with Nairn Creek. The Little Ausable sub-basin is excluded from this area. The Ausable flows down the west side of this sub-basin, and much of the sub-basin is drained by tributaries from the east.

Sub-surface Geology: The sub-basin is dominated by silty clay to sandy silt till matrix. There are isolated gravel deposits near the main stem of the Ausable (see Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland covers approximately 10 % of the sub-basin. Some of Hay Swamp is within the northern part of this sub-basin. Small riparian forests and scattered woodlots are prevalent in the southern part of the sub-basin.

General Fish Community:
The Ausable River provides a variety of flow regimes, substrate types, and vegetative cover. Much of the sub-basin drains silty-clay tills and has poor infiltration. Tributary runoff is therefore, highly variable with short periods of high discharge and long periods with extremely low base flows. Fish communities are typically limited in these intermittent streams. Tributaries that drain the isolated gravel deposits (such as Vanneste Drain) may have more opportunity to provide consistent flows and perhaps, better fish habitat.

FISH COMMUNITY SEGMENT

Ausable main stem
Warm water tributaries: Centralia Drain, Colwell Drain, Vanneste Drain, Henderson Drain, Cann-Mitchell Drain

Fish Habitat Summary (Upper Ausable - Ausable main stem)

Segment and Current Designation	Fish Community	Issues	Potential Actions
main stem warm water fish with top predators	warm water, with top predators (particularly smallmouth bass, northern pike and walleye)	**Habitat:** Excessive water temperatures, eutrophication, land erosion and resulting sedimentation may limit fish habitat. Overall, main stem does provide good flow regime and substrate variability.	Encourage practices that reduce nutrient and sediment inputs.
		Fish Population: There may be harvesting pressure on walleye.	Some anglers feel the fishing season should be reduced. In Huron and Perth counties, the walleye season is closed between April 1 and the second Saturday in May. The walleye season is open all year in Middlesex County (OMNR 2001). In this example, the fishing season does not reflect biology (i.e., walleye freely migrate the Ausable River in all counties). Concerned anglers should write a letter to OMNR to suggest that the walleye season in the Ausable River follow Huron and Perth dates.
		Inadequate information on: The abundance and distribution of walleye.	Evaluate walleye distribution and spawning success in the Ausable River.
		Some anglers feel fishing opportunities are limited due to restricted access on private land.	Educate landowners about the benefits of health fish communities.
		Potential Point Source Pollution: Sewage facilities from the Towns of Exeter, Huron Park and Ailsa Craig discharge to the Ausable River.	Continue to monitor water quality at Exeter. Evaluate trends in the concentrations of inorganic nitrogen and phosphorus.

Fish Habitat Summary (Upper Ausable - warm water tributaries)

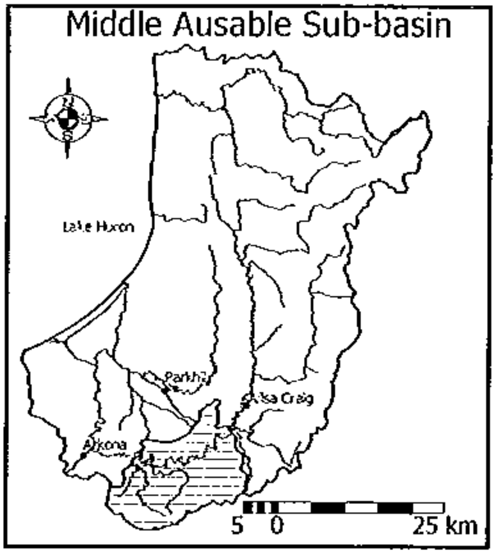
Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
warm water tributaries warm water fish community comprised of forage fish	warm water fish community comprised of forage fish	**Habitat:** Low summer base flow limit fish habitat.	Drain maintenance could allow for substrate and macrohabit variability (i.e., riffles and pools). Investigate the reasons for the low summer base flows. Protect all wetlands.
		Fine sediment substrate dominates and there is very little substrate size variability.	Encourage practices that reduce sediment inputs.
		Many of the head-water streams are intermittent and do not have treed buffer strips.	Encourage practices that increase streamside cover and headwater forests.
		Cattle access to creeks increases the width: depth ratio, increases bank erosion and resulting sedimentation and may result in nutrient enrichment (*Vanneste* and *Colwell Drains*).	Encourage projects that reduce cattle access.
		The sub-surface geology indicates that gravel deposits near the confluence of *Vanneste Dr.* with the Ausable may provide ground water recharge.	Consider *Vanneste Dr.* for future stream improvement works.
		Inadequate Information on: stream temperatures in Huron County (i.e., *Centralia Drain*).	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.

Priority Projects

1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin.

2. Protect all wetlands.

MIDDLE AUSABLE - 230 KM²



BACKGROUND

Location: The Middle Ausable sub-basin includes the Ausable River from its confluence with Nairn Creek (south of Ailsa Craig) to its confluence with Adelaide Creek. Adelaide Creek, Mud Creek, one unnamed second order and one unnamed third order creek are also part of this sub-basin. The Ausable River flows in southwesterly direction. Much of the sub-basin is drained by tributaries from the south.

Sub-surface Geology: Clay deposits dominate much of this sub-basin. The headwaters of the southern tributaries drain Rannoch till, a tightly bound silty clay to sandy silt material (Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 12 % of the sub-watershed. There is continuous riparian coverage along much of the Ausable River. Within the sub-basins of the Ausable tributaries, there are small riparian and upland wood-lots and scattered remnants of original wetland.

Fish Community: The Ausable River and its second and third order tributaries provide a variety of flow conditions, macro-habitats (i.e., riffle/pool/run sequences), substrate types and vegetative cover. These rivers provide good habitat to warm water fish, such as northern pike. There is also migratory Lake Huron runs of walleye and rainbow trout. However, there is a lack of information regarding walleye distribution. Much of the sub-basin drains silty-clay tills and has poor infiltration. Discharge in the headwater streams is therefore, highly variable with short periods of high discharge and long periods with extremely low base flows. These conditions may be accentuated by artificial drainage systems. Fish communities are usually inhibited in these intermittent streams.

FISH COMMUNITY SEGMENT

Ausable main stem
Cold water tributaries: Lenting Drain
Warm water tributaries: Unnamed Tributary A (Ausable River Trib A11A, from Reig Drain), Unnamed Tributary B (Ausable River Trib A11B, from Lewis Drain), Mud Creek (Dortmans and Sutherland Drains), Adelaide Creek (Morgan Drain), Big Swamp Drain

Aquatic Resources Summary (Middle Ausable - Ausable main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
main stem warm water fish with top predators and migratory salmonids	warm water, with top predators (particularly northern pike, walleye and migratory runs of salmonids)	**Habitat:** Excessive water temperatures, eutrophication, erosion and resulting sedimentation may limit fish habitat.	Encourage practices that reduce nutrient and particularly sediment inputs (i.e., buffer strips and restrict livestock access).
		Overall, main stem does provide good flow regime, variation in riffle/run/pool habitats, substrate variability and cover (i.e., overhanging vegetation, large rocks).	
		Low summer discharge is occasionally problematic, as stable high water flows are preferred for the migration of walleye larvae to nursery areas in the lake.	Determine if low summer base flows are accentuated by water taking permits, agricultural drainage issues, or lack of wetlands.
			Protect all wetlands.
		Inadequate information on: walleye spawning locations and the success of spawning attempts.	Investigate walleye spawning activities (i.e., location, success) and the subsequent success of juveniles.
		Anglers have reportedly caught Muskellunge in the Ausable.	Investigate the abundance and distribution of Muskellunge.
cold water tributaries (migratory rainbow trout)	migratory rainbow trout	**Habitat:** Excessive summer water temperatures, low summer discharge and erosion and resulting sedimentation may limit fish habitat. Cover and shade is low at some road crossings. However, water is typically clear.	Encourage practices that reduce nutrient and particularly sediment inputs (i.e., buffer strips and restrict livestock access). Protect all wetlands.

Aquatic Resources Summary (Middle Ausable - warm water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
warm water tributaries warm water fish with top predators	warm water fish with top predators (particularly northern pike and smallmouth bass)	**Habitat:** High nutrient concentrations promote excessive aquatic vegetation growth.	Encourage practices that reduce nutrient inputs (i.e., buffer strips and restrict livestock access).
		Low summer discharge in headwaters result in stagnant waters with excessive filamentous algae.	Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools).
		Many of the headwater streams do not have treed canopy.	Encourage practices that increase stream-side cover along the tributaries and forest in the headwaters.
		Second and third order streams have adequate discharge, but are sediment laden. Some of the introduced sediment is the result of cattle access and bank erosion but sediment may also result from landscape level activities (i.e., lack of forest cover) and the clay sub-surface geology.	Encourage practices that reduce sediment inputs and encourage forest in the headwaters.
		Cattle access to creeks makes the creek wider and more shallow, increases bank erosion and sedimentation, and results in nutrient enrichment.	Encourage projects that reduce cattle access.

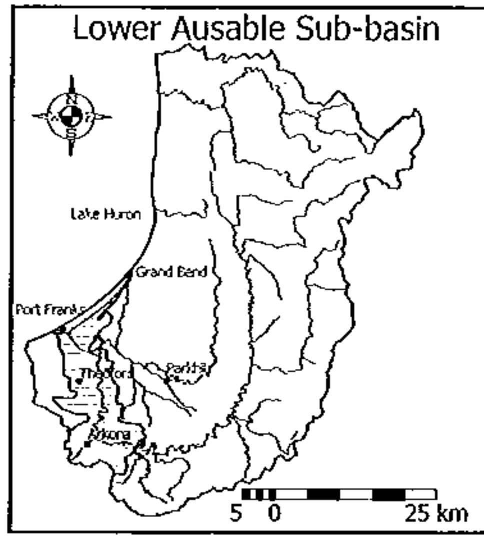
Priority Projects

1. A detailed investigation into the spawning habits and success of walleye juveniles is a main priority for the main-stem of the Ausable River.

2. Establish canopy cover on first order streams.

3. Protect all wetlands.

LOWER AUSABLE - 200 KM^2



BACKGROUND

Location: This sub-basin includes the Ausable River from its confluence with Adelaide Creek to its outlet at Port Franks. The Ausable River flows northwards to the "Cut" and then flows west.

Sub-surface Geology: This sub-basin predominantly drains St. Joseph till, a silt to silty clay matrix. Muck deposits exist in the vicinity of the old shallow lake, Lake Burley (later Lake Smith). The Old Ausable River Channel which is in the Pinery Provincial Park drains only sand (Figure 1.1.2).

Land Use: Except for lands near the old Ausable River Channel, which is protected as the Pinery Provincial Park, agriculture is the dominant land use. Forest and wetland covers approximately 27 % of the sub-basin.

Fish Community: The Ausable River provides a variety of macro-habitats (i.e., riffle/pool/run sequences), substrate types and vegetative cover. Therefore, there is good habitat for warm water fish such as northern pike. There is reportedly good adult walleye habitat in both the Ausable Cut and the Ausable Gorge. Identification of walleye spawning sites would improve habitat management strategies. Tributary drainage in much of the sub-basin is intermittent as a result of the silty-clay till. However, there are tributaries in the gorge with subsurface geology dominated by deposits of sand and gravel that may provide groundwater discharge and cold water fish habitat.

FISH COMMUNITY SEGMENT

Ausable main stem
Cold water tributaries: Zimmerman Drain
Warm water tributaries: Baird Drain, Butler Drain, Hobbs-McKenzie Drain, Decker Creek, Boothill Creek

Fish Habitat Summary (Lower Ausable - Ausable main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
main stem warm water fish with top predators	warm water, with top predators (particularly northern pike and walleye)	**Habitat:** Excessive water temperatures, eutrophication, land and bank erosion and resulting sedimentation may limit fish habitat.	Encourage practices that reduce nutrient and particularly sediment inputs (i.e., buffer strips and restrict livestock access).
		Overall, the main stem provides adequate discharge and macro-habitat variability (i.e., variation in riffle/run/pool habitats), substrate variability, and cover (i.e., overhanging vegetation, large rocks).	
		Low summer discharge may be problematic, as stable high water flows are preferred for small-mouth bass nesting and the migration of walleye larvae to nursery areas at the mouth of the river.	Determine if low summer base flows are accentuated by water taking permits, agricultural drainage issues, or lack of riparian wetland.
		Walleye and northern pike nursery areas (i.e., emergent vegetation) are not extensive in the backwaters of the Ausable River in Port Franks.	Educate landowners about the benefits of aquatic plants. Dredging activities at the outlet should minimize the removal of aquatic plants.
		Dredging at the mouth of the Ausable may disrupt nursery and feeding areas.	Use *Fisheries Act* to mitigate effects of dredging.
		Anglers suggest beaver activity may, at times, obstruct flow in the Ausable.	Consult with local OMNR officials about the safe removal of dams that obstruct fish migration.
		Inadequate information on: walleye spawning locations and the success of spawning attempts.	Investigate walleye spawning activities and their subsequent success.

Fish Habitat Summary (Lower Ausable - warm and cold water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
warm water tributaries warm water, forage fish	warm water fish with top predators (particularly northern pike and smallmouth bass)	**Habitat:** Low summer discharge in headwaters result in stagnant waters with excessive filamentous algae.	Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools).
			Encourage practices that reduce nutrient inputs (i.e., buffer strips and restrict livestock access).
		Many of the headwater streams do not have treed buffer strips.	Encourage practices that increase stream-side and forest cover in the headwaters.
		Artificial drainage patterns (i.e., headwalls) discourage fish migration.	Recognize that highly artificial watercourses draining the old Lake Smith area are likely to provide unique drain maintenance requirements.
		Potential Point Source Pollution: Thedford sewage facilities discharge to Decker Creek.	Continue to monitor water quality near Thedford. Evaluate trends in nitrogen and phosphorus concentrations.
cold water tributaries migratory trout	cool, cold with migratory and resident trout	**Habitat:** Some creeks seem quite turbid, the deposition of fine sediment in gravel spawning beds may limit trout production.	Encourage practices that reduce sediment inputs.
		There is marginal flow in some creeks.	Determine if low summer base flows are accentuated by water taking permits, agricultural drainage issues, or lack of riparian wetland.
		Excessive water temperatures may limit a resident salmonid population.	Examine drainage characteristics and % riparian cover to help determine which attribute is limiting the cold water potential of these creeks.

Priority Projects

1. Artificial drainage patterns of the old Lake Smith area provide unique fish habitat issues. For example, watercourses in this area do not flow in the same direction all the time. For overall ecosystem integrity, this area should be re-habilitated to its former wetland state.

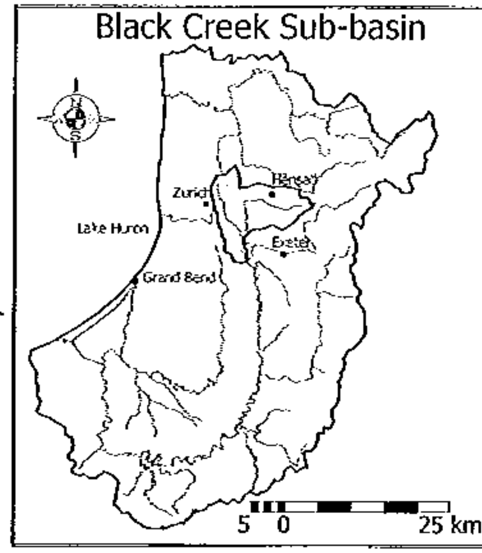
2. Maintain cool/cold water designation of the cold water tributaries.

3. Identify factors that are limiting extensive macrophyte beds in Port Franks. Dredging and landowner plant removal are two possible explanations, that might be considered.

4. A detailed investigation into the spawning habits and success of walleye juveniles would help to develop management strategies for the main-stem of the Ausable River.

5. There are eleven dams located within this sub-basin. One dam was partially washed out in the spring of 1991. ABCA (1991) cautioned that further dam disruption might result in silt movement from the reservoir. Further investigation and possible repair of this structure is warranted. Further investigation of the function of all dams and other potential fish barriers (such as perched culverts, weirs, and in-line stormwater management ponds) in this sub-basin is also suggested.

BLACK CREEK - 107 KM²



BACKGROUND

Location: Black Creek joins the Ausable River west of Exeter. Headwaters of the Black Creek rise near Hensall in Huron County. This sub-watershed also includes much of Hay Swamp and the municipal drains that are in the west part of this wetland.

Sub-surface Geology: The sub-basin is characterized by large surficial deposits of sand that may provide water during low flow periods (Figure 1.1.2).

Land Use: Agriculture is the dominant land use. However, forest and wetland cover is approximately 27 % of the sub-watershed. There are scattered riparian and headwater woodlots.

Fish Community: The upper section of Black Creek is considered a cold water system with resident and migratory trout. The remainder of the watercourses are warm water. One recurring problem for fish habitat in the ABCA jurisdiction is the lack of summer base flow in the main rivers. Watercourses in Hay Swamp provide a small base flow contribution to the larger streams flowing through the area and are therefore, an important aquatic resource. Hay Swamp provides flood plain areas, a potentially important habitat feature for northern pike spawning success.

FISH COMMUNITY SEGMENT

Cold water tributaries: upper Black Creek
Warm water tributaries: Black Creek, Black Creek Drain West Branch, Stephen Drain, Wildfong Drain

Black Creek - Fish Habitat Summary

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
cold water tributaries cold, with rainbow trout	cold, with resident brook trout	**Inadequate information on:** water temperature.	Measure stream temperature following Stoneman and Jones, 1996.
		Fish species present: rainbow trout were recently verified but no current information about brook trout.	Conduct a fish survey.
		Potential Point Source Pollution: landfill and composting facility beside creek. Hensall sewage facilities discharge to creek.	Evaluate trends in the concentrations of inorganic nitrogen and phosphorus at provincial water quality monitoring site.
		Habitat: cattle access downstream of restoration efforts on the headwater section of Black Creek.	Inform general public and landowners about ongoing programs that improve water quality and fish habitat
		Bank erosion identified at a few sites.	Encourage projects that reduce cattle access and stream bank slumping.
		Insufficient trout spawning habitat (i.e., lack of cover, fine sediment in-filling gravel beds).	The stream could be more narrow and have more cover. Encourage projects that reduce erosion (i.e., buffer strips and restrict livestock access).
warm water tributaries warm, bait fish	warm, with diverse fish communities	**Habitat:** This sub-basin has a high number of water taking permits.	Determine the impacts of water taking on the local fish community.
		Inadequate Information on: the abundance and distribution of northern pike and the potential for cold water in some watercourses.	Conduct temperature, habitat and fish assessment surveys.

Priority Projects

1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin. The warm water courses in Hay Swamp have been designated as warm water, bait fish however, Paragon Engineering Limited documented catching northern pike (1986) and local anglers also catch pike in this area. A current fish survey of Black Creek is warranted.

2. Maintain cool/cold water designation (and the population of brook trout) in the Upper Black Creek. Continued rehabilitation efforts on this watercourse should be a priority. Wherever cold water potential is identified, in-stream habitat improvements should be encouraged.

3. Protect and rehabilitate wetlands. One recurring problem for fish habitat in the ABCA jurisdiction is the lack of summer base flow in the main rivers. Watercourses in Hay Swamp provide a small base flow contribution to the larger streams flowing through the area and is therefore, an essential aquatic resource.

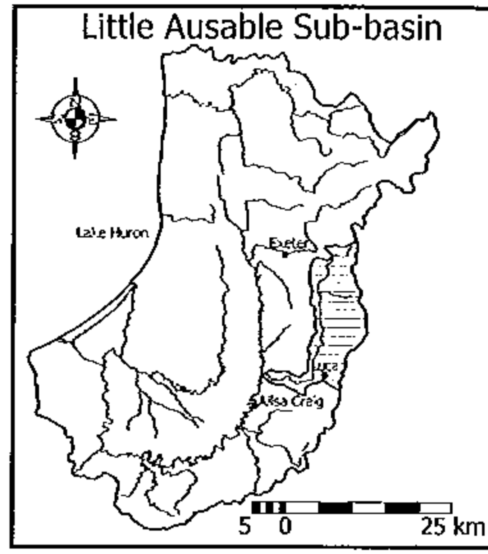
4. Expand spawning habitat for brook trout by first determining the location of their successful spawning activities.

5. If a drainage petition is received by the Authority, the application should be reviewed to ensure that:
   i) base flow will not be diverted from the study area;
   ii) storage in the wetland will not be reduced;
   iii) channelization will not eliminate the ability of soils adjacent to the channel to absorb moisture; and
   iv) erosion protection measures be provided to minimize scour and silt deposition in the wetland (Paragon and Associates 1986).

6. Future attempts to modify the channel structure in tributaries in this sub-basin should ensure that channelization will not reduce macro-habitat variability (i.e., riffle, pool sequences).

7. Determine the impacts of water taking on the local fish community.

LITTLE AUSABLE - 152 KM^2



BACKGROUND

Location: The Little Ausable rises north of Elimville in South Huron, formerly Usborne Township. The river flows into the Ausable north of Alisa Craig.

Sub-surface Geology: The sub-basin is dominated by Rannoch Till, a silty clay to sandy silt till matrix. Gravel deposits are found at the confluence of the Little Ausable with the Ausable (see Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland covers approximately 6 % of the sub-basin. Most of the forested area is river valley woodland in the lower part of the sub-watershed.

General Fish Community:
The Little Ausable River provides a variety of macro-habitat regimes (i.e., pools, riffles and runs) and substrate types (i.e., gravel and cobble). These conditions provide for good migratory salmonid spawning. However, warm summer temperatures and dry portions on the main stem may limit fish production.

FISH COMMUNITY SEGMENT

Little Ausable main stem
Warm water tributaries: Winchelsea Drain, Wallis Drain, Mitchell Drain, Brock Creek and Pym Drain

Fish Habitat Summary (Little Ausable - Little Ausable main stem)

Segment and Current Designation	Fish Community	Issues	Potential Actions
main stem warm water fish with top predators	warm water, with top predators (particularly smallmouth bass, northern pike, and migratory rainbow trout)	**Habitat:** In the upper main-stem, channelization may result in a loss in the variety of macro-habitat (i.e., riffle/pool sequences) and substrate conditions.	Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools).
		In the lower main-stem, excessive water temperatures and low flow conditions may limit rainbow trout production. Inadequate summer base flows may also limit the abundance of northern pike.	Determine if low summer base flows are accentuated by water taking permits, agricultural drainage issues, or lack of riparian wetland. It is important to note that resolving these issues for the entire watershed will likely have more appreciable results than if these issues were only addressed for the main stem. Protect wetlands.
		Inadequate information on: rainbow trout spawning success	Evaluate rainbow trout spawning locations and success.
		Potential Point Source Pollution: Sewage facilities from the Town of Lucan discharge to the Little Ausable River.	Continue to monitor water quality at Lucan. Evaluate trends in the concentrations of inorganic forms of nitrogen and phosphorus.

Fish Habitat Summary (Little Ausable - warm water tributaries)

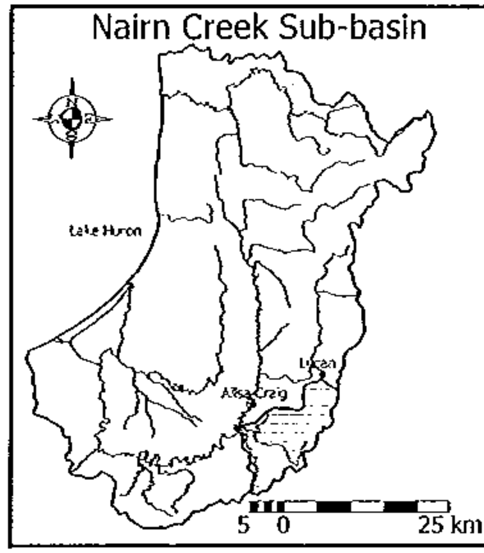
Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
warm water tributaries warm water fish community comprised of forage fish	warm water fish community comprised of forage fish	**Habitat:** Channelization and low summer base flow limit fish habitat.	Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools). Investigate reasons for the low summer base flows.
		Many of the first order streams do not have treed buffer strips.	Encourage practices that increase stream-side cover and headwater forest.
		On-line rock dams block fish migration and their failure could result in the introduction of excessive silt (*Winchelsea Drain*).	On-line ponds are not typically permitted by ABCA.
		Inadequate Information on: stream temperatures in Huron County (i.e., the upper *Elimville* and *Winchelsea Drains*).	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.

Priority Projects

1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin.

2. Investigate the success of rainbow trout spawning. Consider the expansion of spawning habitat if trout are successfully reproducing in the Little Ausable.

NAIRN CREEK - 129 KM^2



BACKGROUND

Location: The headwaters of this sub-basin rise south of Lucan. Nairn Creek meets the Ausable River south of Ailsa Craig. Bear Creek, a main tributary of Nairn Creek, flows north and joins Nairn Creek just upstream of Nairn's confluence with the Ausable River. The Nairn Creek is known as the Denfield Creek or the Stanley Creek Drain

Sub-surface Geology: This sub-basin predominantly drains a tightly-bound Rannoch till. However, there are extensive areas of sand deposits near the confluence of the Nairn, Bear and Ausable systems. An isolated gravel deposit in this sub-basin is the likely source of cold groundwater in Lenders Drain (Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 9 % of the sub-watershed. There are small riparian and headwater woodlots.

Fish Community: Historically, Nairn Creek system has provided cold water fish habitat. The 1999/2000 temperature surveys indicated that the cold water system is much restricted.

FISH COMMUNITY SEGMENT

Nairn main stem
Cold water tributaries: Lenders Drain, Carpenter Drain, Stumpf Drain, Watson Drain No. 2
Warm water tributaries: Bear Creek

Fish Habitat Summary (Nairn Creek - Nairn Creek main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
Main Stem warm water, migratory rainbow trout	cold water, with resident and migratory trout	**Habitat:** Excessive water temperatures and livestock access limit fish habitat.	Encourage projects that increase stream-side cover and reduce cattle access.
		Substrate in the upstream reach (north of Highway 7) is predominantly fine silt and clay. Gravel and cobble dominates the lower reach. The lower main stem provides good riffle/pool sequences and adequate discharge. The lower main stem provides substrate and flow conditions suitable for spawning trout.	
		Inadequate information on: low summer base flows. Are low flows accentuated by water taking permits, agricultural drainage issues, or lack of riparian wetland?	Investigate MOEE water taking permit authorization (i.e., numbers of permits and discharge permitted) in this sub-basin.
			Investigate the amount of land that is artificially drained in the sub-watershed.
			Investigate the amount of riparian and headwater forest in this sub-basin.
			Protect all wetlands.

Fish Habitat Summary (Nairn Creek - cold water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
cold water tributaries (cool, cold with resident and migratory trout population)	cool, cold with a resident and migratory trout population	**Habitat:** Excessive summer water temperatures may limit the potential for a resident salmonid fishery in some creeks.	Encourage the development of riparian cover that will shade the streams.
			Examine artificial drainage characteristics and % riparian cover to help determine which attribute is limiting the cold water potential of these creeks.
		Channelization may result in natural habitat loss.	Drain maintenance could allow for substrate and flow variability (i.e., riffles and pools).
		In-stream cover (i.e., boulders, undercut banks, logs etc.) is lacking.	Encourage practices that improve cover in these creeks.
		The transformation of open, surface drains to closed, tiled drains has occurred in this sub-basin. Investigation of air photos from 1975 to 1999 showed that 14% of open watercourses had been transformed to closed, tiled watercourses in this time period.	Evaluate the impacts of converting open, surface drains to closed, tiled drains. Drains near Carlisle might provide an excellent case study. Determine temperatures at tile out-falls, are they cooler than the open drain? Does the closed drain out-fall result in erosion?

Fish Habitat Summary (Nairn Creek - warm water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
warm water warm water, forage fish	cool water, with migratory trout	**Habitat:** Excessive water temperatures, low base flows, and livestock access limit fish habitat.	Encourage projects that increase stream-side cover and headwater forests. Reduce cattle access.
		Channelization and drain maintenance may result in natural habitat loss.	Drain maintenance should allow for substrate and macro-habitat variability (i.e., riffles and pools). Encourage bottom clean-outs only (i.e., remove silt) and leave shade on south side of the watercourse.
		Inadequate information on: low summer base flows. Are flows exacerbated by water taking permits, agricultural drainage issues, or lack of riparian wetland?	Investigate MOEE water taking permit authorization (i.e., numbers of permits and discharge permitted) in this sub-basin. Investigate the amount of land that is artificially drained in the sub-watershed.

Priority Projects

1. Temperatures recorded during roadside habitat assessments in 1999 and 2000 suggested that many sites were warm water. However, brook trout were collected in some creeks suggesting that there must be pockets of cold water recharge between the road crossings. The number of sites at roadside crossings with warm water temperatures is disconcerting for this cold water habitat.

2. Maintain cool/cold water designation of the tributaries. One approach that may provide further protection to this area is to designate cold water streams, as verified by stream assessments conducted in 1999 - 2000, as Environmentally Significant Areas (ESAs). Environmental impact studies would be required of developments affecting ESAs. All cold water streams in the Haldimand-Norfolk Region have been designated as ESAs since 1978. Due to topography and geology, there are far fewer creeks in the ABCA area jurisdiction that have cold water potential and therefore, these creeks need protection.

   A sensitive area study is being completed for Middlesex County. Cool/cold water stream attributes are being included in the study's sites criteria.

3. Protect all wetlands.

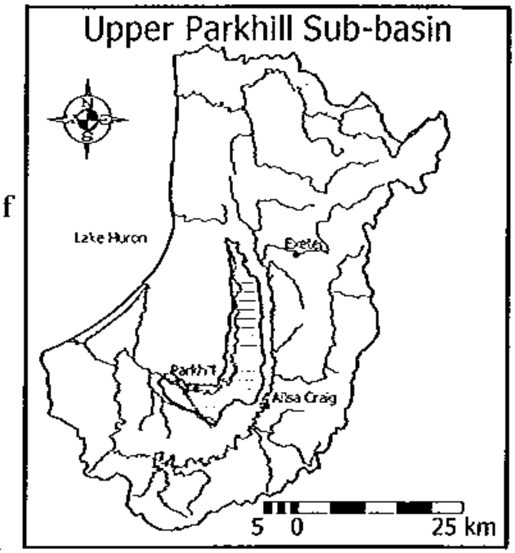
4. Investigate the forest distribution in the Nairn Creek sub-basin. Headwater forest and riparian forests should improve shading and potentially improve in-stream cover.

5. Investigate the effects of transforming open, surface drains to closed, tiled drains in this sub-basin.

6. Ensure that the Drainage Superintendent is aware of the sensitivity of habitat in this sub-watershed. Clean-outs in some drains will require a site visit from Fisheries and Oceans, Canada staff. Thus, maintenance schedules need to reflect the additional site visit requirements.

7. Investigate the spawning success of rainbow and brook trout. Consider the expansion of spawning habitat.

UPPER PARKHILL - 147 KM^2



BACKGROUND

Location: This sub-basin includes the headwaters of the Parkhill Creek (east of Dashwood in Huron County) to the Parkhill Dam near Parkhill. The upper portion of Parkhill Creek is known as Mud Creek, or the Mud Creek Drain and the headwaters as Bender Drain.

Sub-surface Geology: This sub-basin drains a tightly-bound clay (St. Josephs till). However, the area immediately adjacent to the upper main stem drains organic soils (see Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 13 % of the sub-watershed. There is some ESA woodlots in the basin and extensive riparian cover above the reservoir.

Fish Community: The sub-basin is dominated by silty-clay tills and has poor infiltration. Tributary runoff is characterized by a reduction in base flow and increases in the frequency and magnitude of peak discharge. Fish communities are typically limited in these streams.

FISH COMMUNITY SEGMENT

Parkhill main stem
Warm water tributaries: McLean and Bice Drains, Morley-Robinson Drain, Ryan and Lewis Drains, Scott Drain, Cameron-Gilles Drain
Reservoirs: Parkhill

Fish Habitat Summary (Upper Parkhill - Parkhill main stem and warm water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
Main Stem warm water fish with top predators (particularly largemouth bass)	warm water fish with top predators (particularly largemouth bass)	**Habitat:** Although many sites have excellent cover and good shade, low summer base flow limits fish habitat.	Drain maintenance could allow for substrate and variability (i.e., riffles and pools). Protect and rehabilitate wetlands.
		Much of the headwaters do not have treed buffer strips.	Encourage practices that increase stream-side cover in the headwaters
		Turbid waters indicate both sheet and bank erosion.	Encourage upstream projects that reduce sediment inputs.
		Inadequate information on: Are low summer base flows accentuated by water taking permits, agricultural drainage issues, or lack of riparian wetland?	Investigate MOEE water taking permit authorization (i.e., numbers of permits and discharge permitted) in this sub-basin.
Warm water tributaries (forage fish)	warm water fish with top predators	**Habitat:** Cattle access, low flow, eutrophication, little cover (i.e., boulders, overhanging vegetation, etc.) and little stream structure (i.e. riffle/pool/run sequences) limit fish habitat.	Encourage projects that reduce cattle access. Drain maintenance could allow for substrate and macro-habitat variability (i.e., riffles and pools).

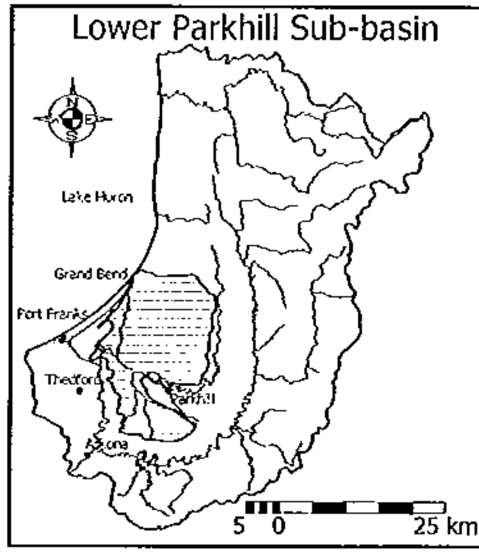
Fish Habitat Summary (Upper Parkhill - Parkhill Reservoir)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
Parkhill Reservoir (warm water with largemouth bass and white crappie).	warm water with largemouth bass and white crappie	**Habitat:** Water turbidity and a low standing crop of aquatic vegetative limits fish habitat.	Carp are known to suspend fine sediment and dislodge aquatic macrophytes. Some efforts have been made to reduce carp numbers however, if the habitat is perfect for carp, it is an uphill battle to eradicate this species. Efforts would be better realized in encouraging projects that reduce the introduction of fine sediment into the upper reaches of Parkhill Creek (Mud Creek).
		There is little littoral zone in this reservoir. Some anglers feel there is insufficient cover for crappie.	Investigate habitat concerns.

Priority Projects

1. Investigate potential options to provide cover for crappie in the Parkhill Reservoir.

LOWER PARKHILL - 310 KM^2



BACKGROUND

Location: The Lower Parkhill sub-basin includes the Parkhill Creek from below the Parkhill Creek Reservoir to the mouth, which was constructed at Grand Bend in 1893.

Sub-surface Geology: This sub-basin predominantly drains a tightly-bound (silt/clay mixture) St. Joseph till and lacustrine deposits of clay. Muck deposits exist in the vicinity of the old shallow lake, Lake Burley (later Lake Smith) (see Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 14 % of the sub-watershed and is mostly riparian and headwater woodlots. There are areas with extensive riparian cover (i.e., Ptsebe Creek and Parkhill Creek main stem).

Fish Community: The sub-basin is dominated by clay tills with poor infiltration. Tributary runoff is therefore, highly variable with short periods of high discharge and long periods with extremely low base flows. Fish communities are typically limited in these intermittent streams. However, the main stem of the river provides good cover, good shade, adequate discharge and diverse bottom substrate.

FISH COMMUNITY SEGMENT

Parkhill main stem

Warm water tributaries: Ptsebe Creek, Moray Creek (Prance Creek Drain), Canada Company North Drain, Defore Drain, Goosemarsh Drain, Ratz Drain and Desjardine Drain

Fish habitat Summary (Lower Parkhill - Parkhill main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
Main Stem warm water fish with top predators (largemouth bass and white crappie. Migratory rainbow trout are incidental.)	warm water fish with top predators (largemouth bass and white crappie.)	**Habitat:** Bank erosion and resulting turbidity and sediment deposition may limit habitat. Some erosion may occur with the rise and fall of water in the Parkhill reservoir. However, this creek has a clay bottom and some turbidity has to be attributed to this natural feature.	Encourage practices that reduce upstream sediment inputs.
		Dredging at the mouth of Parkhill Creek at Grand Bend may disrupt nursery and feeding areas.	Use *Fisheries Act* to mitigate effects of dredging.
		Inadequate information on: the success of spawning efforts by smallmouth bass and rainbow trout.	Investigate spawning success of smallmouth bass and rainbow trout.
		Potential Point Source Pollution: Sewage facilities discharge into Parkhill Creek at Parkhill and two locations in Grand Bend.	Consider collecting water samples from the lower Parkhill Creek. Analysis and evaluation of inorganic nitrogen and phosphorus concentrations would be beneficial.

Fish Habitat Summary (Lower Parkhill - warm water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
warm water tributaries warm, forage fish	warm, diverse forage communities	**Habitat:** Good cover and riparian vegetation present for many tributaries.	
		Coarse stream bottom material available in some tributaries (i.e., *Ptsebe Drain).*	
		Low base flow conditions result in standing water in pools.	Investigate the reasons for the low summer base flows.
		Excessive aquatic vegetation growth and high turbidity obvious at some sites.	Encourage practices that reduce nutrient and sediment inputs (i.e., buffer strips and restrict livestock access).
		Some drains are very wide and shallow with simple channel structure (i.e., few riffle, pool, run sequences - *Desjardine Drain*). These channels are also isolated from their floodplains.	
		Artificial drainage patterns (i.e., headwalls) discourage fish migration.	Recognize that highly artificial watercourses draining the old Lake Smith area are likely to provide unique drain maintenance requirements.
		Inadequate information on: Temperatures and fish habitat for watercourses in Stephen Township.	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.

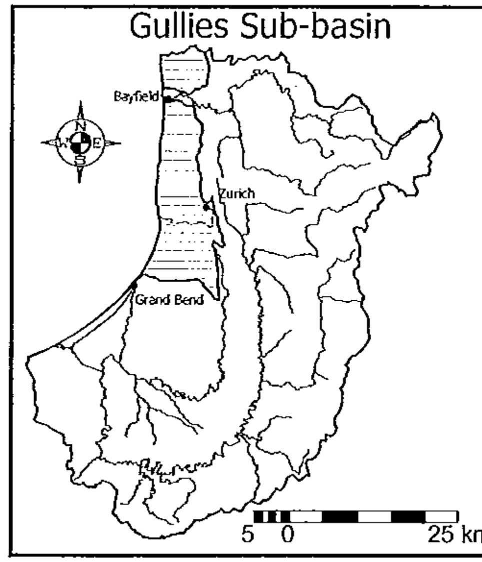
Priority Projects

1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin.

2. The sub-surface geology map indicates there are fluvial gravel deposits in Ptsebe Creek. The relatively coarse substrate, potential for groundwater discharge and good cover should provide good fish habitat. However, we found remarkably few species (i.e., creek chub and carp) during recent fishing surveys (1999). Future efforts might investigate the factors that limit fish community diversity in this creek.

3. Recognize that highly artificial watercourses draining the old Lake Smith area are likely to provide unique drain maintenance requirements. For overall ecosystem integrity, this area should be rehabilitated to its former wetland state.

GULLIES - 241 KM^2



BACKGROUND

Location: This sub-basin is comprised of numerous tributary systems flowing west into Lake Huron. A gully is defined as a water erosion feature, having a head and a mouth and constant or intermittent discharge.

Sub-surface Geology: This sub-basin predominantly drains a tightly-bound St. Joseph till. However, north of the Bayfield River there are extensive sand deposits (see Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 13 % of the sub-watershed. However, in the more forested area, north of the Bayfield River there are high ranked ESA's and the Bayfield North ANSI. Wood-lot area decreases in the southern gullies (see Figure 1.1.4).

Fish Community: In basins with silty-clay tills (southern gullies), tributary runoff has periods with low base flows. Fish communities are typically limited in these intermittent streams. However, there are some streams that have gravel substrate that provide opportunity for groundwater discharge. These streams may therefore, have sufficient base flow during dry periods. There is also potential for these streams to provide cold water fish habitat.

FISH COMMUNITY SEGMENT

Cold water tributaries: Gully Creek, and two Unnamed Tributaries (Unknown Goderich L and M)

Warm water tributaries: many unnamed tributaries, Zurich Drain

Fish Habitat Summary (Gullies - cold and warm water tributaries)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
cold water tributaries (migratory salmonid populations)	cool, cold with migratory salmonid populations	**Habitat:** Excessive summer water temperatures may limit the success of migratory salmonid fishery in some tributaries.	Encourage the development of riparian cover that will shade the streams.
		Highway 21 and related infrastructure may provide a fish barrier along many tributaries.	Determine the potential for Highway 21 crossings to restrict fish movement.
		Inadequate information on: Stream temperatures and fish habitat.	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.
warm water tributaries warm, bait fish	warm, diverse forage communities	**Habitat:** Many tributaries that rely on surface drainage may be intermittent.	
		In other tributaries there is good riffle/pool sequences, large cobble, woody debris, deep pools, and coarse substrate.	
		Inadequate information on: Stream temperatures and fish habitat.	Measure stream temperatures following Stoneman and Jones, 1996 and conduct habitat assessments.
		Potential Point Source Pollution: Sewage facilities from the Town of Zurich discharge to Zurich Drain.	Evaluate trends in the concentrations of inorganic nitrogen and phosphorus.

Priority Projects

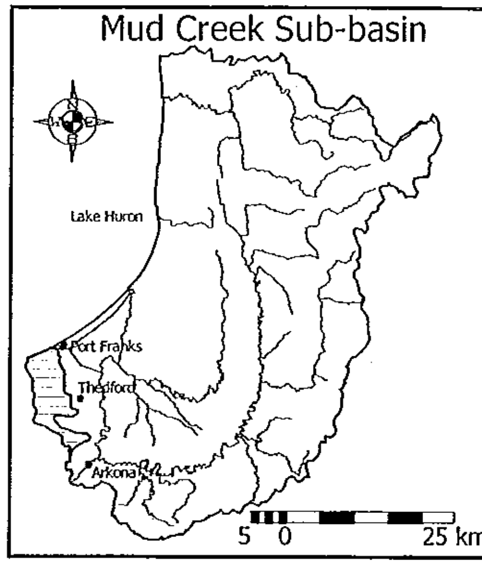
1. Conduct habitat assessments (including temperature evaluations) in all watercourses in this sub-basin. Creeks that appear to have gravel substrate as indicated by the subsurface geology map include: Unknown M Creek, Armstrong Drain, Taylor-Greer Drain, Talbot Watson Drain, Unknown Stanley G Drain, Bechler-Durand Drain and Dysdale Drain. These drains may provide adequate base-flow during drought conditions.

2. Identify barriers to fish migration. Several dams were located within this sub-basin (ABCA 1991). Further investigation of the function of these dams and other potential fish barriers (such as perched culverts, weirs, and in-line stormwater management ponds) is warranted.

3. Interview land owners of dams to determine utility of these structures. One dam (ABCA 008, ABCA 1991) was partially washed out in the spring of 1991. ABCA 1991 cautioned that further dam disruption might result in silt movement from the reservoir. Further investigation and possible repair of this structure is warranted.

4. There are reports of the Redside Dace in Gully Creek (MNR 2001). This species is recorded on Index list of vulnerable, threatened, endangered, extirpated or extinct species of Ontario (May 10, 2000). The present cold water classification of this creek and reported occurrence of the threatened Redside Dace warrant further fish survey work in this creek. Investigators from the Royal Ontario Museum may be interested in further sampling Gully Creek and environs.

MUD CREEK - 64 KM^2



BACKGROUND

Location: Originally, Mud Creek was a tributary to the Ausable River. The location of the Ausable River mouth changed and now Mud Creek flows into Lake Huron at the original outlet. Mud Creek is also known as Jericho Creek or Mud Creek Drain.

Sub-surface Geology: This sub-basin predominantly drains a dense St. Joseph till. Sand deposits are found along the Lake Huron Shore and west of Thedford (see Figure 1.1.2).

Land Use: Agriculture is the dominant land use. Forest and wetland cover is approximately 26 % of the sub-watershed and is mostly north of Highway 21.

Fish Community: The main stem of the river provides good cover, good shade, adequate discharge and diverse bottom substrate. Some of the headwater tributaries lack adequate flow.

FISH COMMUNITY SEGMENT

Mud Creek main stem
Warm water tributaries: Golden Creek, 10th Concession Drain

Fish Habitat Summary (Mud Creek - main stem)

Segment and Current Designation	Fish Community Objective	Issues	Potential Actions
Main stem warm water, white crappie and migratory rainbow trout	warm water fish with northern pike, white crappie and migratory rainbow trout	**Habitat:** Good cover and riparian vegetation present for the main stem and for many of the tributaries.	
		Adequate discharge exists for the main stem. However, there is very little macro-habitat diversity (i.e., riffle, pool, run sequences) in the creek.	Drain maintenance could allow for substrate and flow variability (i.e., riffles and pools).
		Fine sediment dominates at most road crossings. This material may limit fish species that prefer coarse substrate.	Encourage practices that reduce sediment inputs.
		Associated wetlands (such as L lake) provide good habitat for crappie and pike.	Protect all wetlands.
		Inadequate information on: Aquatic macrophyte beds used to be extensive in lagoons in Port Franks (1949). Do these expansive riparian wetlands exist today? Do they provide nursery or spawning habitat?	Educate landowners about the benefits of aquatic plants. Identify factors responsible for the macrophyte abundance.
		Fish species currently found in this sub-basin.	Conduct fish survey.
warm water tributaries warm, forage fish	warm, diverse forage communities	**Habitat:** Low base flow conditions result in standing water in pools.	Investigate the reasons for the low summer base flows.
		Tributaries are typically turbid and fine sediment dominates stream bottoms. Much of the fine sediment is a result of the clay material in this basin.	Encourage practices that reduce sediment inputs.
		Channelization may result in natural habitat loss (i.e., riffle, pool, run sequences).	Drain maintenance could allow for substrate and flow variability (i.e., riffles and pools).
		Inadequate information on: Fish species found in this basin.	Conduct fish surveys.

Priority Projects

1. Complete fish habitat assessments (particularly fish surveys) in Mud Creek.

2. Identify factors that are determine the abundance and distribution of extensive macrophyte beds in Port Franks. Consider the effects of dredging and landowner plant removal.

3. 0 CONCLUSIONS AND RECOMMENDATIONS

3.1 General Conclusions and Recommendations for the ABCA area

Fish habitat potential is based on both natural features and land use practices. Important natural features include sub-surface geology and the amount of forest and wetland cover in the drainage basin. The sub-surface geology for the Ausable-Bayfield Conservation Authority (ABCA) area is comprised predominantly of fine till with poor infiltration (Table 3.1.1 and Figure 1.1.2). Typically, watercourses draining areas with poor infiltration are turbid and have low summer base flows and warm temperatures. Areas in the ABCA with more coarse till have some watercourses with adequate summer discharge and cooler temperatures. For example, more watercourses in the Bayfield sub-basins have cool water potential (Table 3.1.1). The high number of cool water streams in the Bannockburn sub-basin likely represents marginal cool water temperatures. These streams likely provide habitat for migratory salmonids. Sub-surface geology is not the only characteristic determining fish habitat however, it is an important consideration for the natural potential for warm and cold water fish communities.

The amount of wetland and forest present within a watershed has also been recognized as an important factor in determining water quality and quantity (Environment Canada et al. 1998). In an effort to improve the water quality in the Great Lakes, restoration targets for vegetative cover have been established for the major watersheds. Forest cover targets of *30 per cent* were recommended. The targets for wetland rehabilitation is to have *greater than 10 per cent of each major watershed in wetland habitat, greater than 6 per cent of each sub-watershed in wetland habitat, or restore to original percentage of wetlands in the watershed. Streams should have a 30 m wide naturally vegetated buffer on both sides.* (It was recognized that soil type, slope, and adjacent land use alter the effectiveness of the buffer strip. It should be noted that at a current workshop on buffer strip management {June 2000}, officials from the United States Department of Agriculture (USDA) recognized that any width buffer is better than no buffer.) These target percentages are suggested by Environment Canada et al. 1998. In the ABCA area, some sub-basins such as the Lower Ausable and Mud Creek are between 25 and 30 % naturalized (Table 3.1.1). However, headwater sub-basins (i.e., Upper Bayfield, Ausable Headwaters and the Little Ausable) are typically less than 10 % naturalized. Increased forest and wetland cover in these headwater areas might improve water quality and aquatic habitat conditions.

Overall, the ABCA area provides habitat for approximately 80 fish species. However, the distribution of some of the more sensitive fish species (i.e., warm water intolerant species, such as trout, or sediment intolerant species, such as walleye) may be limited by land use activities that increase fine sediment deposition, increase temperatures or modify stream hydrology. Thus, the most important future project considerations from a fish habitat perspective, are those that address these alterations. Reductions in sediment deposition, water temperatures and improvements to stream hydrology also benefit water quality and habitat for other aquatic organisms.

Table 3.1.1: Summary of Size, Sub-surface Geology, per cent Natural Area and Number of Cold Water Streams for the 14 Sub-basins in the ABCA area.

Sub-basin	Sub-basin Area (km^2)	Sub-surface Geology	% Woodlot	%Wetland	% Natural Area[a]	Number of Cold Water Streams
Upper Bayfield	72	fine till coarse till	6.0	0.4	6.1	4
Lower Bayfield	82	fine till coarse till sand	19.0	1.5	19.1	6
Bannockburn	107	fine till sand	9.2	0.4	9.4	7
Ausable Headwaters	98	fine till coarse till	8.5	0.3	8.6	0
Upper Ausable	241	fine till	9.7	2.3	10	0
Middle Ausable	230	clay fine till	12.2	0.7	12.3	1
Lower Ausable	200	fine till sand organic muck	27.1	6.5	27.2	1
Black Creek	119	sand	18.0	12.3	20.0	1
Little Ausable	153	clay fine till	5.9	0.1	6.0	0
Nairn Creek	129	fine till	8.6	0.5	8.9	4
Upper Parkhill	147	fine till	12.8	0.2	12.9	0
Lower Parkhill	310	fine till clay organic muck	13.7	0.6	13.7	0
Gullies	240	fine till	12.9	0.4	13.0	3
Mud Creek	64	fine till	25.3	0.7	25.7	0

[a] The total per cent of wetland and woodlot in the sub-basin. The wetland value may also comprise some wetted woodlot therefore, the natural features value may be less than the sum of wetland and woodlot components.

3.1.1 Stewardship Practices

Erosion Control

The deposition of fine sediment can reduce spawning and feeding habitat for fish and reduce habitat for benthic invertebrates. Therefore, practices that reduce erosion are important considerations that may improve freshwater habitat in the basin. The following practices are recommended and supported by local OMNR stewardship councils and conservation authorities.

1. Conservation tillage is an agricultural practice that results in at least 20 to 30 percent of the soil surface remaining covered with residue from the previous crop. The residue helps protect the soil surface from wind and water erosion.
2. Streambank stabilization practices such as restricting livestock access, rotational grazing, and buffer strips are activities that reduce bank erosion. Across the landscape, it should be recognized that stream bank erosion from flashy streams may partially be the result of a lack of forest cover in headwaters. Initiatives to promote forest in headwater tributaries should therefore, be encouraged.
3. Incorporate silt traps in municipal drains. Construct several small pools in strategic locations (i.e., where the gradient is relatively flat with minimum turbulence) as they will capture more sediment than one pool which occupies a similar total surface area. If possible, sediment traps should be situated in accessible location for maintenance and inspection purposes. Properly maintained silt traps should reduce the frequency of bottom clean-outs and therefore, reduce maintenance costs over the long term (Reid 1988).

Site specific erosion control measures are best developed with technical assistance from the OMNR and ABCA. Soil conservation practices are well established best management practices (see Agriculture and Agri-Food Canada and Ontario Ministry of Agriculture, Food and Rural Affairs 1997). Agencies need resources for incentive grants to land owners and staff time to promote and implement projects.

Watercourse Temperatures

In the ABCA area, St Josephs and Rannoch till dominate the geology. The poor infiltration capabilities of these tills limit the number of cold water systems in the ABCA area. However, there are a few cold water streams that support migratory and resident trout in the ABCA jurisdiction (notably Tricks Creek and Nairn Creek). In 1999/2000, water temperatures measured from Nairn Creek exceeded the cool water temperature threshold (as determined by Stoneman and Jones 1996). The presence of brook trout in these watercourses suggest that there must be pockets of cold water between the road crossings. However, the number of sites with warm water temperatures in these cold water systems (particularly the Nairn Creek sub-basin) suggest that cold water fish habitat is being constrained to very small areas.

To promote cold water temperatures in these systems, riparian land use should be forest (particularly the headwaters of these systems), wherever possible. The ABCA and other water management agencies should not encourage other land use on these lands. Further examination of the distribution of riparian forest through air photo interpretation would be essential to highlight those areas that require stream-side cover.

To promote the number of cold water streams in the ABCA watersheds, potential cold water candidates could be determined from the sub-surface geology map (Figure 1.1.2). This map shows the fine and coarse till deposits within the ABCA jurisdiction. Areas with gravel deposits may provide ground water discharge to creeks and therefore, provide a consistent supply of cold water to a watercourse. For example, there are extensive areas of coarse moraine north of the Bayfield River both east and west of Clinton. There are also areas near Seaforth and Staffa where there are pockets of coarse material. The Bannockburn and Black Creek systems drain sandy material and therefore, may also have potential for ground water discharge. When considering creeks for improvement, streams that drain these coarse moraine areas may have more potential than other streams because they may have more permanent discharge.

It is also important to note that many watercourses that have ground water discharge due to coarse sub-surface geology may also have associated aggregate activities in the basin. The extraction of aggregate may promote warm water temperatures in nearby watercourses. Therefore, future aggregate extraction facilities should be examined for impacts to groundwater amounts and temperatures.

Stream Hydrology

Perhaps the most noticeable characteristic of watercourses in the ABCA area is the intermittent nature of many headwater tributaries. This is not a recent development. The 1949 review of the Ausable River watershed also indicated that many watercourses dried to standing pools in the summer (Department of Planning and Development 1949; Figure 1.1.5). Intermittent watercourses may be a result of the impermeability of the till plain geology and annual precipitation patterns. However, land use activities may accentuate these natural conditions. The lack of forest cover and wetland in the headwaters may in part, explain the low summer base flows. Drainage activities (i.e., systematic or random tiling of fields) in seepage areas and the removal of instream structures (i.e., riffles, pools and meanders) that retain the water in the headwater tributaries, may also contribute to the flashy systems (Newbury and Gaboury 1993). Activities such as, irrigation from watercourses that have depleted base flows may further deplete the base flow. Solutions are difficult, particularly when the intermittent nature is to some extent the result of natural conditions (i.e., precipitation or impervious soil).

Although, base flow conditions are currently considered when issuing water taking permits (OMOEE 2001), the monitoring of irrigation activities and their impact on fish habitat is currently not addressed. The ABCA has a lead role in managing water resources in drought conditions through Water Response 2000 and should consider sensitive fish habitat when future water allocation budgets are designed.

Protection and rehabilitation of wetlands should be encouraged, as these areas provide water to downstream areas. Wetlands not only augment summer base flow but also provide critical spawning habitat to fish such as northern pike. Important wetland areas in the ABCA area include Hay Swamp and part of Hullet Marsh. Wetlands are also scattered throughout the landscape (see Figure 1.1.3) and these areas should be protected, regardless of evaluation scoring. (Wetlands were evaluated and scored in the 1980's and 1990's by the OMNR mainly according to species composition. Hydrologic characteristics may have been undervalued.) Because wetland areas are so scarce in the ABCA area, all remaining wetlands should be protected.

To promote the number of wetlands in the ABCA area, potential wetland candidates could be determined from the sub-surface geology map, or from a soils map. Areas with high organic matter may have been wetlands prior to drainage. For example, possible wetland areas include Lake Smith (north of Thedford) and the upper Parkhill Creek. Furthermore, the OMNR (Clinton District) has Wetland Series data (1982) for the ABCA area. These maps illustrate, at a scale of 1: 50 000, the current and past location and characteristics of wetlands. These maps could identify potential wetland rehabilitation sites and also provide data regarding the amount of wetland that has been lost since settlement times.

Additional Aquatic Habitat Considerations

One current attempt to balance the drainage of agricultural land and aquatic habitat is the Drain Classification Project. Municipal drains are classified according to current information about water discharge, temperature, physical stream attributes (i.e., sediment size, width, depth, and riffle/pool distribution), and fish communities. Maintenance of the drains have specific timing restrictions according to its classification (A through F) (Appendix 3). Drain maintenance activities are not authorized during critical life history periods (i.e., spawning). These measures may help to minimize habitat alteration however, may not address hydrologic issues. Thus, further examination of the impacts of drain maintenance on the hydrology in headwater tributaries, particularly for natural channel sinuosity and loss of macro-habitat features (i.e., riffles and pools) should be examined.

A 1991 Environmental Youth Corps Survey identified 41 dams in the ABCA area. Some of these dams may no longer serve their intended purposes. Some dams were found in poor condition. Many dams were located in areas that support sensitive fish habitat (i.e., the lower Bayfield, Bannockburn, upper Gullies and lower Ausable sub-basins). Therefore, future initiatives should re-examine the intended purpose of the 41 dams and ensure that dams that were in ill-repair have been fixed. In addition to the dams inventoried, there are additional barriers to fish movement such as perched culverts, weirs, and in-line storm-water management ponds in the ABCA area. The location of these additional fish barriers should also be identified.

3.1.2 Monitoring and Future Studies

Maintain and Update Key Data

Ongoing implementation of this plan or the watershed management strategy (Snell and Cecile Environmental Research 1995) requires the most current and accurate data. The most critical data necessary to implement strategies regarding land use and aquatic habitat/water quality include: watercourse data, wetland and woodlot information, fish habitat information and water quality data. The watercourse layer should be ground-truthed to ensure that watercourses are not closed. The wetland and woodlot information is based on OMNR Ontario Base Mapping 1985, interpreted from aerial photography. These data should be updated. The fish habitat information (Drain Classification Project) is current but will need to be maintained. The provincial water quality data collected from the Provincial Water Quality Monitoring Stations (PWQMS) needs to be summarized. These key data need to be accurate and current when providing information to the public, when projecting future scenarios and when comparing past and present conditions.

Water Quality Data

Water quality trends (particularly for inorganic phosphorus (P) and nitrogen (N) concentrations) should be evaluated on an annual basis. This issue was recommended in the Watershed Management Strategy (Snell and Cecile Environmental Research 1995). A recent report conducted in Huron County found P concentrations at seven of nine PWQMS have been reduced from 1990 to 1998 (Bonte-Gelok and Joy 1999). Three of the nine PWQMS are in the ABCA jurisdiction and two of these stations reported the same trend. Although there were reductions in P concentrations, nitrate concentrations and faecal coliform counts increased at some of the same stations. Since PWQMS in the ABCA area are typically downstream of municipal sewage treatment plants, improvements made to the quantity and quality of municipal waste may be reflected by reduced P concentrations. The annual evaluation of P and N concentrations may help to prioritize sub-watersheds that require nutrient management strategies.

Benthic Invertebrate Monitoring Program

Chemical and microbial analysis of water are typically the main measures of water quality. These measures are an essential component of a watercourse health monitoring program as they address drinking water, recreation and agriculture issues. However, using only chemical analyses to assess watercourse health has limited application because spills may go undetected; knowledge of water chemical concentrations does not always provide accurate information about the biological availability of certain compounds; chemicals may interact with each other and with other environmental factors (e.g., hardness, pH and temperature) that alter their biological effect; and impacts on water resources resulting from channelization, flow and temperature alterations or physical habitat destruction are not typically detected by chemical monitoring programs (Griffiths 1998).

Living organisms incorporate chemical and physical conditions and are therefore, excellent indicators of watercourse health. Furthermore, water pollution is defined by its affect on living organisms thus, assessment of watercourse health must incorporate biological endpoints. The abundance, distribution, and species composition of benthic macroinvertebrates (small organisms associated with the bottom of streams lakes) respond to changes in sediment, nutrient and contaminant loading and alteration of riparian habitat (i.e., maximum temperatures and daily temperature fluctuations and reductions in the amount of woody material entering the watercourse). Therefore, benthic macroinvertebrates are the most widely utilized group of organisms to evaluate watercourse health.

In the ABCA area, a benthic monitoring program was established in 2000. Twelve headwater sites of the main tributaries were sampled (Figure 3.1.1.). The biotic sampling will help to identify aquatic habitats that need protection or rehabilitation and will help to identify specific land use activities that may affect freshwater habitats. Preliminary results from the 2000 survey suggest that sedimentation and nutrient enrichment are affecting all tributary sites that were examined. Sampling these 12 sites in subsequent years will provide ongoing information about watercourse health for the headwaters of the main tributaries in the ABCA area.

Species At Risk

Future biological surveys should also incorporate species at risk. Species at risk are species that have been nationally listed as endangered, threatened or vulnerable. The Northern Riffleshell (*Epioblasma torulosa rangiana* Bivalvia: Unionidae) was found in the Ausable River. However, recent attempts to document their occurrence found numerous shells, but only two live animals (Staton et al. 2000). Fish species that warrant further investigation include the River Redhorse (*Moxostoma carinatum*) from the Ausable River. This species was last collected in 1936. There are reports of the Redside Dace (*Clinostomus elongatus*) in Gully Creek (MNR 2001). Investigators from the Royal Ontario Museum (Icthyology Department) might be interested in sampling Gully Creek and environs. The rare occurrence of these freshwater organisms warrant further survey work in the ABCA jurisdiction, particularly if their disappearance is a reflection of degraded aquatic habitat conditions.

Municipal Drain Classification Project

The municipal drains in Huron and Perth Counties were classified according to fish habitat potential as part of a Drain Classification pilot project (1995). However, the classifications were not based on the Department of Fisheries and Oceans protocol that is currently used for the Southwestern Ontario Drain Classification Project.

Figure 3.1.1: Ausable-Bayfield Conservation Authority
Benthic Invertebrate Sampling Sites (2000)

Therefore, the ABCA should revisit Huron and Perth Counties and take temperatures in accordance with the methodology outlined in Stoneman and Jones 1996 (as described by the Department of Fisheries and Oceans Action Plan on Fish Habitat see Appendix 2). Reevaluation of watercourse temperatures and habitat should provide consistent data for the entire watershed.

During the 1999/2000 fish habitat survey, it was observed that some open, surface watercourses had been closed and tiled. The costs and benefits of this activity have not been documented. The closed and tiled watercourse is no longer providing habitat for freshwater organisms, however, the water inside the tile may be cooler and contain less sediment and may therefore, benefit downstream fish habitat. The lack of information regarding the potential costs and benefits of closing drains and the extent to which this activity is occurring in the entire ABCA basin needs to be addressed before the effects of drain closures on aquatic habitat is understood.

Walleye fishing in the Ausable River is considered quite good (Ausable Anglers 2001). There is, however, a lack of information about the distribution and abundance of these fish. There is also limited information about the success of reproductive efforts of Pacific Salmon in both the Ausable and Bayfield systems. Further examination of the location of spawning activities and spawning success of walleye and Pacific salmon would help to expand habitat and potentially increase population abundance for these game fish species.

3.1.3 Education and Public Awareness

Promote Fishing

All agencies should promote fishing. The OMNR has events such as Family Free Weekend and Take a Kid Fishing Week. The ABCA should encourage angling opportunities by ensuring that the authorities' properties have facilities that support fishing and supporting events like the Ausable Angler Annual Carp Classic fishing derby. The ABCA should continue to hold and advertise fishing derbies and invite the Ausable and Bayfield Anglers to show the public how to fish on these days. (Some feel that the admission charge to the current event discourages potential anglers. Perhaps finding local sponsors for this activity might offset the cost.) Promoting angling is important because it provides local residents with opportunities to value local aquatic resources.

The Education Department at the ABCA might also consider incorporating a fish habitat program. Such a program might focus on attributes of fish habitat (i.e., water quantity and quality, see Section 1.1.3) and issues that may locally compromise habitat attributes (i.e., low to intermittent summer base flows, sedimentation and water temperature increases). Courses could be offered to local schools and youth groups. Another possible means to promote local fisheries is to depict the fish species found in the ABCA area on the ABCA web site. A brief synopsis of important life history traits and habitat requirements might also be included.

A new concept in tournament fishing is gaining popularity in southern Ontario. Shorefishing Tournament Series (STS) are tournaments that take place from shore. Winners are based on total cumulative weight of fish caught during each event and any species of fish counts. Cash pay backs, prizes and prestige are the incentive for anglers to improve shorefishing techniques. Again this type of event educates the public on overlooked angling opportunities that exist in many local water bodies.

Private Landowners

The majority of land in the ABCA area is privately owned. Landowner concerns for fish habitat and the protection of fish habitat must be recognized and addressed. One frequently mentioned issue pertaining to fish habitat in municipal drains is that some of these drains were excavated and that by constructing the watercourses, landowners actually created fish habitat. Therefore, one study that landowners would like to see is an historical analysis of the creation of specific drains. This analysis should not alter drain maintenance procedures. However, recognition of various contributions to fish habitat made by landowners is an important first step to improving aquatic resources across the ABCA landscape.

3.1.4 Summary Recommendations for ABCA watersheds

Immediate Actions:

1. Examine riparian forest amounts for the entire ABCA area. Test the hypothesis that much of the riparian lands seem to be on the lower main stems of the main rivers compared to tributaries;
2. Identify possible wetland rehabilitation areas;
3. Future rehabilitation for streams and wetlands should consider sub-surface geology;
4. Apply class-authorization conditions to mitigate impacts of municipal drain maintenance activities;
5. Update information from 1991 dam survey;
6. Update fish habitat and temperature assessments in Huron and Perth Counties;
7. Update and/or ground-truth watercourse, wetland and woodlot data;
8. Investigate the potential for fish habitat educational programs (i.e., structured programs and web site information);

Recommendations to be implemented over time:

9. The ABCA with the OMNR should continue to encourage projects that reduce erosion and resulting sedimentation (i.e., tree planting and conservation tillage);
10. Cold water habitat is limited. Riparian land use should be forest, this is particularly essential in headwater areas;
11. Protect all wetlands, regardless of evaluation scoring;
12. Annually evaluate N and P concentrations to help identify areas with relatively high nutrient concentrations;
13. Continue to use benthic macroinvertebrates as indicators of aquatic health;
14. Examine the location of spawning activities and spawning success of walleye in

the Ausable River;
15. Incorporate species at risk into future biological surveys;
16. Encourage angling opportunities; and
17. Recognize the important contributions private landowners make to aquatic resources.

3.2 Priority Sub-basins

3.2.1 Criteria for Prioritizing Sub-basins

To maximize the use of limited financial resources, one important planning tool is to prioritize the sub-basins according to the fish habitat. Criteria used to prioritize fish habitat for protection/rehabilitation were developed with OMNR, DFO and ABCA staff. The criteria included the following:

1. **Current habitat potential**. Habitat potential is typically based on features such as discharge, temperature, substrate type and cover. However, discharge (more is better) and temperature (< 20 °C in the summer is better) are key determinants;
2. **Current land use stress**. Are urban or agricultural activities becoming more intensive in the sub-basin? Might these activities impact the local watercourses?;
3. **Sensitivity of resource**. How sensitive are the desired fish species to the current land use?; and
4. **Fishing level.** Fishing level will likely reflect the current habitat potential (Criteria 1). Angler clubs may be involved in improvement projects which indicates relatively good fish habitat potential. Remember that angling activity responds in a pulse-like fashion to migrations from Lake Huron of species such as rainbow trout and walleye.

Proposed projects should also consider:

5. **Cost effectiveness**. Might the proposed project result in improved habitat for desired species? *or* Is project likely to have inconsequential effects on immediate habitat but perhaps add value for the sub-basin?;
6. **Community interest**. The general public might be interested in improvements to local watercourses;
7. **Educational purposes**. Some watercourses are in locations that are visible to more people and therefore, may inform more people about conservation practices; and
8. **Landowner interest.** This is key to ensure that the protection and rehabilitation efforts are maintained into the future.

Based on the above criteria, the Lower Bayfield and Nairn Creek were two sub-basins ranked as priority one (Figure 3.2.1). According to local anglers, the Lower Bayfield sub-basin provides rainbow and brook trout, chinook salmon and smallmouth bass fishing. The current habitat potential and fishing level stressed the protection of fish habitat in this sub-basin. Nairn Creek was considered a top priority due to the sensitivity of the resource (i.e., few watercourses in the ABCA jurisdiction, particularly in the southern part of the basin, provide brook trout habitat) and pressure from current land use activities (forested area < 10 %). Future efforts to improve the fish habitat in the ABCA watersheds would be best spent protecting and expanding fish habitat in these areas.

Three sub-basins, Bannockburn, Black Creek and the Little Ausable were considered priority two (Figure 3.2.1). This determination was based primarily on fishing activity and angler involvement. Both Bannockburn and Black Creek have had recent stream improvement projects. The interest by local anglers in these sub-basins indicates that there is potential for better fish habitat. The Little Ausable is considered one of the 'nicest' local watercourses with good small-mouth bass, trout, pike and carp fishing (Ausable Anglers 2000). The location of key spawning habitat that supports these fish could be investigated. This could then be used to extend this habitat throughout the Little Ausable.

3.2.2 Specific Implementation Strategies for Priority Sub-basins

In addition to the recommendations that were summarized in section 3.1.4 for the entire watershed, the following projects may further promote the fish habitat potential in these priority sub-basins.

Drain Maintenance

Drain maintenance activities may result in fish habitat alterations (i.e., changes to riparian vegetation, substrate composition, and width: depth ratios). The municipal drain class authorization system was designed to minimize effects of drain maintenance on fish habitat. The effective implementation of this program is important for the entire ABCA area, but particularly critical for watercourses in the priority basins. Therefore, at the initial stage of implementation the ABCA should arrange effective meetings with Township Drainage Superintendents by:

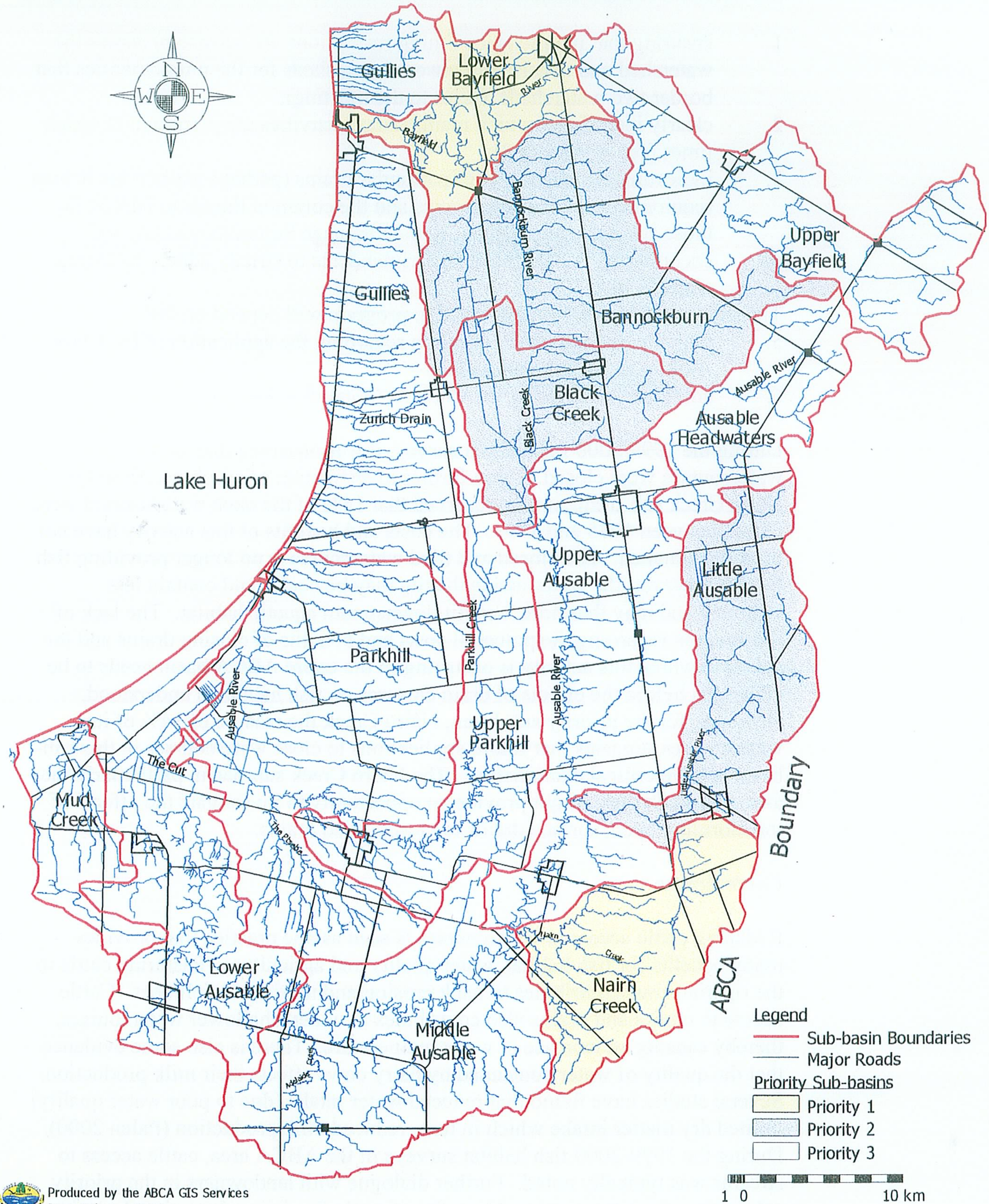


Figure 3.2.1: Priority Sub-basins for Fish Habitat in the Ausable-Bayfield Conservation Authority

1. ensuring that maintenance timing restrictions are consistent across the watershed and consistent between watersheds for the municipalities that border two watersheds, (prior to the meeting);
2. clearly identifying which maintenance activities are permitted at which times (see Appendix 3);
3. indicating the sensitivity of particular drains (perhaps explain the habitat requirements of the fish species and the common threats to habitat for those species - Appendix 1, to the Drainage Superintendents); and
4. encouraging the Drainage Superintendents to strictly adhere to timing restrictions.

The success of the Drain Authorization program will depend on the:

5. ongoing dialogue and education regarding the application of the Class Authorization program; and
6. continued monitoring the Class Authorization Program.

During the 1999/2000 fish habitat survey, it was observed that some watercourses were closed. Upon further investigation of air photos from the Nairn Creek sub-basin, it was observed that 14% of the open watercourses were closed between 1975 and 1999. The costs and benefits of this activity have not been documented. The closed and tiled watercourse is no longer providing fish habitat however, the water inside the tile may be cooler and contain less sediment and may therefore, benefit downstream aquatic habitat. The lack of information regarding the potential costs and benefits of closing drains and the extent to which this activity is occurring in the entire ABCA basin needs to be addressed before the effects of drain closures on fish habitat is understood. However, for the priority sub-basin, Nairn Creek the closure of 14% of its watercourses suggests that future applications to close watercourses in this sub-basin receive critical examination. The Nairn Creek sub-basin, particularly the area around Carlisle might provide an opportunity to investigate the effects of transforming open, surface drains to closed, tiled drains.

Cattle Access

Reducing cattle access to watercourses is seen as one practice that provides many benefits for fish habitat, water quality and agriculture. Pasturing cattle in the riparian zone contributes to bank erosion and nutrient enrichment. Cattle access to creeks and drains also contributes to wider, shallower watercourses, thereby causing an increase in water temperature. There is also some evidence that the quality of water consumed by dairy cows affects their milk production. Several studies have found that reduced water intake (due to poor water quality) limited dry matter intake which in turn, reduced milk production (Palen 2000). During the 1999-2000 fish habitat surveys in the ABCA area, cattle access to streams was typically noted. Further dialogue with landowners in the priority sub-basins about the costs and benefits of cattle fencing and rotational grazing of livestock might reduce cattle access to these streams which in turn, might promote vegetative turf and stabilize stream banks (Lyons et al. 2000).

Environmentally Significant Areas

The priority sub-basins (the Lower Bayfield and Nairn Creek) have areas that are currently recognized for their natural heritage features. The Lower Bayfield includes an 850 ha ANSI (Area of Natural and Scientific Interest). There are another four Environmentally Significant Areas (ESAs) in this sub-basin (average area = 71 ha). These areas are associated with riverine habitat however, the criteria used to designate ESAs are based on terrestrial community characteristics. Nairn Creek likewise, has scattered ESAs. Again, the three ESAs (average area = 42 ha) are based on terrestrial community characteristics (ABCA 1995). Current consideration of natural heritage features includes more than terrestrial community characteristics and fish habitat is one feature that is being considered (OMNR 1999). Further protection may be provided to fish habitat, in watercourses in the priority sub-basins, if they were recognized as natural heritage features.

All cold water streams, as mapped by the OMNR, were identified as ESAs in the 1978 Official Plan of Haldimand-Norfolk Region. This raised the profile of Norfolk's cold water streams and helped to protect them. Environmental Impact Studies (EIS) were required of developments affecting these ESAs. This plan was updated in 1995 and such streams are still protected within a new designation about stream corridors. The lack of habitat that supports brook trout in the ABCA area suggests that the summer water temperatures, water quantity and substrate composition (i.e., > 2 mm substrate) that permit brook trout in some watercourses be protected. In the ABCA area, the recent amalgamation of member municipalities means that the new municipalities will likely be reviewing their Official Plans. It is therefore, an opportune time for the ABCA to recommend that Nairn Creek and its tributaries and the Bayfield River below Clinton (and tributaries) be considered Environmentally Significant Areas or Natural Heritage Features.

There is, however, some concern that the current ESA designation may not provide adequate protection to some areas of significant natural heritage. It is imperative that areas that are recognized for their environmental significance (i.e., Nairn Creek and the lower Bayfield) be protected with Municipal by-laws.

Riparian Areas

Riparian buffer strips and headwater forests are understood to improve freshwater habitat, by providing shade (i.e., reducing water temperature) and reducing sediment loadings. Air photo interpretation of buffer strip widths (particularly for the tributaries) in priority sub-basins would be a valuable exercise. This data could be used to encourage the development of riparian cover in areas that currently lack riparian vegetation.

Fish Habitat Studies

For this plan, the priority sub-basins were chosen because their current habitat potential was considered to be relatively good. It would therefore, be beneficial to conduct more detailed fish habitat studies for key species to determine which attributes contribute to the success of these fish in this area. Investigations should quantify the distribution of spawning activity and reproductive success. Spawning activity can be determined by random egg collections. Larval drift samples provide information about juvenile success (Newbury and Gaboury 1993). This information could then be used to extend the habitat first, within the priority sub-basins and eventually to sites throughout the watershed.

Open House Meetings

Future grants may target specific action in the priority sub-basins. Therefore, open house meetings should be held in the five priority sub-basins to explain:

1. Fish habitat and sensitivity of fish habitat in the specific sub-basin; and
2. Best management practices that benefit fish habitat and water quality.

Sub-basin Management Plans

Sub-basin management plans for priority sub-basins are the next step in managing fish habitat in the ABCA area. The first step is to map the priority basins and include the following attributes on this map:

1. wetlands and woodlots;
2. Environmentally Significant Areas;
3. habitat issues such as: a lack of macro-habitat variability (i.e., pools and riffles), cattle access and sediment/erosion problems;
4. summer water temperatures;
5. sewage treatment plants, septic problems;
6. closed, tiled watercourses;
7. rare, endangered and threatened species;
8. drain classification letter;
9. barriers to fish migration (from 19991 survey) but additional obstructions should also be identified; and
10. water quality, benthic invertebrate, and fish sampling sites.

3.2.3 Summary Recommendations for Priority Sub-basins

1. Encourage Drainage Superintendents to strictly adhere to mitigation techniques for drain maintenance operations;
2. Investigate potential costs and benefits of transforming open, surface drains to closed, tiled drains in the Nairn Creek sub-basin and critically examine future proposals to close open, surface drains in this basin;
3. Approach landowners about costs and benefits of reducing cattle access in waterways;

4. Conduct air photo interpretation of riparian zones to determine areas that lack forest cover;
5. Recommend that Nairn Creek and its tributaries and the Bayfield River below Clinton (and tributaries) be considered Environmentally Significant Areas or Natural Heritage Features;
6. Conduct detailed fish habitat studies (particularly studies of spawning success and juvenile abundance) for key species to determine which local habitat features contribute to their success; and
7. Hold public meetings in priority sub-basins to explain fish habitat and the effects of particular land use practices on fish habitat.

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Appendices
Appendix 1: Fish Habitat Requirements

Habitat Requirements for Selected southern Ontario Fishes (the following information is taken from Scott and Crossman 1973 and Newbury and Gaboury 1993)

Species	General Habitat	Spawning habitat	Spawning time	Feeding	Threats to Habitat
Rainbow Trout	gravel riffles above pool (optimal temperature 18-21°C, oxygen >5 ppm)	gravel beds 10 -15° C	April/May	insects, crayfish	loss of riparian vegetation; siltation; migration blockage
Brown Trout	clear, clean, cold water	gravel areas in headwaters	fall	fish, insects, crayfish, molluscs	loss of riparian vegetation; siltation; removal of rocky substrates; alteration of flow.
Brook Trout	cold water near eddies, log dams, undercut banks, overhanging trees	gravel areas in headwaters (near areas of groundwater percolation preferred temperature 14-16° C)	September/ November	insects, crayfish, fish	loss of riparian vegetation; siltation; migration blockage; and reservoir creation.
Northern Pike	clear/warm/slow/ quiet/heavily vegetated water	weedy bays often in less than 1 foot of water 4-11°C	April/May	fish, frogs, ducks, muskrats	channelization (removes pools, backwaters, vegetation); water level fluctuation - low water may strand eggs or young; eutrophication and oxygen depletion
Smallmouth[A] Bass	clear, rocky waters with little vegetation 21°C	gravelly areas 16-18° 2-20 ft nest protected by rocks, logs, parents	June	fish, crayfish, insects	Sudden shifts in water levels or temperatures may inhibit eggs or larvae Slow, muddy waters may inhibit spawning
Largemouth[A] Bass	warm, weedy slow or still waters with mud bottoms 26 -27°C	emergent vegetation roots 1-4 ft 16-18°C	June	fish, crayfish, frogs	avoid low oxygen concentrations

Species	General Habitat	Spawning		Feeding	Threats to Habitat
		habitat	time		
White Crappie	silted streams, lakes, ponds and slow moving areas of larger rivers	rooted plants 8 -38 inches 16-20° C	June	fish, aquatic insects, crustaceans	
Black Crappie	clear, quiet warm standing waters or slow flowing rivers	sand/gravel/mud 10 - 24 inches	late May - mid July	invertebrates, small fishes	
Yellow Perch	clear water/ vegetation	shallow water	April/May	insects, crayfish, snails, fish	Increases in turbidity may reduce feeding efficiency
Walleye/ Pickerel	turbid, large lakes and rivers	gravel near high velocity areas 6-11° C	April/May	mainly fish	Channelization (loss of flow habitat diversity); siltation; migration blockage

[A] In waters with both large and smallmouth bass, largemouth bass spawn earlier. The shallower, protected waters warm to optimum temperatures sooner than deeper, rockier sites preferred by smallmouth bass.

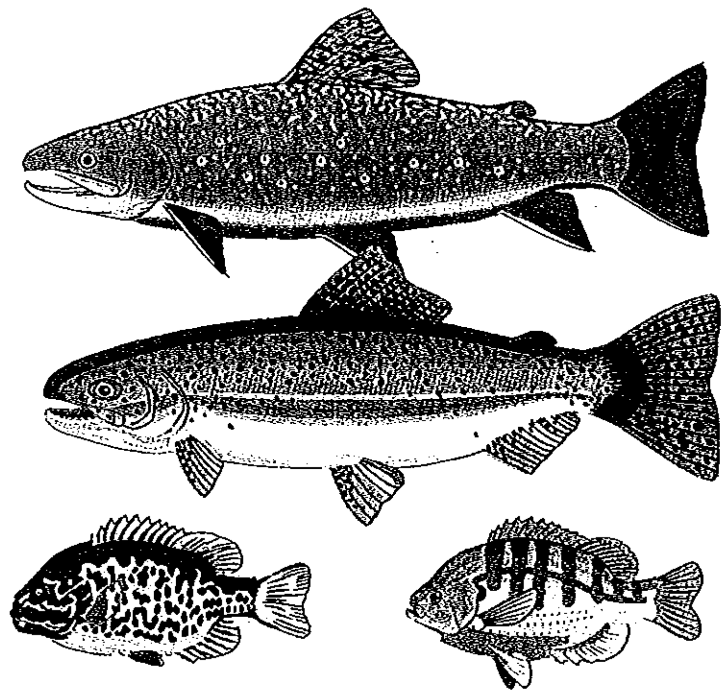
Appendix 2: Fish Habitat Survey Protocol (1999/2000)

A Simple Method to Determine the Thermal Stability of Southern Ontario Trout Streams

The average water temperature at a stream site is of vital importance to the survival and well being of trout. In particular, brook and brown trout require coldwaters not prone to large temperature fluctuations. Rainbow trout prefer slightly warmer (coolwater) temperatures. All three trout species tend to avoid areas of warmwater where darters, sunfish and minnows thrive.

In the past, water temperature regimes were monitored daily or weekly throughout the summer months to obtain a reliable estimate of the site's ability to buffer the effects of high air temperatures. Sites are considered coldwater, or thermally stable, if they remain cold even on very hot days. Conversely, warmwater, or thermally unstable, sites quickly reach water temperatures often considered lethal to trout on hot days

The method* outlined here allows a user to obtain a reliable estimate of the summer thermal stability of a site - whether it is cold, cool or warm - based upon a one day measurement of air and water temperatures.



What you need:

- A day in July, August or the first week of September when maximum air temperatures exceed 24.5°C
- Water temperature at 4pm
- Maximum air temperature
- The nomogram on page 3

__Coldwater__ sites contain thermal habitat typically considered ideal for brook and brown trout. The average maximum summer water temperatures are approximately 14°C.

__Coolwater__ sites contain thermal habitat considered ideal for rainbow trout. Average daily maximum summer water temperatures are approximately 18°C.

__Warmwater__ sites may still support a small number and biomass of trout, however average summer maximum daily water temperatures are high at approximately 23°C

For further details on the development of this methodology refer to:
Stoneman, C.L. and M.L. Jones. 1996. A simple method to evaluate the thermal stability of trout streams. N.Amer. J. Fish. Manage. in press

Sampling Protocol

1. The sampling period extends from July 1st to September 10th. Prior to and after these dates, overnight cooling of the streams does not allow for adequate separation between the three categories

2. Sample on days when maximum air temperatures have reached at least 24.5°C. During July, August and early September the daily maximum air temperatures are often at least this high.

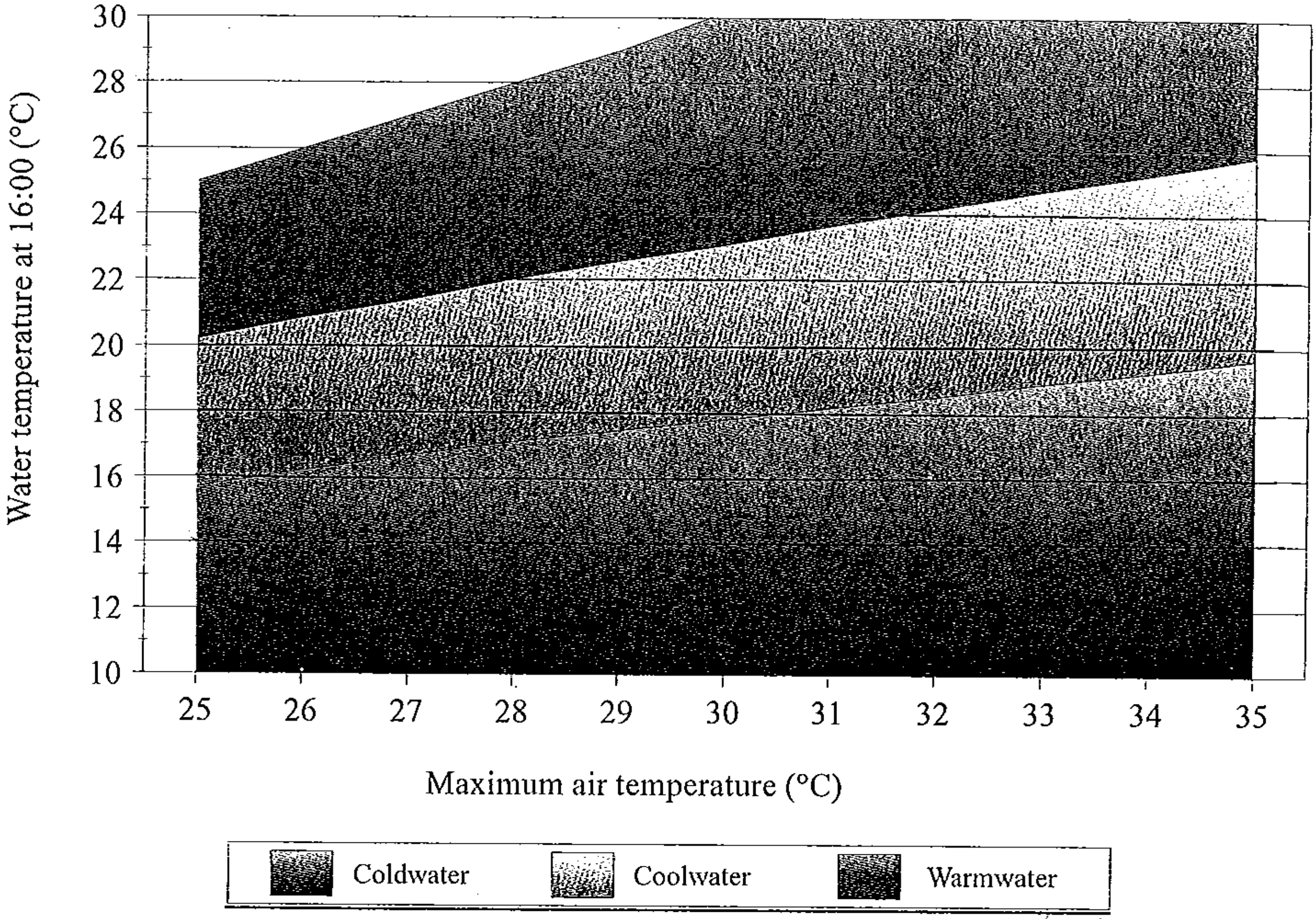
3. Sample only when the previous 2-3 days are relatively similar in daily maximum air temperature. For instance, do not sample on a 25°C day that was preceded by two days of 32°C OR 20°C weather. This can be easy to do when waiting for a day that is finally "hot enough", or when a cold front moves in during the morning or early afternoon on a day scheduled for sampling.

4. Obtain water temperature measurements between 16:00 and 16:30. This measurement is representative of the maximum daily water temperature. Maximum water temperatures may occur slightly earlier or later, however our study indicates the difference is never greater than 0.5°C, beyond the resolution of most thermometers. A reliable temperature recorder or maximum/minimum thermometer could also be placed in the site at any time before 16:00, and removed and checked for maximum water temperature after 16:30.

5. Obtain the measure of maximum air temperature for the day of sampling. This is not a measure of the air temperature at 16:00. Daily air temperature maximums are often available from Environment Canada weather stations. Locate the weather station closest to the stream site being sampled. Alternatively, a reliable temperature recording device, or maximum/minimum thermometer could be placed in a shaded spot nearby, and checked at the end of the day.

6. Using the nomogram provided, read off the maximum air temperature against the 16:00 water temperature. Determine the location of your data point on the nomogram as belonging to the cold, cool or warmwater category. Keep in mind that coolwater categories are able to support large numbers of trout, and that warmwater sites, as defined for this procedure, may support small trout populations.

7. To increase accuracy of site classification several measurements can be taken on different days. Examine the plotted data to ensure that the original water temperature measurement was not unusually cold or warm for that site.



Cautions and Limitations

- This method categorizes only the immediate area where measurements are made; thermal refugia may be located nearby.
- The categorization of sites in summer does not necessarily provide insight into the corresponding spring/fall/winter thermal characteristics.
- Many sites lie close to category boundaries as any stream will change gradually from cold in the headwaters to warm at the mouth.
- The model should be calibrated/developed for use in areas outside of southern Ontario - see page 4.

Notes on: development of thermal stability model for use in areas other than southern Ontario

The model outlined on the previous 3 pages was developed and tested for use in the southern Ontario region only. If you wish to use a technique similar to this one outside of southern Ontario, the development of a new model unique to that area is essential. The following is meant only as an overview of the calibration/development process, please refer to Stoneman and Jones (reference page 1) for full details.

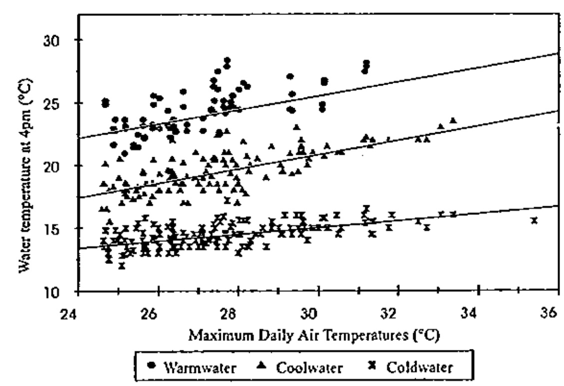
1. Choose sites that are known to have contrasting thermal stabilities in your area. The categories you choose may not be the same as the present model, but instead should represent the thermal contrast ecologically important in your area. These choices may be based upon historic water temperature data and/or species composition.

2. Collect detailed water temperature data. Continuous temperature recorders are now available at reasonable prices (approximately $150.00 per unit). Place a recorder at each site, in a shaded pool.

3. Collect air temperature data. These data are often available from Environment Canada. You can also record air temperatures for the area with a continuous temperature recorder, placed in a shaded spot nearby.

4. Data should be collected for the time period in which you would like to develop the model for. The work presented here indicates July-September show the best separation.

5. Plot maximum daily air temperatures against the corresponding water temperatures at 4pm. Calculate and plot regression lines and 95% confidence intervals. On your plot, note the air temperatures above which maximum separation between the categories occurs. The points and regression lines used in the present model are shown at right.



6. If the regression lines lie very close to, or intersect, one another, such that there is considerable overlap of the 95% confidence, one of three types of problems may be the cause:

   - The sites selected do not provide enough contrast - i.e. the site selected as warmwater may actually be cool-warm. Using knowledge of the streams in your area, you may wish to sample again at different site(s)

   - The technique may need refinement for use in your area. A different time of day for sampling (maximum water temperatures may occur earlier or later), narrower sampling period (i.e. August only), or higher maximum air temperature may be required for the model to work in your area. Examine the data to determine if a variation in the sampling technique results in a usable model.

   - The technique does not work in your area. This may happen if air temperatures rarely exceed levels that allow contrasting thermal regimes to become evident.

7. A new nomogram can be developed if the 95% confidence intervals do not overlap considerably. Define the nomogram boundary lines as the the point at which a water temperature measurement (for a given air temperature value) is equally likely to have come from either category. This is done using the regression lines and t values for your data.

CA/DFO Habitat Assessment

Siteno ______ Initials ____ Photo# ____ Date ______ Time ____

Name/Location ______

Flow — Present ☐ / Absent ☐ — Quantity ______ / Quality ______

Turbidity — Clear ☐ / Turbid ☐ / Opaque ☐

Channel — Natural ☐ / Ditched ☐ / Tiled ☐ — Width ______ / Depth ______

Bridge ☐ or Culvert ☐

Erosion — None ☐ / Little ☐ / Some ☐ / Lots ☐

Pool % ______ Riffle% ______ Run% ______

Substrate

Boulder	____ %	Silt	____ %	CPOM	____ %
Cobble	____ %	Clay	____ %	FPOM	____ %
Gravel	____ %	Bedrock	____ %	Debris	____ %
Sand	____ %		100%		

Aquatic Vegetation — Amount ______ % of channel

Emergent ______

Submgent ______

Algae ______

Riparian Vegetation — Width ______ Shade ______ % of Channel

Trees ____ % Shrubs ____ % Herbs ____ %

Cover — Amount ____ % of channel Type ______

Fish — Present ☐ / Absent ☐ — Description ______

Landuse ______

Temperature — Air ______ Max temp for Day ______

Water — Minimum ______ Maximum ______

Comments (Barriers, Pollution, etc.) ______

Landowner ☐

Appendix 3: Municipal Drain Class Authorized Activities and Work Periods (from DFO 1999 and DFO 2000).

Class	Type	Authorized Activities	Work Periods	Terms and Conditions
A	cold/cool with no salmonids present	brushing of side slope; bottom and debris clean out	June 16-Sept. 15 Jan. 1-Feb. 28	-width: depth ratio not increased -shade producing side of drain left unaltered and replanting of bank vegetation on altered side of drain -implementation and maintenance of sediment and erosion control measures; all disturbed soil must be stabilized -work in water when flows are not elevated
B	warm with top predators -less than 10 years since last clean out	brushing of side slope; bottom and debris clean out	July 16-Oct. 31 Jan. 1-Feb. 28	-width: depth ratio can be increased but finished channel shall be as narrow and deep as possible -re-establishment of bank vegetation that was removed -implementation and maintenance of sediment and erosion control measures; all disturbed soil must be stabilized -work in water when flows are not elevated
C	warm with baitfish	brushing of side slope; bottom, debris and full clean out	June 16-Oct. 31 Jan. 1- Feb. 28 June 16-Sept. 15 for full clean out	-width: depth ratio can be increased but finished channel shall be as narrow and deep as possible -re-establishment of bank vegetation that was removed -during a full clean out, bank slopes must be graded so as to maintain stability and any bends in channel must be stabilized -implementation and maintenance of sediment and erosion control measures; all disturbed soil must be stabilized -work in water when flows are not elevated
D	cold/cool with salmonids present	project specific		project specific
E	warm with top predators	project specific		project specific
F	intermittent	work in dry conditions and stabilize soils		