Exceptional Waters

State of the Resource Report

(Grand River Paris to Brantford)

THE GRAND
A Canadian Heritage River

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Exceptional Waters Reach
State of the Resource Report
Paris to Brantford

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with contributions from S. Bellamy, D. Boyd, S. Cooke, J. Wright,
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November 2005
Exceptional Waters Community Advisory Committee
c/o The Grand River Conservation Authority
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Executive Summary

Exceptional Waters State of the Resource Report
Robert Scott and Jack Imhof, November 7, 2005

In 2003 the Exceptional Waters Community Advisory Committee initiated a report to define the state of the Grand River as it passed through the Exceptional Waters reach between the Penman's Dam in Paris, Ontario and the Cockshutt Bridge in Brantford, Ontario.

The Exceptional Waters Approach is a community-based process that engages local communities to protect, manage and restore waters of exceptional quality and productivity. The process is inclusive and strives to ensure that exceptional environments are protected as a community asset and resource for everyone. The emphasis is protection, management and restoration through a process of engaging everyone in the community, including landowners, interest groups, agencies and organizations to share responsibility for these environments.

The initiation of the Exceptional Waters Approach was a recommendation of the Grand River Fisheries Management Plan and identified as a "Best Bet". This report looks briefly at the history and state of the Grand River watershed with special emphasis on this reach.

Early settlement, agricultural development and industrialization removed up to 95% of the historical forested areas in the watershed. These forests contributed to the stable flows of the river. The removal of the forests, the discharging of sediment from agricultural land and waste from municipalities and the use of the river as a means of transportation created change. The river became an irregular flowing polluted waterway, void of game fish and with very poor water quality.

The devastating spring flooding, followed by extreme drought, particularly in the late 1930's, brought to a head the need for change in river management. The building of dams under the direction of the Grand River Commission was the first measure to control floods and to augment summer flows. This led to the current situation today where the commission's successor, the Grand River Conservation Authority works with other agencies to manage not only the water flow but the entire watershed for sustainability as a critical resource.

This State of the Resource report examines a variety of contributing factors in the rivers current status as an exceptional waterway. The watershed is a biophysical system, where the geology and climate dictate the nature of the stream. There are 11 physiographic areas in the watershed. In the Exceptional Waters reach, the Galt and Paris moraines are major contributing factors to the character and quality of this section, contributing large volumes of clear, cold ground water to the surface flow. The ground water is a major contributing factor to the substantial cold water game fish that have naturalized this area. The character of the river changes significantly from the source to the mouth. The coarse texture of the moraines and the deeply incised valley in this reach generate major inputs of groundwater contributing to higher baseflows to the river as it drops significantly between Cambridge and Brantford. On the table land, the moraines provide major recharge areas that feed these water tables. The major groundwater inputs from the moraines help the river to revitalize its natural conditions.

The natural recharge found on the moraines is enhanced by the work of many partners in efforts such as the Rural Water Quality Program. The RWQP partners with municipalities and rural landowners to keep contaminates from entering streams. This is accomplished by restricting livestock access and developing riparian zones next to water.

From a biological perspective, the report looks at the requirements for healthy aquatic communities and reviews their current status. Preliminary work on the biology of this reach was done by the Grand River Fisheries Management Plan which examined the watershed in detail from 1994 to 1998. It calls for a variety of ways to improve overall fish habitat and the contributing factors that allow it to happen. Based on the Fish Plan and this report, many indicators tell us that the river is in relatively good health. These indicators include the variety and volume of invertebrates living in the substrate, a major source of fish sustenance, relatively constant temperatures moderated by groundwater discharges and a thriving avian population, including insect feeders and predators. The healthy fish population is an indicator of water quality with a side benefit of recreation and tourism to the local and broader communities.

In addition to surface and groundwater contributions, other critical components include healthy riparian zones, wetlands and floodplains. These also help to maintain the integrity of the stream channel, moderate floods, reduce bank erosion and improve water quality. All three vegetative zones contain a variety of grasses, shrubs, trees and other plants contributing to the improved river quality. Maintaining these zones and restricting development or harvesting or extraction, benefits the overall river habitat, providing for shelter and food to the aquatic and land inhabitants. These zones are home to many land based animals and the diversity they add to the natural experience is immense.

The human use of the river has changed. Over time the importance of a clean river has become apparent, not only from a drinking water perspective (and as we know Brantford and Six Nations derive their drinking water from the river), but also as a recreational and tourism component of the riverside communities. The development practices of the local communities will have a long term impact on these amenities. Careful management of the Exceptional Waters reach and the entire Grand River watershed will prevent a reversion to the previous unhealthy, unattractive waterway.

The State of the Resource report is a combination of scientific research and individual input and observations. A substantial base of information on the watershed has been collected over time. The Grand River Conservation Authority and other agencies maintain a great deal of detailed information on the science and history of the watershed. The Ontario Ministry of Natural Resources, the Ontario Ministry of the Environment and Environment Canada have also collected and maintained a large amount of data on the river and its watershed. This information is supported and can be expanded by many local volunteer and education groups including wildlife conservation advocates. These include anglers and hunters who make up the bulk of the conservation group membership.

A number of emerging issues will challenge our ability to maintain and enhance the health of this Exceptional Water. These emerging issues include: the impact of large influxes of new residents and their supporting industry and infrastructure to this reach of river; ongoing management and reduction of non-point source pollution; enhanced management of wastewater treatment plants; and the emerging issue of pharmaceutical products and their potential impact on fish in the river. New methodologies for examining these factors are constantly being developed.

The Grand River is a true jewel upon the landscape. Our challenge is to both maintain the luster and to make the tarnished facets of the jewel shine as well!

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The Grand River between Paris and Brantford has become a valuable community resource for residents .

Foreword

The intent of this report is to provide a synthesis of background information on the Grand River as it passes through the Exceptional Waters reach between Penman's Dam in Paris, Ontario and the Cockshutt Bridge at the south end of Brantford, an approximately 20 km stretch of the river.

The Exceptional Waters Community Advisory Committee endorses the development of this report. The Committee believes a document illustrating some of the history and the resulting changes in the river over time can be a valuable tool for informing residents of the special features of the river and can also help inform future watershed and local resource management planning. The report can also provide a baseline for measuring improvements to this section of the watershed.

This report began as primarily a technical document but has evolved to include observations by users on both the current and future potential for the reach as a recreational and ecological /environmental gem in the County of Brant and the City of Brantford. Information that is based on observation, rather than studies or measurements is identified in the text. Many of the observations and expectation apply to the watershed as a whole.

The Grand River Conservation Authority has gathered a substantial amount of data over its existence as watershed managers. To support the water conservation and flood control provisions of its mandate it has of necessity needed to look at the watershed as an integrated entity. Much of its work therefore focuses on knowing what affects water quality and how to preserve and improve water resources, both quality and quantity, for the benefit of all residents of the watershed. This work has resulted in the collection of large amounts of data. The authors have utilized this work in examining historic trends and possible future directions in watershed and local management.

In preparing the report it became obvious there are many uses for the river. The river has always been a water supply for many communities, whether from groundwater to wells or directly from the river. It has also been the outlet for waste treatment facilities. Many industries use the water, two being gravel extraction and process water. Recreation has only recently begun to make a comeback, especially since waste water plants and industrial users have improved their stewardship of water use. The main users, however, are the wildlife and it is their presence that so remarkably enhances the watershed.

The most significant challenge for the authors was to build on the recognition by the citizens and municipal governments that the river has improved. Many still think of it as a polluted, unpleasant mess. We hope the readers will visit the river corridor and take a closer look at what we really have as a community resource. It has recovered significantly. When we begin to realize this as a whole community and reduce the contamination to a minimum we will have accomplished our goal.

We would like to thank the many contributors to the project for their input, whether through technical reports or from their general affection for the Grand River watershed.

Bob Scott and Jack Imhof
November 2005

The Grand River, a Canadian Heritage River State of the Resource, November 7, 2005 Exceptional Waters Reach,Paris to Brantford R. Scott, J. Imhof, with contributions from J. Wright, D. Boyd, S. Cooke, S. Bellamy, T. Zammit (GRCA); A. Timmerman, K. Cornelisse (OMNR)

The Grand River through the Exceptional Waters area has intact vegetation along its banks for most of this reach despite flowing through a well populated area.

Introduction

The Exceptional Waters Approach is a community-based process that engages local communities to protect, manage and restore waters of exceptional quality and productivity. The process is inclusive and strives to ensure that exceptional environments are protected as a community asset and resource for everyone. The emphasis is protection, management and restoration through a process of engaging everyone in the community, including landowners, interest groups, agencies and organizations to share responsibility for these environments.

Not all waters are created equal. Some are more productive, functional, and aesthetic than others in the same region. These waters should be managed as waters of exceptional value in order to create a focus for excellence within their watershed. Management for excellence encourages the improved management of other adjacent waters by facilitating a linkage in people's minds.

The initiation of the Exceptional Waters Approach was a recommendation of the Grand River Fisheries Management Plan and identified as a "Best Bet".

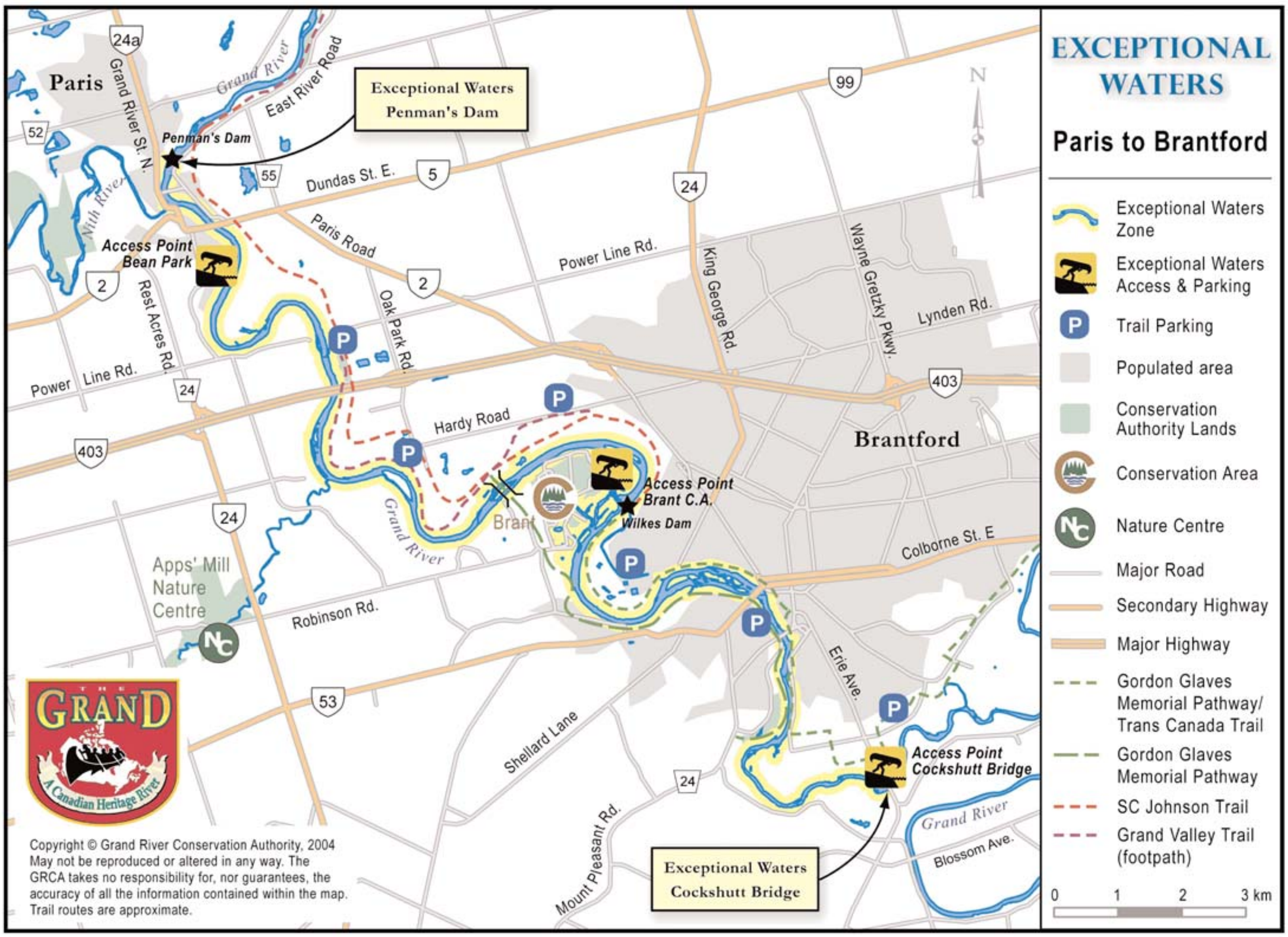


Figure 1: The Exceptional Waters Reach of the Grand River Between Paris and Brantford Showing Recreational Features.

The Exceptional Waters Approach

Goal of the Exceptional Waters Approach

"To develop and promote the engagement of members of local communities so that waters of exceptional quality may be managed as a community resource to ensure their sustainability."

Exceptional Waters Criteria

- A Water that has exceptional productivity and ecological values compared to surrounding waters;
Is still relatively healthy from a physical, chemical and biological perspective;
- Has the size and aesthetics that may attract people and provide a quality experience;
- Has the capability of maintaining healthy sustainable populations of fish and other animals within the local and regional terrestrial and aquatic systems.

What Makes this Section Special?

- The Fish
- Migratory and stream-resident rainbow trout
- Smallmouth Bass, Pike, Walleye; Species at Risk
- The Natural Heritage Features
- Perched Fen, complex floodplain and valley forests
- The Groundwater Flow - high discharges
- The Channel - healthy morphology
- Aesthetics of the valley
- Community Interest (hiking, fishing, water sport, water quality, birding, parks, access to trails)
- Community Use (the Grand River is the water supply for Brantford)

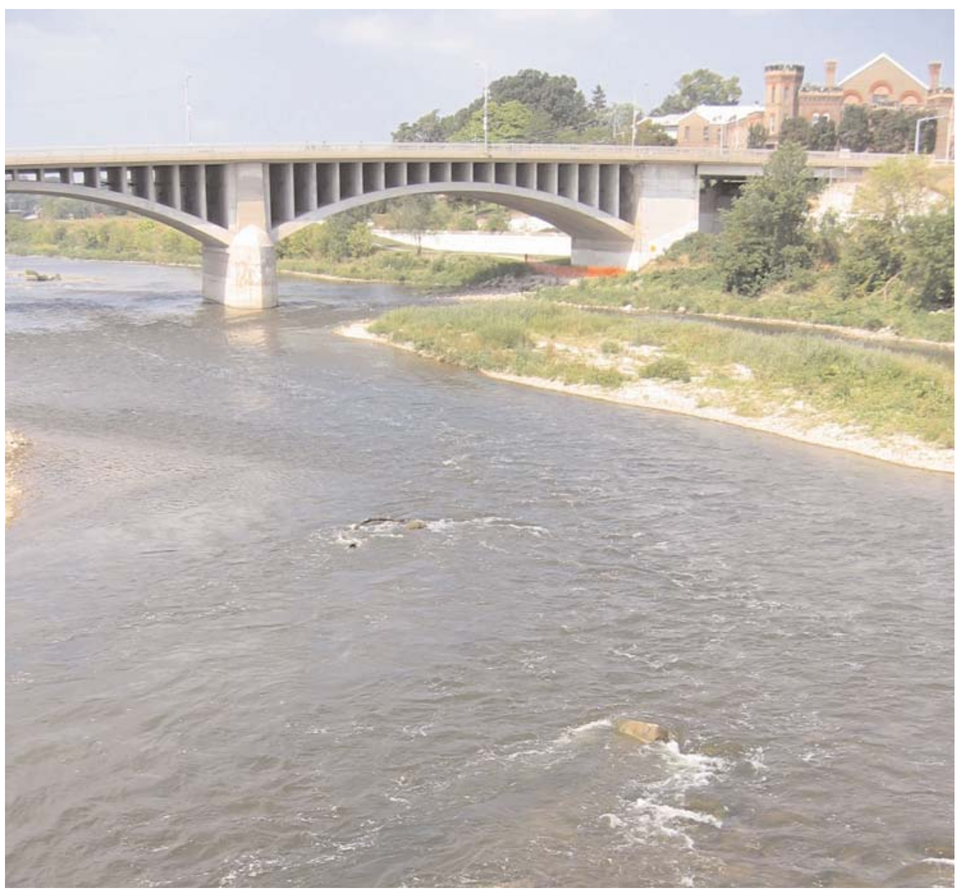
Desired Measurable Outcomes

- Community awareness of their local waters;
- Awareness of the importance of the local water by local politicians and business;
- Community embraces the active, co-operative management and protection of their local waters;
- Improvement in the local quality of life;
- Potential benefits to recreation and local economics;
- Development of a broader watershed stewardship ethic;
- Promotion and Engagement of other Waters based on the success of the already established Exceptional Waters.

Outcomes to Date of the Initial Exceptional Waters "Best Bet"

- Community contacts with landowners and interest groups initiated in 1998/99;
- Special Regulations to protect sensitive game fish established Jan. 2001;
- General valley air photo interpretation and pool characterization summer 1999;
- Major river data collection work 2000-2001;
- Fish Community structure assessed through new scientific approach in 2000 and 2001, reports completed;
- Major Reports on River Habitat Health and Characteristics completed 2002;
- Draft Access Management Completed 2002 and implementation begun;
- User Surveys on two reaches of river - Paris to Brantford; Brantford to Caledonia;
- User preferences, concerns and access info 2000, 2001;
- Economic information, 2001;
- Basic Water Quality information, using simple metrics and aquatic invertebrates;
- Visual Quality Analysis (provide planning info for Community group underway).

The above outcomes to date of the initial Exceptional Waters process are being built upon through the more recent EW initiative. Some of the outcomes of the new initiative include the establishment of the Community Advisory Committee, the preparation of this State of the Resource document and the development of a community led Resource Management Plan for the EW Reach.



Good fish habitat is found below the Lorne Bridge right in downtown Brantford.

1.0 History

The Grand River begins in the Dundalk Highlands as a trickle and meanders its way for approximately 290 kilometres to Port Maitland on Lake Erie. Its valley was home to First Nations people long before the coming of fur trappers and later settlers. Its richness contributed to the health of the First Nations populations, providing a source of food and clothing, both from the water and surrounding riparian zone. The richness of the land and forests encouraged immigration towards the end of the 1700's and into the early 1800's. The early efforts at settlement, focusing on agriculture and lumber, resulted in a major clearing of the land. The water resources were the basis for much industrial development along its shores. As lumber, grist, wool and various other industrial operations using waterpower were developed the quality of the water began to decline. Additional contaminates flowed unrestricted into the river as textiles, gypsum mining and other heavier industries evolved and the populations grew. In time it became not much more than a cesspool.

Perhaps the largest single factor in the decline of the river's quality was the deforestation of the upper watershed and lands around Luther Marsh. Early immigrants, believing their land grants to be agriculture based, cleared the forests and built drainage ditches to try and make the wetlands arable. None of this worked. What they had accomplished was to remove the ability of the wetlands to retain water and sustain flows year round. The resulting flooding in the middle and lower reaches each spring and the disastrously low summer flows finally reached a critical point in the early 1900's.

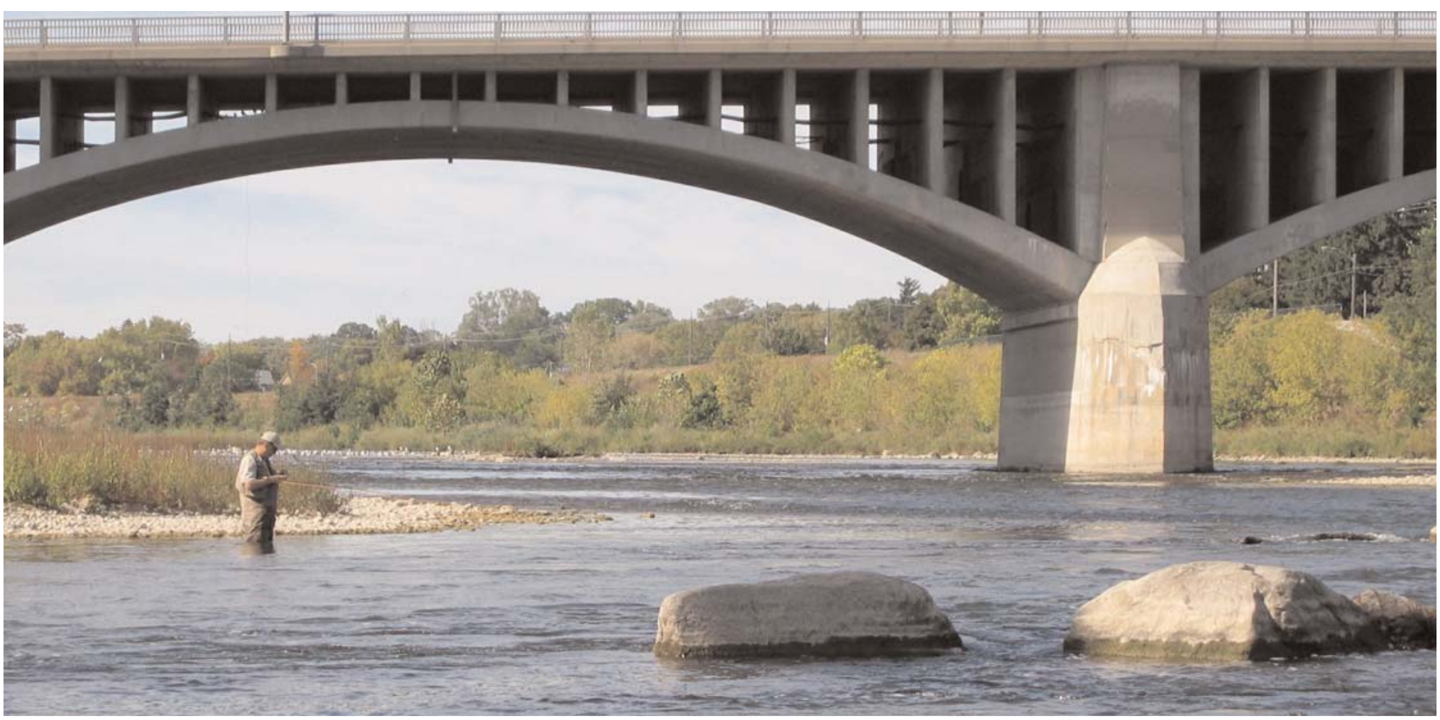
It became apparent that the quality of the river needed to improve. Fish populations had dwindled and there was no joy in a riverside walk. More and more of the population depended on the river water as growth became too dense to depend on wells alone. The esthetics was poor and uncontrolled development had removed much of the natural riparian zone vegetation. This contributed to major floods every spring. In 1934 the Grand River Commission received its charter, after heavy government involvement in searching for a solution to the water flows and quality. Over the last half century, with the multi-level input of governments, the quality of the water in the Grand has improved significantly. This is demonstrated by the return to the river of the natural wildlife and fish populations through sustainable summer flows. The Grand is now recognized as a Canadian Heritage River, gaining that recognition in 1994.

1.1 Local Perspective

The local history of the Exceptional Waters Reach between Paris and Brantford is extremely interesting. The Town of Paris, Ontario was named after the product produced in the area, Plaster of Paris. Kilning gypsum rock produces Plaster of Paris. As early as the late 1770's, large horizontal veins or strata of gypsum were found in the valley walls around the present Town of Paris.

The first major European settlement on this reach of the Grand River is believed to be on the east side of the river opposite Brant Conservation Area. Remnants of settlement and travel routes are still evident for those that look. The Conestogo Trail from Port Maitland, upstream to what became Galt and Ebytown (now Kitchener), traveled up the Grand River Valley through this reach. It is believed that the original corduroy road across a few groundwater rich areas can still be found in the Exceptional Waters Reach of the river.

The large island and back bay structure of the Grand River between the 403 highway and the mouth of Whiteman's Creek are believed to have been dredged for a barge canal to carry gypsum rock from the mines south of Paris downstream to manufacturing operations in Brantford.



An angler fishes for rainbow trout in the shadow of the Lorne Bridge in Brantford. This is an easily accessed, quality fishery for urban anglers.

2.0 Landscape

As glaciers retreated from the last ice age the land vegetation and associated wildlife changed from a tundra community to a mixed hardwood forest over several thousands of years. In the south of the watershed plants are distinctively different from those in the upstream areas where oaks, hickories, walnuts and other southern species are missing or much reduced.

Native inhabitants influenced the landscape through clearing and cultivation and intentional burning.

European settlers saw the forests as enemies and a hindrance to livelihood. Through their activities, forest cover was reduced to approximately 5% during the 1800's, being replaced with crops, pasture and settlements. The result was more extreme weather and stream flows. It was a virtual clearing of the watershed in one century.

In time the realization of the value of the forest cover became apparent. Efforts have been on going to re-establish as much as possible. Cover has been increased to about 19%. The term "cover" includes forested areas and areas of natural vegetation such as grassed floodplains and riparian areas. Environment Canada has set a target of approximately 30% for this watershed to be healthy.

The watershed and specifically the EW reach is home to the northern limits of the Carolinian forest. Typical species found in this habitat are Sugar Maple, Beech, Basswood, Silver Maple and various Oaks. Lesser species include Elm, Ash, Hickory, Black Cherry and Yellow Birch. Species such as Hickories, Sassafras, Sycamore, Black Oak, Chinquapin and Dwarf Chinquapin Oaks, and American Chestnut are at their northern limits. To the north of the watershed Great Lakes-St. Lawrence forest species occur. Examples of these species are Eastern Hemlock, White Pine, Eastern White Cedar, Balsam Fir, White Spruce and White Birch. These species are at their southern limits. Black Spruce can be found in the boreal style bogs found in the headwater areas. Species such as American Chestnut, other Large Oaks, White Pines and Walnuts were adaptable to ground fires typically occurring in the grassy areas.

As the forests were depleted the mammals at the top of the food chain disappeared as their food source was reduced or disappeared altogether. Representative of these species were the black bear, timber wolf, eastern cougar, lynx, fisher and marten. The red-tailed hawk replaced the red-shouldered hawk.

The ecology or the Grand River watershed is still in a period of re-adjustment. This will continue as populations continue to grow and replace vegetation with roads, housing and industry, often referred to as impervious surfaces.

The natural landscape of much of the Grand River watershed was deciduous forest with a significant portion of long grass prairie interspersed with wetlands. In the southern reaches, the Carolinian forest was a major portion of the deciduous cover. The Carolinian forest was drastically reduced as the clearing of the land for agriculture, forest harvesting and the industrialization of towns and cities progressed. This was worsened by accidental introduction of diseases such as Chestnut Blight and Dutch Elm Disease. Many species became rare. The impact of poor stewardship on these elements of population expansion became more and more evident. Efforts to protect the wetlands and geological significant landscape became a more focused affair. No longer was it acceptable to go in and drain or fill wetlands without consideration of the consequences.

Two major moraines have an influence on this watershed. Their value became apparent as the uncontrolled taking of water impacted these major reservoirs of deep groundwater. The destruction of parts of the Paris and Galt moraines through mining and wetland loss became significant in the drought conditions that occurred over time. The most recent drought has occurred in the late 1990's and early 2000's. It also became evident they could be damaged by uncontrolled pollution from existing agriculture, municipal and industrial practices which allowed contaminates to seep into groundwater sources (GRCA 2001 Regional Groundwater Study; Cooke 2005).

An aerial view of Brantford reveals the mix of urban development, agriculture and natural habitat that is typical of what is found along the Exceptional Water's reach.

3.0 Land Use

Prior to settlement the land in the Grand River watershed was predominately forest, with Oak Savanna's typical in the mid to lower Grand River, maintained by either natural fire episodes or native induced fires. The rapid removal of the forest for lumber exploitation and for clearing for agriculture meant that by the end of the 19th century a major land use change had occurred. Over the 20th century the original agriculture focus was added to with a solid industrial and urban component. Large sections of the watershed, especially in the Waterloo/Kitchener/Cambridge and Guelph area, and lesser so in Paris and Brantford, had the softer agriculture/woodland component substituted with hard landuse identified by impervious surfaces such as streets, parking lots and building coverage. These impervious surfaces fundamentally changed the water budget in urbanized landscapes, dramatically reducing recharge and evapo-transpiration and dramatically increasing surface run-off. Therefore, moisture, instead of being absorbed back into the land after rain or snowfall, now ran off, mixing with oil, road dirt, salt and many other materials through storm sewers directly into streams and eventually the mainstem of the river. The increase in the magnitude and frequency of runoff severely damaged stream channels, increasing their widths, decreasing depths and filling them with sediment. This changed the water budget of the Grand river substantially, providing far more surface runoff, leading to more severe and intense floods. Figure 2 provides an example of the change in water budget from a forested landscape, to agriculture to urban.

Treated waste from sanitary sewage treatment facilities was directly added to the mix entering the main river channel, bringing with it a high load of nutrients and undesirable chemicals (Cooke 2005).

4.0 Watershed Biophysical System

The character, form and nature of rivers and streams are a function of the geology and climate of an area. The geology and climate dictate the nature of the stream, its gradient, substrate, fertility, productivity and the animal and plant communities found adjacent and within its waters. Dr. H.B.N. Hynes, an eminent river ecologist, eloquently stated in 1975 that, "A stream is only as healthy as the valley through which it flows". Put another way, rivers and streams and the life supported by them are the ultimate integrators of the physical, chemical and biological processes that occur throughout the watershed.

The background document to the Grand River Fisheries Management Plan describes and summarizes the impact of the geology in more detail than we have explored in this report. It identifies the impact of soil and ground structure in defining the type of flows found in a watershed system.

The geology of the Grand River watershed provides significant releases of groundwater in some areas of the watershed to support coldwater fish populations. However, the distribution of these groundwater discharge zones is controlled by the surface and bedrock geological conditions. These conditions also affect the valley and channel forms and subsequently the habitat available for various fish species. As a result, some reaches and sub-watersheds of the Grand have coldwater fish communities and other areas with less groundwater and a warmer aquatic climate support mixed water or warmwater fish populations.

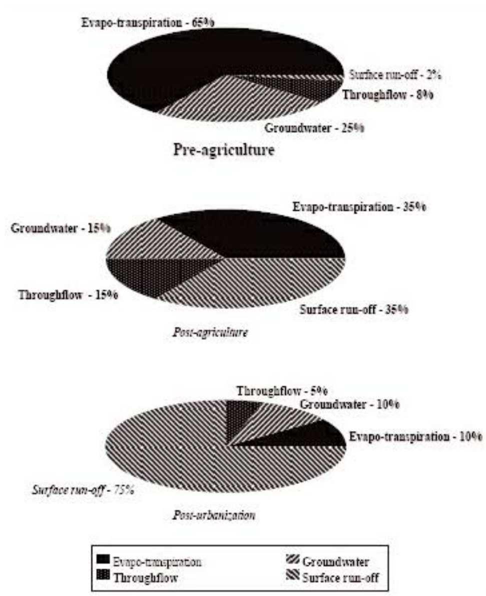


Figure 2: Change in a Watershed from Pre-European Settlement (in a Forested Landscape) to Agriculture to Urban (Wright and Imhof).

There are 11 physiographic areas in the watershed and each supports slightly to extensively different habitats. In further studying the physical and biological data on the watershed it becomes apparent there are different habitats, divided into three (3) major zones. These 3 zones can be further sub-divided between the main stem and the tributary's eco-zones. To aid in planning and management of the aquatic resources of the Grand River watershed, seven (7) major ecological zones were established:

- Upper Grand River Reach
(Headwaters to upper end of Belwood Reservoir)
- Middle Grand River Reach
(Belwood Reservoir to Brantford-Cockshutt Bridge)
- Lower Grand River Reach
(Brantford-Cockshutt Bridge to Lake Erie)
- Conestoga River Sub-Basin
- Speed River Sub-Basin
- Nith River Sub-Basin
- Horner's/Whiteman's Sub-Basin

The three primary geological zones established in the main stem resulted from an examination of the geology and resulting ecology of the river. There was a sufficiently different set of characteristics to divide the main stem into three reaches. A partial summary will help to develop an understanding of how these impact fish habitats.

In the Upper Grand we find clayey to silty/clayey till plains and low moraines with poor to very poor infiltration, flashy flood flows and extreme low base flows. Many first order tributaries are intermittent in nature. Bedrock outcroppings occur near the surface of the main stem upstream and downstream of Grand Valley. In the lower reaches below Grand Valley and east of Bellwood there are limited occurrences of shallow moraines that generate low active groundwater discharge features. This combination of features provides limited stable year round fish habitat and reproduction environment.

The surficial geography of the Middle Grand (see Figure 3) is complex with extensive kame moraines, sand moraines and glacial spillways interspersed with sandy to sandy/silty till moraines with rolling topography. The hydrology in the tributaries is complex because of the large amounts of groundwater due to the surficial and bedrock geology. This generates higher base flows, cooler temperatures and better opportunities to restore water quality quickly because of the dilution factor. Groundwater is a significant factor in the Middle Grand, especially between Cambridge and the southern end of Brantford. Localized outcropping of Devonian bedrock, especially Amabel formation, creates regional groundwater discharge points. At the edge of the boundary between the middle and lower Grand there is a finger of the Norfolk Sandplain with substantial groundwater discharges. The main river channel also has numerous areas of active groundwater discharge generating thermal refuges for various fish species, especially in the middle to lower portion of the sub-basin.

Glacial lake deposits of silts and clay resulting in very poor infiltration dominate the Lower Grand Reach from the Cockshutt Bridge in Brantford to Lake Erie. Under the glacial lake deposits occur deep deposits of silty/clayey till mixed with cobble and boulders. Topography of the section ranges from moderate to rolling to relatively flat.

Riparian zones are limited in much of the lower grand allowing the infiltration of silt from agricultural operations. The removal of most of the larger trees for agricultural purposes limits the opportunity for debris deposits that contribute to channel complexity, particularly in the tributaries, therefore it is lacking.

The tributaries are predominately highly meandering, narrow and with deep sand or silt substrates often referred to as E5 or E6 type. In the Lower Grand the main stem predominately flows through a wide and deep valley cutting through the silty/clay deposits into the older formation comprised of silty/clayey cobble boulder till. This results in a course substrate despite the dominant fine particles of the surface geology.

The absence of significant riparian zone, intensity of agriculture, large old dams such as Caledonia and Dunnville, the presence of berms and dykes and unstable banks all add constraints to fish management.

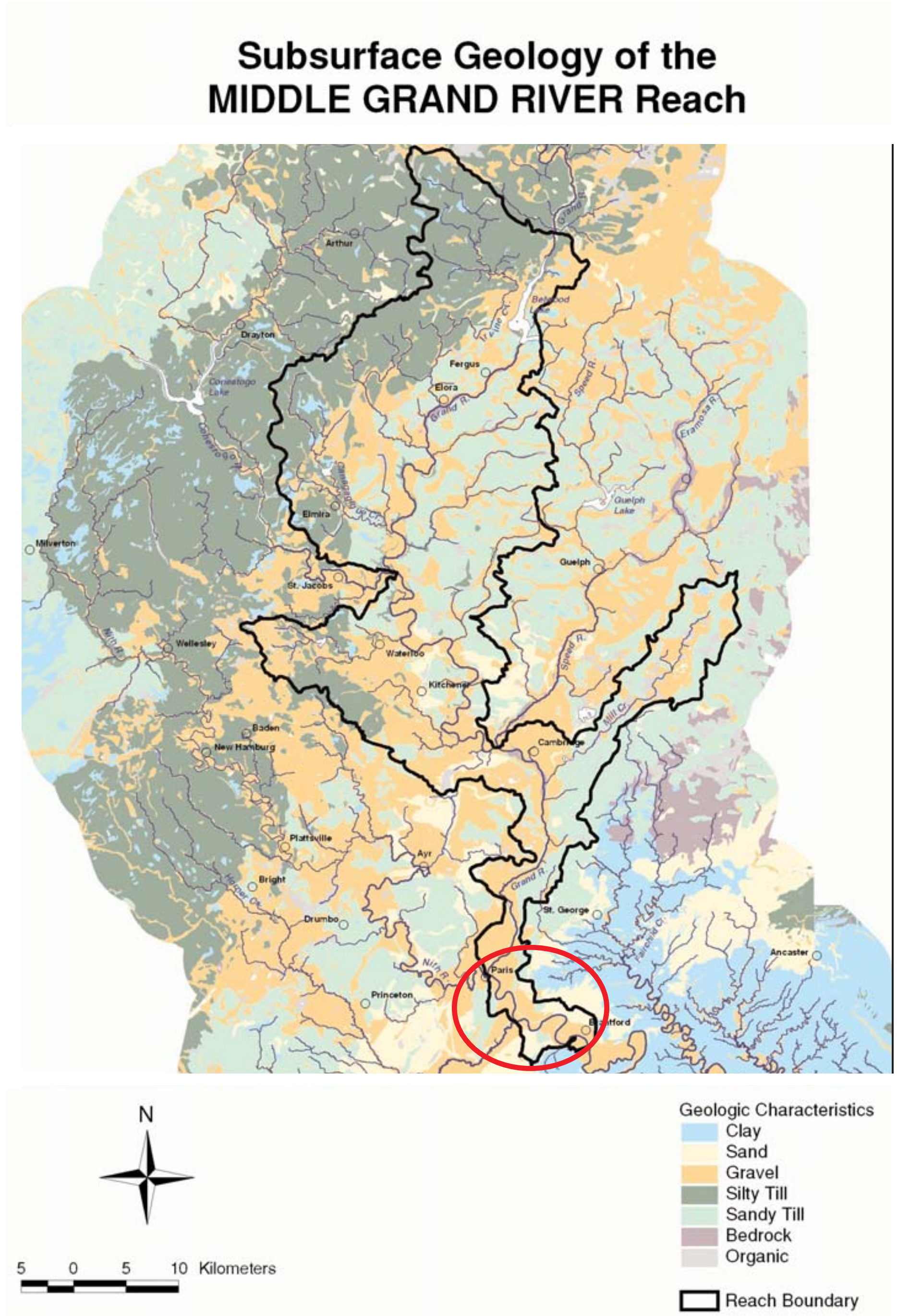


Figure 3: Surficial Geology of the Middle Grand River (Exceptional Waters Reach Circled in Red)

Rehabilitation efforts in the limited number of suitable zones would be best directed to pike and muskellunge. The population of walleye in the area is less than would be anticipated and causes for this are under investigation.

The Exceptional Waters zone is found within the Middle Grand River Reach and in addition to the main stem is fed by both the Nith and Horner's/Whiteman's tributaries. It contains a variety of water conditions. Specifically, this reach of river is found on the main stem of the Grand River, with contributions from two other eco-zones, the Nith and Whiteman's Creek Sub-basins. Fish communities in this reach of river are a mixture of cold water, mixed water, and warm water communities. The reason for this diversity is the enormous amounts of groundwater that enter this reach, directly from groundwater seepages and from the tributaries as well. As a result, some portions of this reach of river have "two story" fisheries hosting both healthy warm water and coldwater fish communities. The coldwater communities are concentrated in the areas of highest groundwater discharges. These discharges moderate water temperature extremes allowing for suitable temperatures and thermal refuges for coldwater fish.

The three major community types are defined below (From Wright and Imhof 2001):

Coldwater: Fish community comprised primarily of fish species intolerant of water temperatures that exceed 22°C in the summer. Communities usually found only in groundwater rich areas.

Mixed water: Fish communities comprised of species that can tolerate more variable water temperatures and conditions. This will include species that are cool water tolerant and some species of salmonids (often migratory) that can tolerate maximum summer temperatures up to 24 °C for brief periods of time. Communities usually found where occasional groundwater discharges occur.

Warmwater: Fish communities comprised of species that are highly tolerant of wide temperature and flow fluctuations and can withstand temperatures in excess of 26°C for prolonged periods of time. Communities usually found were groundwater discharge is minimal, lacking or relatively inconsequential (i.e., large portions of rivers or in reservoirs).

An elevation profile of the Grand River and its Nith and Whitemans tributaries would show a significant drop between Cambridge and the Cockshutt Bridge. This gradient contributes to the diversity of habitat as it changes from flatter to steeper slopes. The steep gradient and limited direct drainage between Cambridge and Paris allows it to be a recovery reach feeding the Exceptional Waters reach of the river.

Adding to the diversity is a measurable climate change as the river passes through the area south of Cambridge. The band that runs east and west near St George marks the line where the change can be most notable and the slope the steepest.

5.0 Water Resources

As a result of the diverse geological nature of the Grand River watershed and its mix of agricultural and urban landscapes, water resources and water resource management are complex.

5.1 River Flows

The present flow characteristics of the Grand River are very different than they were at the time of European settlement. The potential of the Grand River to return to its historical natural flows is, practically, wishful thinking. Current land practices and the needs of an ever-expanding population have removed the potential to ever achieve this objective. The natural holding capacity of the river valley in pre settlement times has forever been removed. The destruction of the forest cover and the draining of the Great Swamp, north of Grand Valley, was the first major change in the watershed, removing a major headwater storage area and radically increasing the flood volumes and decreasing the flood durations. The building of drains to accommodate agriculture and urbanization continued this derisive process.

It took most of the late 1700 and 1800's to destroy the natural water holding ability of the watershed. In 1932 the first steps were introduced to manage river flows only after great cries of distress were heard from the communities that suffered major flood damage on a regular basis and catastrophic flooding in the late 1920's. The modern conservation processes that are acting as alternatives to the lost natural environment are demonstrating river improvements are possible through the use of large reservoirs (although not all the benefits of natural storage wetlands are realized).

The management of watersheds by conservation authorities is contributing to the stabilization of flows. This management reduces the extremes of spring floods and summer low flows.

The first effort to stabilize flows came in 1932, after years of pleading by communities, such as Galt and Brantford, which regularly flooded. Devastating flooding in 1929 was the last straw. The Grand River Commission under the chairmanship of William Philip was to build reservoirs to control flows. A study on behalf of the Minister of Mines and Forests, the Hon. William Finlayson, was conducted by Hydro Electric chief hydraulic ngineer Dr. T. H. Hogg and L.V. Rorke, Surveyor-General of Canada. It had recommended three storage dams to contain the high spring flows and to supplement the low summer flows. In effect, the dams were installed to replace the natural hydrological functions and natural holding capacity of the wetlands and of the Great Swamp that once existed around Luther Marsh. The Shand Dam was constructed in 1939. It was the first dam built in Canada for conservation purposes. Therein lay the beginning of the revival of the Grand. Figures 4 and 5 provide examples of the amount of flow augmentation in the main stem of the Grand River for two specific years: 1999 during extreme drought conditions; and 2000 during a near normal precipitation year.

The responsibility for the engineering of flow control for the watershed now lies with the Grand River Conservation Authority. Various studies over time have provided information on the impact of flow rates at varying times of the year. Substantial information on flow management is available on the website at www.grandriver.ca. It is safe to say that the river would not have a healthy coldwater fish community below Belwood Lake, nor have recovered to the point it has today without the building and proper management of these reservoirs and dams.

In addition to the flow control management the management of municipal waste water plants has improved greatly. This has resulted through on going improvements to treating processes and the building of newer facilities. The waste water plants will continue to be challenged as we strive to identify and quantify the impact of biologicals on the watershed, especially those that are not changed by current treatment methods.

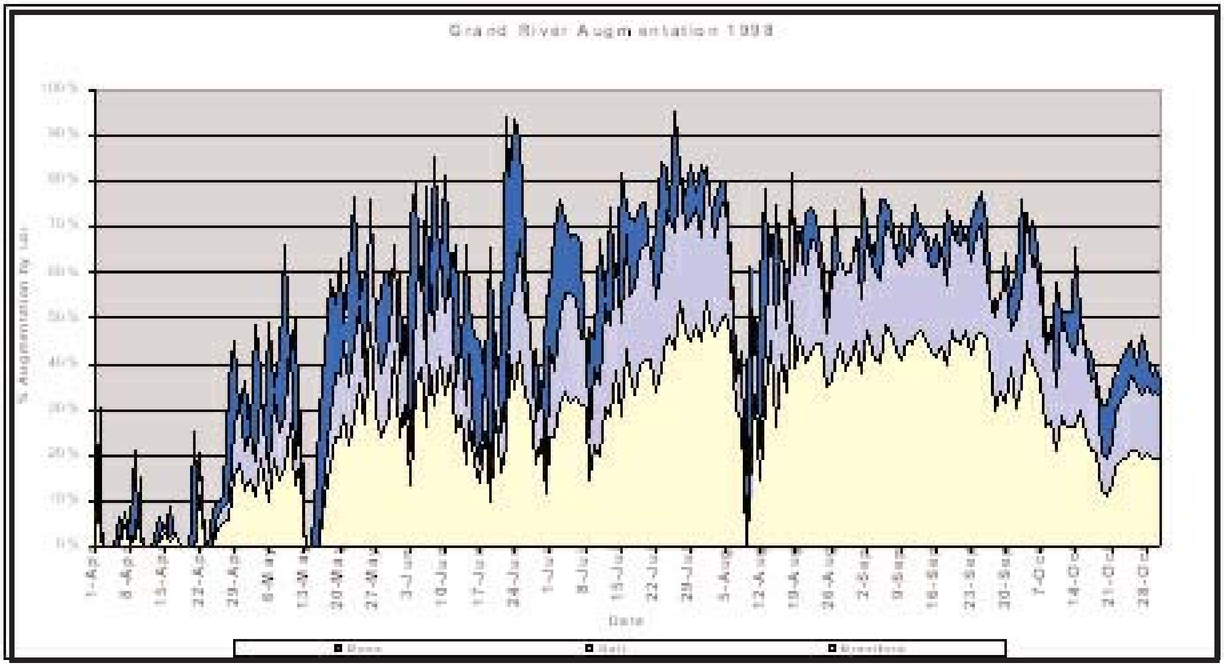


Figure 4: Flow Augmentation During a Severe Drought Year.

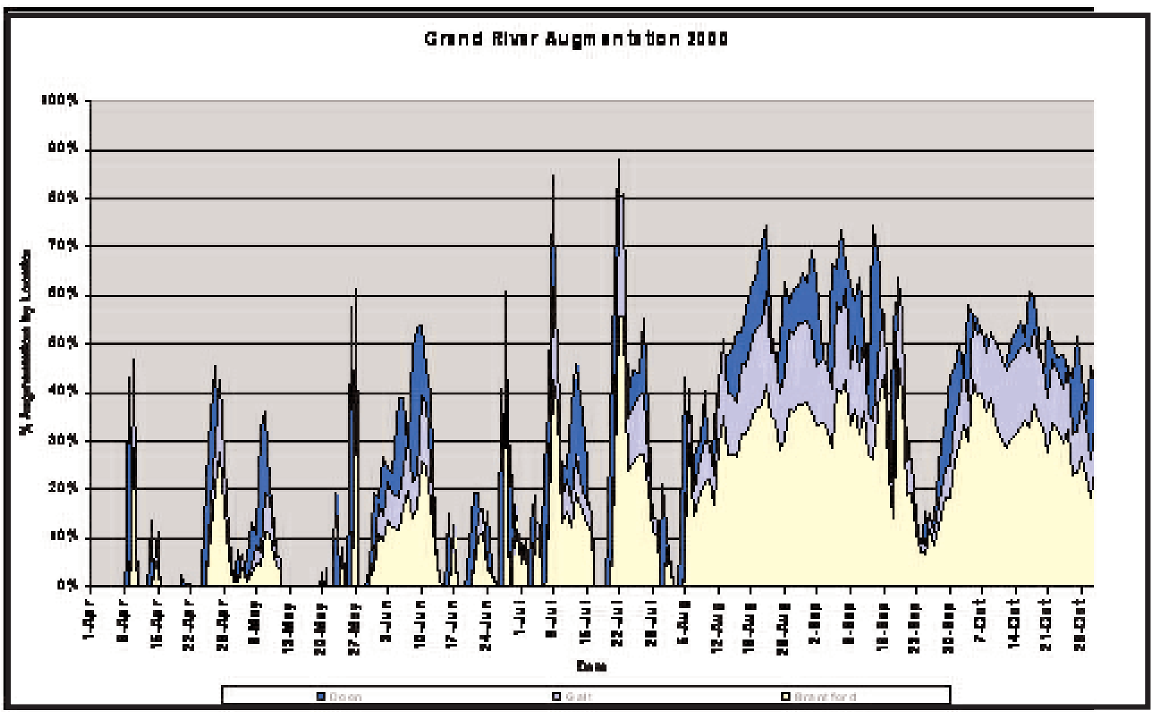


Figure 5: Flow Augmentation on the Grand River During a Normal Year.

5.2 Ground Water

Ground Water is a major factor in the ecology of the Grand River. The cold-water tributaries that support the native brook trout are fed primarily from ground water discharge areas, both as diffuse seepages and by point source springs. In dry periods the only source of flow in these tributaries is ground water.

The ground water's stable, low temperature provides the cooling of surface waters in the summer and the warming of surface water temperatures in the winter when they mix as they move downstream. This moderating effect provides temperatures that are suitable for most species. Trout and bass are the most frequently fished species in the Grand River in the Exceptional Waters reach. The "two story" fishery has both species in the same pools occupying different levels.

In addition to temperature, the ground water provides a significant increase to flows in the middle and lower Grand. The map below (Figure 6) provides an estimate of ground water seeping into the Grand River between Cambridge and Brantford. It can be as much as 25 % of the flow passing through Brantford during normal low flow periods. As well as volume, groundwater provides a better quality of water for municipalities below this area taking their water supplies directly from the river.

5.3 Channel Structure (Exceptional Waters Reach)

In May of 2002, Shelley Gorenc through an MNR/GRCA initiative published a report describing her work in developing a fish species/hydraulic habitat interaction profile of the Grand River between the William Street Bridge in Paris and the Pedestrian Bridge at the upstream limits of Brant Conservation Area. Gorenc had found evidence from studies in 1993 and 1999 that, in larger rivers, hydraulic characteristics are the best descriptors of fish community use.

The research Gorenc and others conducted occurred from 1999 to 2002 and involved 78 riffle and 46 pool intersects in the reach. This work established a base to determine permanent locations for a longer-term study. Five pool and six riffle transects were chosen as permanent sampling sites and a further five pool and two riffle permanent transects were proposed to monitor changes in hydraulic habitat under various river flows (Tables 1 and 2). Results from the study were compared to existing information found in literature and were found to be in agreement. The study determined the morphology of the Grand River between Paris and Brantford matches that of a healthy river system. This demonstrates the huge improvement over the past number of years in river quality and the impact of the work by multi levels of government to improve water quality by upgrading water and waste water systems. Much of the work was conducted during a period of low river flows and made it possible to complete a significant amount of work in 2001.

In comparison with the pool study (See Table 1 and 2), mean total riffle length is 1.75 times

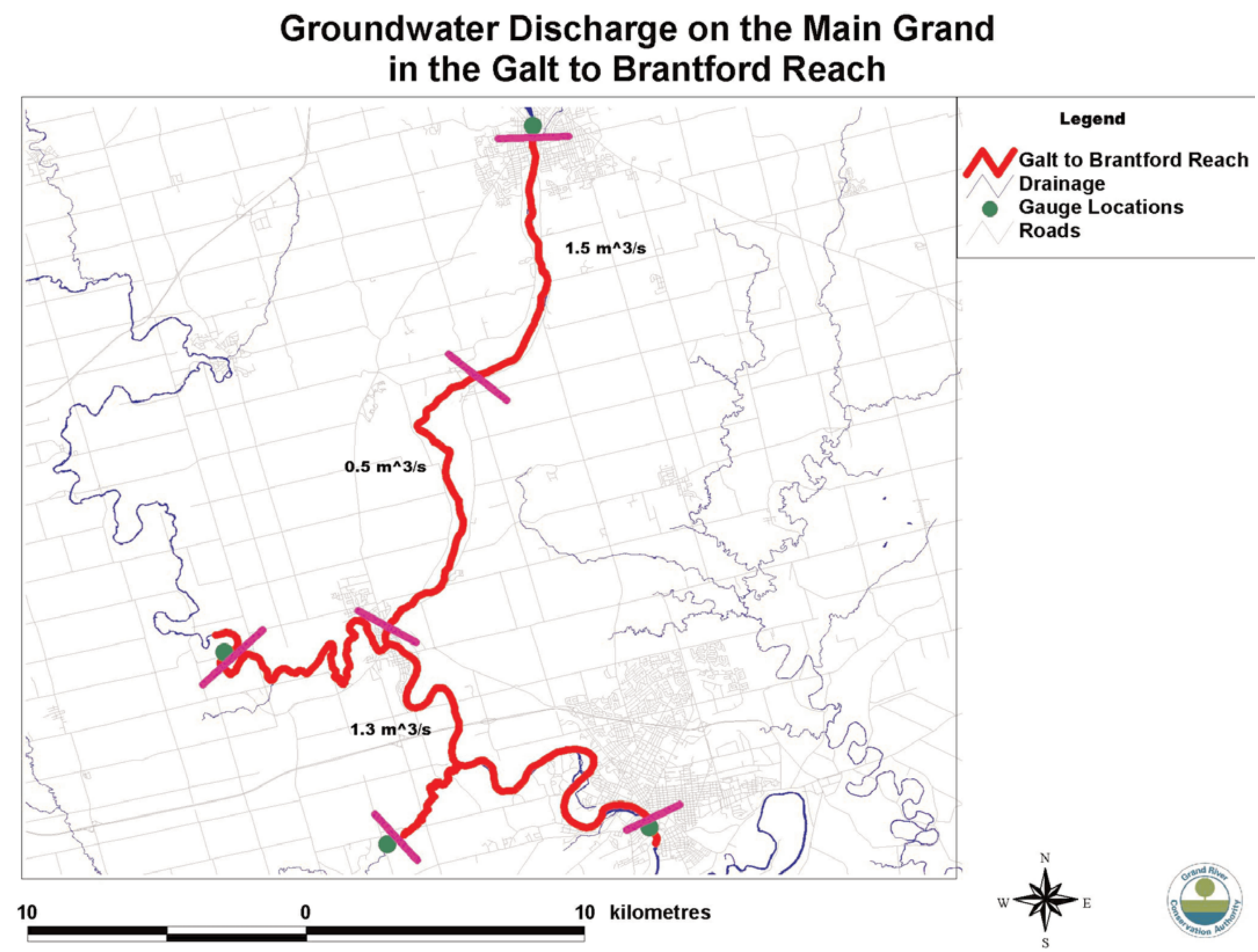


Figure 6: Approximately 3.3 m^3/s of groundwater flows into the Grand between Cambridge and Brantford (excluding the Nith and Whiteman's). The reach was divided into 3 smaller reaches and the respective groundwater discharges are shown. The reservoirs are operated to keep 17 m^3/s going through the Grand at Brantford. The 3.3 measured equates to roughly 20% of the summer low flow target at Brantford.

Total Pool Information (n=7)	Number of Transects	Datum Points	Total Length	Mean Width (m)	Mean Depth (m)	Max Depth (m)	Surface Area $(x10m^2)$	Volume $(x10m^3)$
Average (with unusually sized pools)	6	29	540	74	1.185	2.41	396.4	47.7
Average (excluding unusually sized pools)	7	30	477	76	1.214	2.15	356.8	42.8

Table 1: Summary of Pool Characteristics from Gorenc (2002)

Total Riffle Information (n=8)	Datum Points	Total Length	Mean Depth (m)	Mean Width (m)	Surface Area $(x10m^2)$	Volume $(x10m^3)$
Average	42	946	0.57	89.2	846.8	48.8

Table 2: Summary of Riffle Characteristics from Gorenc (2002)

larger than mean total pool length if the outlier pools are considered in the analysis. With the exclusion of the outlier values, riffles are 2.1 times longer than the pools. In general, one would expect average riffle length values to be 2-3 times larger than pool values. Without Pools 1, 6 and 7, the data from the 2001 field season falls comfortably within this range indicating a healthy channel structure in this reach of river. A similar comparison can be made between the average pool and riffle widths. Including the outlier measurements, the pool and riffle wetted widths measured 74 and 89 meters respectively, resulting in a percent variance of 17%. Excluding these outlier points decreases the percent variance to 14%. According to Gordon, et al. (1992), riffles are 12% wider than pools on average. Consequently, the data collected from the Exceptional Waters hydraulic habitat study falls close to this predicted percent difference. The minimal deviance between the study results and the literature may be explained by the presence of bedrock conditions along portions of the reach. Sections of the river with bedrock controls will experience higher levels of erosion along the banks, creating wider cross sections than would normally be expected.

The exclusion of the outlier pools makes only a marginal difference in the comparison between pool and riffle surface areas and volumes. The overall mean riffle surface area is 2.1 times larger than that of the pools when considering the entire data set and is 2.4 times larger than that of the pools when considering the edited data set. Average pool and riffle volumes, meanwhile, were essentially the same despite the exclusion of the outlier pools. This observation seems logical assuming there are no net gains or losses in water between the pools and riffles.

5.4 Water Quality

Water quality is characterized by evaluating the chemical, physical and biological components of fresh water systems. The water in the Grand River basin typically comes from rich agricultural lands (76%), forested areas (17%) and urban areas (5%). The urban areas are most concentrated in the central portion of the watershed.

Water quality is defined according to use. It is different for the protection of fish and habitat than for contact recreation. Water standards typically protect human health. Both federal and provincial governments have water quality objectives and guidelines. Water quality standards are enforceable by law.

The Grand River Conservation Authority and the provincial Ministry of the Environment maintain a network of 28 water-sampling sites on the rivers and creeks of the Grand River system. A Water Quality Index, adopted by the Canadian Council of Ministries of the Environment, was used to rate general water quality in relation to nutrient content. The changes in water quality characteristics for 1981-2001 or 1981-1995 are displayed in Figure 7.

Using the index based on information gathered between 1999 and 2002, the headwaters of the Grand and its tributaries are rated "good" (See Figure 10). As water flows down the Grand River from headwaters to mouth, it accepts rural and urban runoff and the outflow of sewage treatment plants. The water quality declines from the "good" category in the headwaters into the "fair" category as it passes through major agricultural areas of the watershed. As it passes the major cities, water quality falls into the "poor" category because of the presence of additional high levels of

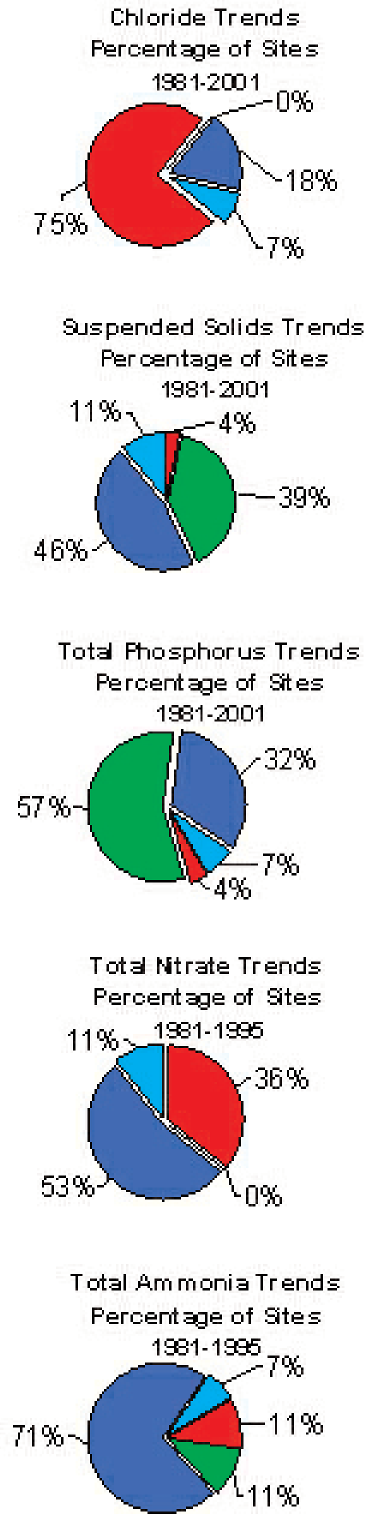


Figure 7. Percentage of monitoring sites improving, deteriorating or staying the same for nutrients and chloride concentrations from 1981 to 2001.

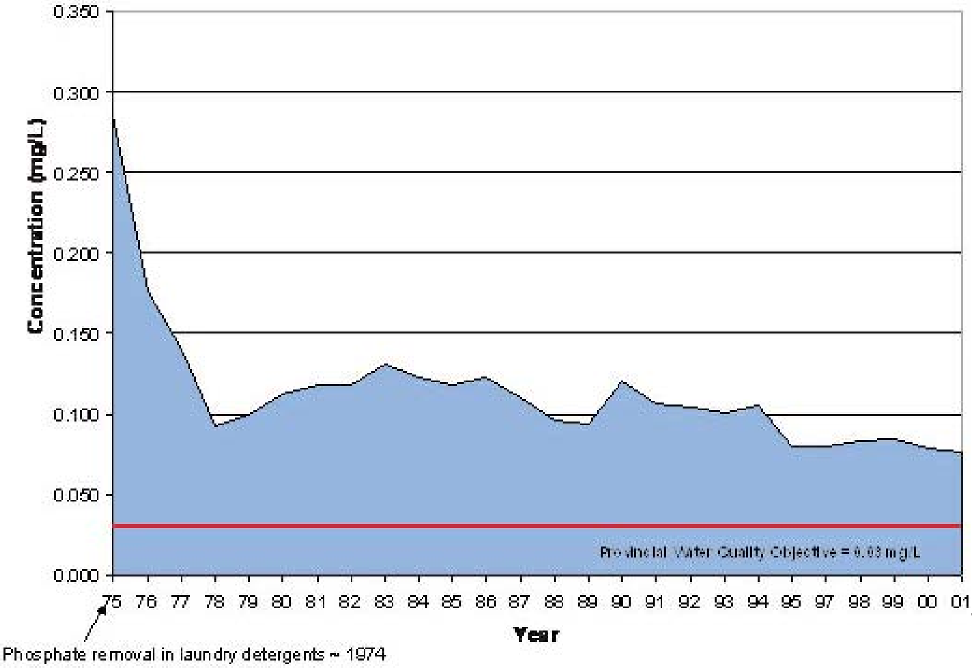


Figure 8. Annual average total phosphorus concentrations in the Grand River at Glen Morris, 1975-2001.

phosphorus and nitrogen from storm water and wastewater treatment plants. Water Quality targets are frequently missed in the middle to lower reaches of the Grand River. This situation should not be surprising given the average annual concentrations of phosphorous in the watershed (see Figure 8).

Recent upgrades to sewage treatment plants in Guelph and Elmira, along with others planned for Waterloo region, should further address the high nutrient concentrations found in some of these areas, but are unlikely to be final solutions.

Low oxygen levels (see Figure 9) can have a serious impact on many aquatic organisms, particularly fish. The Grand River Conservation Authority continuously monitors dissolved oxygen levels at seven locations in the watershed. Occurrences of low dissolved oxygen levels take place in the central Grand on very hot summers and during periods of low stream flows and high stream temperatures. When river flows are higher and temperatures are cooler, there were few instances of low dissolved oxygen levels.

Summary of Sites Exhibiting Trends in Water Quality

Temperature is an important physical parameter of streams as it is a critical indicator of stress on aquatic organisms. Increased water temperatures impact oxygen saturation of freshwaters thereby impacting metabolic rates, growth and reproduction of freshwater fish (Gordon et al 1994). Twenty four degrees is generally the temperature threshold between cool water and warm water fish species (Stoneman and Jones 1996). Even though the reach on the Grand River between Bridgeport and Glen Morris and the Speed River between the Hanlon and Road 32 are classified as warm water fisheries, prolonged periods of time that temperatures are above 24°C creates stress on the aquatic organisms that inhabit these areas of the river.

In 2004, the percentage of the time between June and September temperatures rose above 24°C ranged from one percent in the Speed River at the Hanlon to nine percent in the Grand River at Glen Morris. Generally, these reaches of the Grand and Speed Rivers are considered warm water fishery habitat

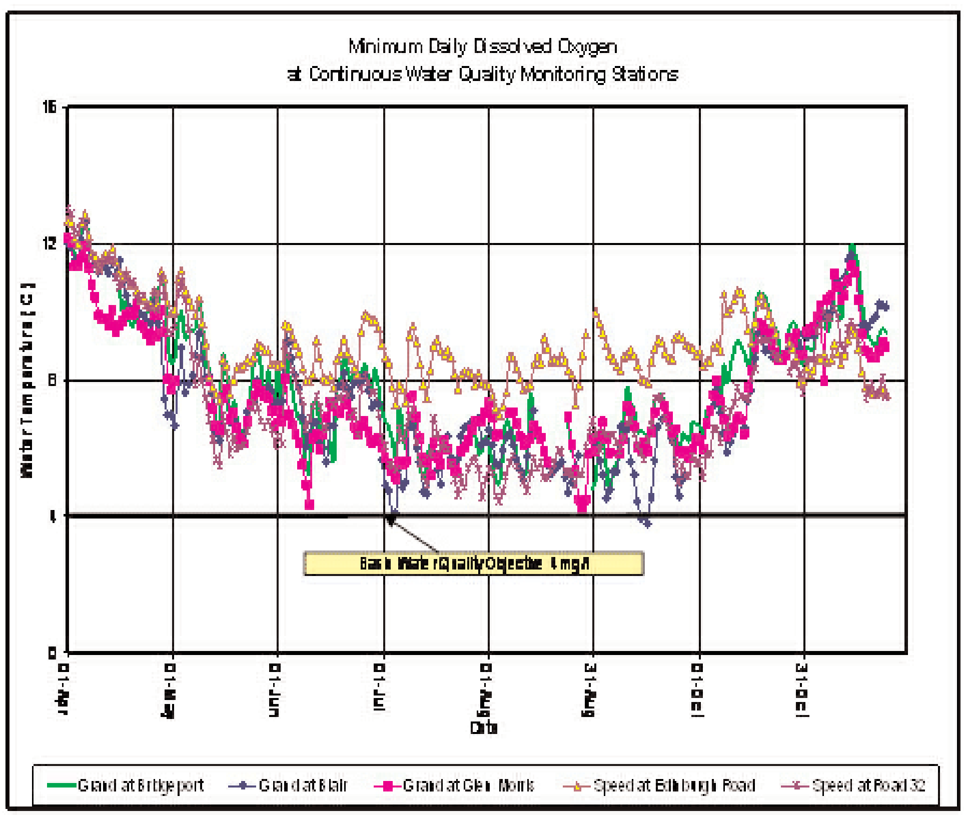


Figure 9. Minimum Daily Dissolved Oxygen at the Five Continuous Water Quality Monitoring Stations in 2004.

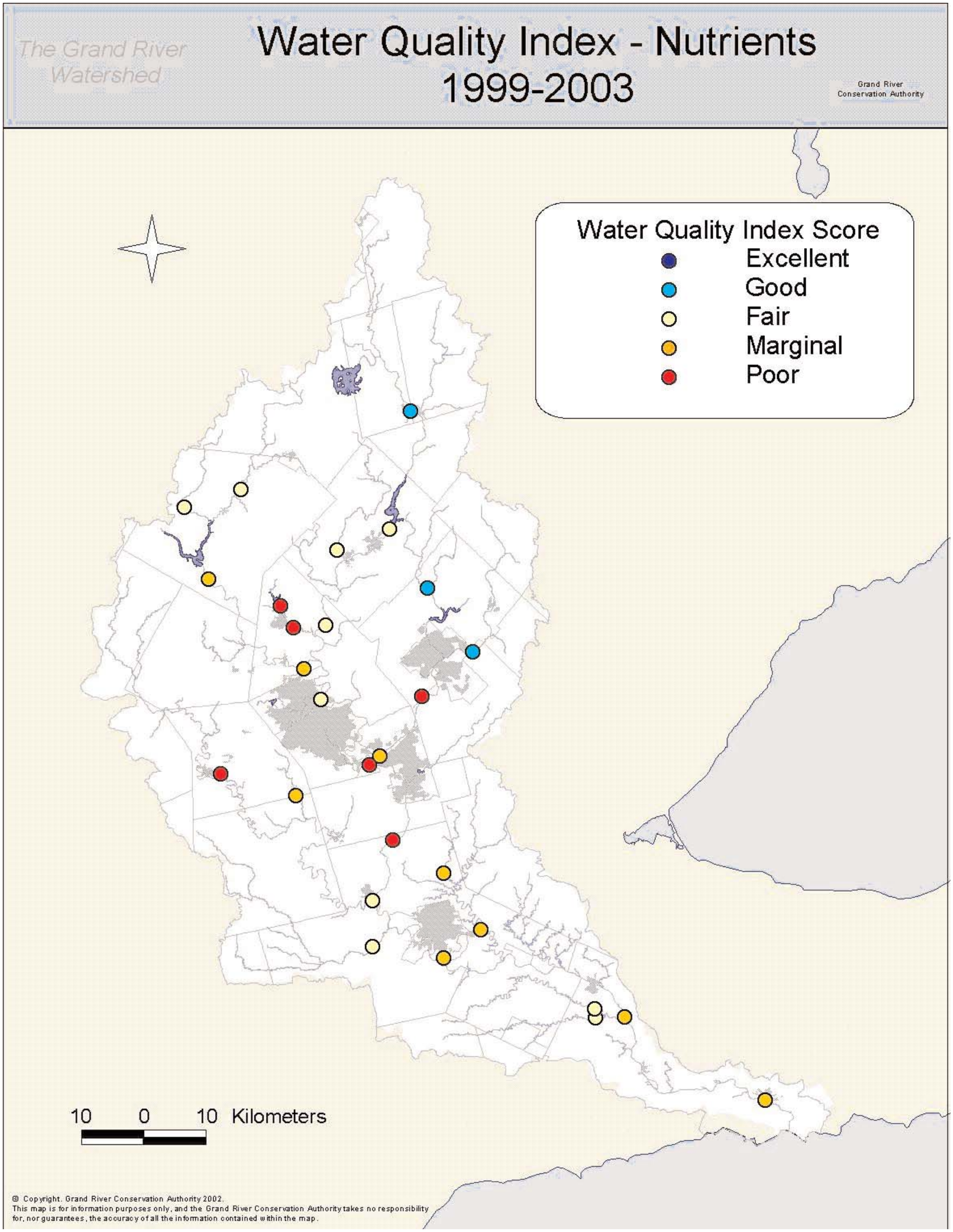


Figure 10. Map of the Grand River Watershed Illustrating the Water Quality Index Scores for Nutrients (1999-2003) for the 28 Monitoring Sites in the Grand River Watershed.

but the longer periods of time temperatures are over 24°C , more stress is experiences by the fish inhabiting these reaches.

A healthy river will support many different types of organisms, from small insects to prize winning game fish. According to a survey carried out in the Grand River during 1999-2001, the impact of pollution on aquatic insects is moderate.

5.4.1 Rural Water Quality Program

A major program working with agriculture and rural landowners was started in the early 1990's. This program, The Rural Water Quality Program, focuses on shared costs to develop riparian zones along streams and ponds on private properties. It targets restricting access of livestock and run-off from manure storage areas into streambeds and ponds. Another target is run-off from agriculture chemicals, fertilizers and silt from freshly cultivated and fallow fields.

A riparian zone provides a buffer between the crop, grazing lands and livestock holding areas and the stream. Even very small streams are significant. This buffer serves to trap and partially consume contaminants before they enter the streambed. A buffer zone is typically made up of native grasses and wild flowers, small shrubs and trees and is left undisturbed.

The many small feeder streams passing through active agricultural land can have a significant impact on contaminates entering the main stem of a waterway. By managing the drainage into these small streams the contamination can be significantly reduced. Not only does the Rural Water Quality Program help to reduce contamination, it also works to conserve water on the property where the program has been introduced. Farm inputs that run off the fields are of no benefit to the crop and contribute to high phosphate and nitrate content in the water. These lead to high plant growth and low oxygen values in the waterway.

Before a Rural Water Quality Program fencing, cattle access damaged water quality and the stream bank at this small stream in Brant County.

After the landowner installed fencing with the help of the Rural Water Quality Program the water quality and habitat values of this site were quickly improved.

6.0 Biological Resources

The Grand River Watershed, specifically the Exceptional Waters Reach, is rich in aquatic and terrestrial resources. This is the legacy of the land and a result of the complex geology, topography and land-use land use practices in the watershed.

6.1 Aquatic Communities

6.1.1 Fish Communities

Before early settlers arrived First Nations people living on or near the Grand found much of their food source to be fish. Evidence of this is found in archeological excavations near the riverbanks. Larger settlement by Loyalist First Nations and other Americans began the decline of the rivers as good fish habitat. Forests were removed for their lumber content and to establish agriculture. This started the loss of shoreline fish habitat and allowed sediment and silts to enter the waterways. Human and animal wastes were dumped into the river as a disposal method. As the population continued to grow and more people needed food and other resources industry developed in the form of mills, most of which were powered by water. Dams were established to create the waterpower needed to run the mills, resulting in the loss of access to spawning grounds traditionally used by fish. Dams create barriers to natural migrations. The building of the dam at Dunnville to facilitate upriver boat traffic and as a feed for the canal connecting Lake Ontario to Lake Erie was a crowning blow to fish migration on the river. Efforts to build fish ways were limited and lacking in functionality. The combination of forestry, farming, industrial practices together with the communities dumping of waste contributed, in a relatively short time, to the demise of fish habitat and subsequently fish. Despite improvements since the establishment of the Grand River Commission followed by the Grand River Conservation Authority, some have yet to return.

Brook trout were eliminated from most of their native range in the Grand River watershed between 1850 and 1880 as a result of degradation of habitat and water quality associated with urban and agriculture development. Some remnant populations persisted in headwater steams draining swamps that were not cleared for agriculture and in first and second order streams on sand plains or kames that received abundant groundwater discharge despite deforestation. Of note in the Exceptional Waters reach, feeder streams such as Whitemans, D'Aubigny and the Nith provided this habitat.

Fish harvested commercially in the late 1800's included pike, muskellunge, channel catfish, sturgeon, bass, suckers, mullet (redhorse) and whitefish. Sturgeon was particularly abundant during this period.

Today, the Grand River watershed is home to over 80 species of fish. Table 3 from Wright

Geographic Area	Number of Species	% of Total
Canada	181	100
Atlantic Basin	142	78
Ontario	132	73
Grand River Basin (confirmed)	80	66 (61)*
Grand River Basin (probable)	92	5 (70)*

* Brackets are the percentage in relationship to all species in Ontario

Table 3: Summary of Species Richness of the Grand River Basin in Comparison to other Geographic Areas of Canada (from Scott and Crossman 1971 and Wright and Imhof 2001)

you consider that the Grand River contains 44% of all species of fish found in Canada and 61% of all species found in Ontario. If we include probable species that need to be verified, the numbers increase to 51% of all species in Canada and 70% of all species in 0 The range of species in the Grand River basin is even more impressive when you consider the river has had a long history of neglect and abuse. It has only been in the last 30-40 years that major attempts to clean up the river and bring it to a level of health have been successful. The present fish community in the Exceptional Waters Reach of the Grand River is illustrated in Table 4. Missing from this table are brown trout, river redhorse suckers, and channel catfish which also exist in this reach.

The preceding table provides an indication of fish species that have been found at various times in Ministry of Natural Resources studies since 1966. A number of species that had virtually disappeared, such as the bass, have returned and established significant populations. Others, such as sturgeon, have not. Other introduced species were not present in historical data prior to the building of canals and large-scale commercial international shipping traffic.

In some years, the lack of a species may be more the result of sampling frequency and location rather than an actual lack of presence.

Anglers and fisheries experts have seen a dramatic improvement in the number and distribution of high quality sport fish throughout the Grand River over the past 20 years. A study of the Grand River in 1967 reported no smallmouth bass upstream of Brantford. Today, they have re-colonized the central Grand River, between Brantford and West Montrose, suggesting significant improvements in water quality. The same is true of a world-class brown trout fishery that has been established in the Fergus-West Montrose area.

In addition, pike and smallmouth bass are doing well in Belwood, Conestogo and Guelph Competition from brown trout and rainbow is a concern in brook trout areas. Small dams that provide a barrier to the introduced species protect some of the brook trout reaches. The design or construction of these old dams act as barriers, even to trout that can jump fairly well (i.e. rainbow trout). Brown trout have been stocked in a number of tributaries over the years, most recently, in the tail waters of the major dams in the Upper Grand where a constant source of cold water is maintained year round. They have yet to become self-sustaining.

The stability and establishment of these populations can be attributed, in part, to a long-term change in landuse practices by many landowners to allow the riparian areas to re-develop. The main river is now an active spawning and rearing ground for bass, walleye, and pike among other warm water species. Large populations of sucker species (some rare or at risk) and carp are also evident. Fishing within the Grand River and its tributaries has begun to attract anglers from local communities, regionally, nationally and internationally as the river develops a reputation for a quality recreational experience.

6.1.2 Fish Habitat

The original fish population in the Grand found their home to be a combination of fully vegetated landscape with deep channels, relatively unaffected by seasonal weather variances. Water was released from natural holding areas in a fairly constant flow. The waters were relatively cold and well-aerated, shaded areas provided protection on the banks and food was plentiful. Large wood debris jams, islands and branching side channels and floodplain pool complexes were common and increased the amount of complex habitats for a large variety of fish species.

The increased settlement began to have an impact. Sediment introduced from forestry and agriculture operations and the irregular flows, high in spring and low in summer, began to decrease fish populations by filling in pools and spawning areas and by adding additional nutrients. The low summer flows introduced broader temperature fluctuation, reduced oxygen content and provided harmful conditions that would no longer support fish. This situation was not to change until the first quarter of the 20th century when devastating spring flooding year after year finally brought the realization that something needed to be done.

The Grand River Commission was established to determine ways to correct the flooding and regulate the summer low flows. Over an extended period of time, and with multi level government input, large dams with sufficient holding capacity to keep back part of the spring flows and to release water in summer low water conditions were constructed. This helped to improve fish habitat through the extreme low flow periods during the summer. Modern programs that try to reintroduce conditions that existed prior to heavy settlement, such as rural water quality programs limiting livestock access and re-growing riparian zones beside smaller waterways, have contributed to the return of smallmouth bass population. The new, larger dams, by providing a cold tail-water flow from bottom discharge, have established an environment that will support cold-water brown trout species. The programs have also allowed natural small tributaries to clean out and go back to being able to sustain a brook/speckled trout population.

Migratory rainbow trout, or also called steelhead, have been introduced from Lake Erie and are now established in parts of the watershed. They had been present below Brantford but never had access to reproduction or spawning areas until the failure and removal of the Lorne Dam. This allowed the migratory rainbow from Lake Erie access to spawning areas on the Grand River and its tributaries upstream to Paris including the Nith River and its tributaries. Rainbow trout are now established in parts of the watershed. There is concern about the introduced brown and rainbow providing unnatural competition to the native brook trout.

Many old dams now in disuse are deteriorating and being breached. As this occurs they are generally not being replaced. As the structures are removed natural flows are being created, providing more sustainable fish habitat.

The role that in-stream dams play and have played in the fragmentation of river habitat cannot be underestimated. The development of dams for milling and power helped to create the prosperity that we enjoy today. However, this prosperity came and still comes at a cost. For example, recent research by a number of scientists suggests that coldwater fish such as brook trout utilized more portions of the watersheds than they do today. Brook trout do have a tendency to move great distances for over-summer and over-winter habitat. There is strong evidence from the Grand River and other rivers that larger adult brook trout once used the main stem of larger rivers such as the Grand for over wintering habitat. These fish would spawn in late fall in the headwater streams and after spawning would migrate downstream to the large river to over-winter. The large river would provide more habitat space, better food and other resources for the winter. These fish would remain in the large river until it warmed in late May and then would migrate up into the tributaries for the summer and until after spawning in the fall. Therefore, large warm-water rivers, adjacent to coldwater tributaries were major habitats for coldwater fish that we always thought only lived in the small coldwater tributaries.

The development of mill dams on our coldwater tributaries cut these larger fish off from critical over-winter habitat and ultimately led to smaller populations of smaller individuals. Other species of fish also show strong movement tendencies between tributaries and larger streams. Therefore, as small dams are breached or removed, we may once more reconnect the river and its fish populations to the tributaries.

A return to an environment where beaver dams were the major hindrance to migration is again occurring, especially in tributaries that provide the prime spawning grounds for trout populations.

6.1.3 Exceptional Waters Fish Communities

The Exceptional Waters reach of the Grand is an area that has seen a rebirth of the fish population. The smallmouth bass population is healthy in numbers and is beginning to rebuild in size range. Migratory rainbow have colonized this reach of the Grand after the removal of the Lorne Dam in Brantford in the late 1980's. Rainbow trout are now common and fish over 2.25 Kg are regularly caught. The tributaries within this reach of river, particularly the upper reaches of these tributaries, have natural populations of brook trout. Rehabilitation efforts aimed at sustaining and enhancing these populations are supported by numerous conservation and environmental organizations. Conservation groups, including Brantford Steelheaders, Brant Rod & Gun Club, Bell City Anglers, Pauline Johnson Environmental Studies and Trout Unlimited Canada have been active in rehabilitating tributary creeks and providing improved habitat for the cold-water species. Brook trout do not seem to be increasing in Whiteman's Creek; however, efforts are being made to protect them on a variety of tributaries of the Nith, Cedar Creek and other streams.

The upper section of the Exceptional Waters has been designated a special fishing sanctuary area for all major game species. This was accomplished in 2001 to protect and restore the game fish population in this reach of river, especially smallmouth bass. With the removal of the Lorne Dam in 1988, rainbow trout populations in this reach began to rapidly increase. Rainbow trout are also protected because this reach of river acts as a staging and over-wintering area for trout spawning in the Nith River and Whiteman's Creek. Protection for trout was also afforded to this section because of the emergence of a stream-resident rainbow and brown trout population as well.

Smallmouth bass populations in this reach exhibited signs of over-harvest, especially for the large, older fish. There were many smaller bass, but very few over 40cm (14" in length). In a lake, larger, older spawning smallmouth bass (e.g. 18" fish) are approximately 7 or 8 years old. In rivers, due to their more extreme conditions, river bass may take as long as 15 years to reach the same breeding size. The special regulation area is a catch and release zone where only artificial bait and barbless hooks are allowed.
This is intended to allow the populations of game fish to grow larger and develop healthy stable populations exhibiting a full range of size and ages.

The Exceptional Waters Reach of the Grand River also contains a large number of other fish species that are either rare, threatened or at risk in Ontario and Canada. Of these species, the various species of Redhorse Sucker are perhaps the best known. The Grand from the EW reach downstream to Lake Erie has one of the highest diversities of Redhorse Sucker species in Canada.

There is still some question about the suitability of some stretches of the river as a habitat for higher quality fish. The southern Grand, near Dunnville and Port Maitland should be a prime place for walleye, but populations are not as high as would be expected.

The rebirth of the fishery is just one sign of the rebirth of the river itself. The Grand has come a long way since it was dismissed as an open "sewer" but faced with the prospect of high population growth and more intensive farming. It will be a constant job to stay on top of the water quality issues facing the Grand River watershed.

6.2 Aquatic Invertebrates

The benthic community which includes the invertebrate populations in and on the river's substrate has a significant impact on fish and birds as they form a major element of the food chain. The invertebrates ingest contaminants that enter the water. As the contaminants move up the food chain, the build-up starts to impact the higher-level predators. The impact of contaminates in the natural food chain was dramatically demonstrated in the 1950's and 60's. DDT and related pesticides created a major and rapid increase in abnormalities, followed shortly by a loss in egg fertility and the ultimate disappearance of top of the pyramid predators. This was most noticeable in the avian population but on closer inspection was evident in fish and river reptiles and mammals. The benthic community is also affected by lower river flows. The low flows contribute to a build up of sedimentation while temperature fluctuations increase. The invertebrate populations important to fish are reduced in numbers and variety, further contributing to a reduced and lower quality food supply.

The invertebrate population appears to have recovered significantly over the last 25 years. The sensitive and somewhat sensitive species appear to be growing in number and diversity. Studies are underway through the EW Community Advisory Committee to substantiate these changes. Many of these benthic invertebrates make up an important compo-

Aquatic invertebrates are a key indicator of water quality. The populations are healthy and large in the exceptional waters reach.

nent of the fish population's diet. The more diverse species and larger numbers showing up in recent samplings are very positive trends in the ecology of the Grand River. Watershed management, improvement of water temperatures and reduction of sediment flushing off the landscape are important actions in order to continue to build healthy aquatic invertebrate populations.

The waterway is home to a large population of mussels. They are an important food source to a number of species both aquatic and land based. In this reach of river, some mussel species are considered at risk.

The wavy-rayed lampmussel is considered Endangered by COSEWIC. Though the wavy-rayed lampmussel is not reported in the Exceptional Waters area, these mussels do occur upstream in the Grand River, in the Nith River and shells have been found downstream of Brantford (Morris, 2003). As a result of their distribution upstream and downstream, Dr. Morris anticipates these mussels likely occur throughout this section of the river, but this area has not been adequately sampled (pers. comm. Mar. 18, 2005).

6.3 Fisheries Management Planning

In 1995 the Ministry of Natural Resources and the Grand River Conservation Authority with a host of conservation groups as partners, began the development of the Grand River Fisheries Management Plan. This major study examined the river in depth as a fish habitat. The Grand River Fisheries Management Plan reviewed the status of the fisheries resource within the Grand River watershed and provided direction on how this resource and the land base that affects it can be managed. The study serves two purposes; namely, as a stand-alone fisheries management plan and as an integral component of the watershed management plan being developed by the Grand River Conservation Authority. In 1998 at the completion of the study, the partners became the GRFMP Implementation Committee with the stated objective of implementing the "Best Bets" identified in the plan.

The Grand River Fisheries Management Plan was a multi-agency, multi-partner effort that has become a model on how to design a fishery management strategy for a watershed or specific waterway. In the end there were 42 "Best Bets" to implement a sustainable, effective management of the resource. The effort to implement the "Best Bets" is an on-going process being guided by an Implementation Committee composed of many of the original partners.

Part of this project included the listing of fish species found at that time in the river. D. Coulson of the Guelph District of the MNR compiled a list that identified 80 confirmed species in the Grand River. A number of these were designated as vulnerable or threatened. There were an additional 12 species probable and six possible. One species was recognized as extinct. This list can be found in appendix 1 of the GRFMP. The fish populations continue to be monitored as a continuing process.

The Management Plan between 1995 and 1998 was a massive effort to examine and look for ways to continue to increase the improving fish populations. There were two goals behind this initiative, one to build a recreational fishing opportunity but foremost, to continue to improve water quality. With improved water quality came the better fishing. The better fish populations also attracted many other animals and birds to the area.

The Fish Management Plan fish community objectives for the main stem of the Grand in the Exceptional Waters reach had two focus points. The first, with respect to the diverse warm water fish community, was to have top predators such as smallmouth bass; pike and walleye dominate the population. The second was to develop a seasonal coldwater community dominated by migratory rainbow trout and to protect and where possible enhance the emerging river resident rainbow trout population.

There are five issues concerning the objectives of the EW reach:

- Water quality and quantity impacts through urban landscape practices;
- Inadequate information on issues such as the baitfish industry, angler harvest and use and public access points;
- Fish habitat impacts on migration below Wilkes Dam, loss of habitat from land use and urban encroachment;
- Fish population impacts such as competition between trout species and over harvest of smallmouth bass below dams;
- And ineffective communication with the municipalities and the public, inadequate knowledge transfer to the public and partners, inadequate familiarity with Ontario Fishery Regulations and ineffective communication between the commercial baitfish industry and the public regarding harvesting practices around trespass, ethics and sustainability.

A number of strategies and tactics were developed within the plan to address these issues and these are being implemented in part through the Exceptional Waters Community Group.

Rainbow trout like this one caught near Five Oakes are fall and winter residents of the Exceptional Waters area.

Table 4: Species Found in the Exceptional Waters Reach,(MNR, Ontario)

Fish Species	1966	1971	1972	1973	1975	1977	1981	1987	1997	1999	2000	2001	2002
American Brook Lamprey					x				x				
Rainbow Trout									x			x	
Northern Pike		x			x							x	
Mooneye									x				
White Sucker	x	x	x		x	x		x	x	x	x	x	
Northern Hogsucker	x	x			x	x		x	x	x	x	x	
Redhorse (Various)					x			x	x				
Silver Redhorse		x							x	x	x	x	
Black Redhorse									x			x	x
Golden Redhorse									x			x	x
Shorthead Redhorse		x							x	x	x	x	x
Greater Redhorse		x							x			x	
Common Carp		x	x		x	x			x			x	
Brassy Minnow			x										
Chubs (Various)								x					
Hornyhead Chub					x	x	x					x	
River Chub		x			x	x	x		x				
Shiners (Various)								x					
Emerald Shiner		x	x										
Common Shiner	x	x	x		x	x				x	x	x	
Rosyface Shiner		x			x	x				x	x		
Spotfin Shiner		x								x	x		
Mimic Shiner									x	x	x		
Bluntnose Minnow	x	x			x	x	x		x	x	x	x	
Blacknose Dace						x	x						
Longnose Dace	x				x	x		x	x			x	
Creek Chub					x	x						x	
Silver Shiner				x	x					x	x		
Striped Shiner									x	x	x	x	
Brown Bullhead		x	x		x							x	
Stonecat		x			x				x				
Tadpole Madtom	x												
Brook Stickleback		x											
Rock Bass		x			x			x	x				
Pumkinseed		x	x										
Bluegill		x	x										
Smallmouth Bass		x	x		x			x	x	x	x	x	
Largemouth Bass		x											
Black Crappie		x											
Yellow Perch		x			x	x			x				
Walleye		x	x		x							x	x
Eastern Sand Darters								x					
Greenside Darter									x	x	x	x	
Rainbow Darter	x				x	x			x	x	x	x	
Fantail Darter					x								
Johnny Darter		x			x			x	x	x	x	x	
Logperch									x				
Blackside Darter					x	x			x			x	

7.0 Terrestrial Resources

The Grand River valley in the Exceptional Waters area has extensive forest cover throughout the rural areas. Although the forest cover is concentrated down through the Grand River valley, it does extend outside the valley in many locations, particularly where small-incised watercourses enter the valley.

The Grand River Valley is a spillway that cuts through a horseshoe moraine and the Norfolk Sand Plain. Due to the permeability of the sandy soils in this area, the soils recharge water and dry quickly. As a result, historically, large patches of the surrounding landscape and portions of the valley included prairie and oak savannah. Today, along the steep upper portions of the valley, the vegetation includes a mosaic of remnant provincially significant dry tall-grass black oak savannah, dry to fresh red oak forests and dry to fresh white ash deciduous forest. The valley tablelands sustain remnant tall-grass prairies and savannah, as well as cultural fields, thickets, plantation and woodlands. Other Carolinian forest types found within the valley include black walnut and hackberry forests (North-South Environmental Inc. April, 2005). Most of the deciduous forests show evidence of recent selective logging.

The savannah and prairies located within the valley are threatened by succession and non-native species. Where canopy openings occur as a result of trees falling over or past agricultural practices, prairie and/or savannah species can be found. On the upper slopes, white ash grows between the open-grown oaks, resulting in shading-out of the tall-grass under story. As a result of the shading, the prairie species can be limited to spring flora species that flourish before the canopy leafs out. Gray dogwood is invading open, dry areas of savannah, while garlic mustard and dame's rocket are dominating the ground cover in areas where the soils have been disturbed, and in the floodplain. Common buckthorn forms a dense shrub layer along the mid-slope areas and along the bottomlands (North-South Environmental Inc. April, 2005).

Due to the steepness of the valley, wetlands are generally limited to a narrow fringe along the river. These wetland communities include reed canary-grass meadow marsh and thicket swamp. The unique geology of the area has resulted in seepage along the valley wall and the formation of a Perched Fen wetland. This perched mineral prairie fen represents the largest and least disturbed example of this globally rare plant community in North America (North-South Environmental Inc. April, 2005).

Though there are many non-native species within the plant community, there are many rare significant species, such as: common hop tree, dwarf chinquapin oak, sweet pignut hickory, pignut hickory, green milkweed, midland sedge, northern drop seed, rigid sedge, bristly buttercup, eastern yellow star-grass, and hairy fruited sedge.

The Ministry of Natural Resources is studying the Grand River valley and its contiguous forested areas from Paris to Brantford as part of a candidate Area of Natural and Scientific Interest, (ANSI). The area above Paris to Cambridge is already designated. The project has undertaken one field season of inventory work and a partial analysis to determine the representation of these features within Ecodistricts 7-6 and 7-2.

The Grand River is considered provincially significant as a linear connected watershed. Because of the nature of the lands adjacent to the river, a contiguous vegetative zone occurs along much of the river's length. This connection is possible because highly variable water flow and significant groundwater discharge dictates an area down through the valley that is flood plain or wetland for much of the watershed. This natural zone allows wildlife to move freely in the watershed. A roaming herd of white tailed deer in Brantford's wooded zone use the corridor to move up and down the area, providing an excellent demonstration of how the corridor functions.

The designated ANSI corridor between Paris and Galt is located along the boundary between two major ecoregions of southern Ontario, namely the Great Lakes - St. Lawrence Forest region and the Deciduous Forest Region or Carolinian Life Zone. The forest areas can generally be characterized as a mosaic of dry-mesic upland forest interspersed with seepage slopes and mixed forest swamps. This 18-kilometre stretch of the Grand River from the Cambridge city limits to approximately four kilometres north of Paris comprises 790 ha of contiguous natural area, including riverine bottomland, slopes, and bank ridges. The area also includes a narrow outwash terrace along the river comprised of gravel and sand derived from the Galt and Paris moraines. The Grand River Forests offer one of the best examples of a largely unbroken, naturally vegetated riverine corridor in southern Ontario. The area also provides excellent examples of forest interior habitat within a landscape of agriculture, aggregate extraction and encroaching rural estate development.

Modern development is discouraged in this zone in order to protect the sensitive ecosystem. Development as exemplified by the remnant historical building, such as in the riverfront through the downtown area of old Galt, now part of Cambridge, and Paris, would not be allowed in today's climate. Much of the impetus for control of the river in the early1900's was due to flooding on the main streets of streamside communities where buildings were allowed in the river's historical flood plain.

The predominately warm microclimates in the sheltered river valley system have promoted the growth of a variety of Carolinian species that are typically associated with more southern climates of the Carolinas in the southeastern United States. Sassafras, sycamore, and tulip trees can be found within this area. Some species such as the American chestnut and butternut are still prone to disease, and are considered very rare in Canada.

Prairie communities occur to the south of the City of Cambridge and include specific zones in Brant County. The prairie along Highway 24 is quite extensive (1 ha) while other remnants are much smaller. However, they contain a number of unique herb associations not represented elsewhere in this region. These prairies are remnants of formerly much more widespread prairie and savannah ("plains" and "oak plains"), which occurred here prior to European settlement. These prairie remnants occur on the well-drained stony loam soils of the Galt Moraine, and the sandy soils of the lower-lying spillway that abut the moraine. They are located on the crests of bluffs, along their slopes and along the level railway right-of-way that parallels the Grand River, and small, dry, sandy knolls surrounded by marsh.

The vegetation communities include dry and dry-mesic prairie types. A few open-grown oaks likely of pre settlement age are also found here. These remnants support a wide variety of plant species, including 31 prairie indicator species and three provincially rare species.

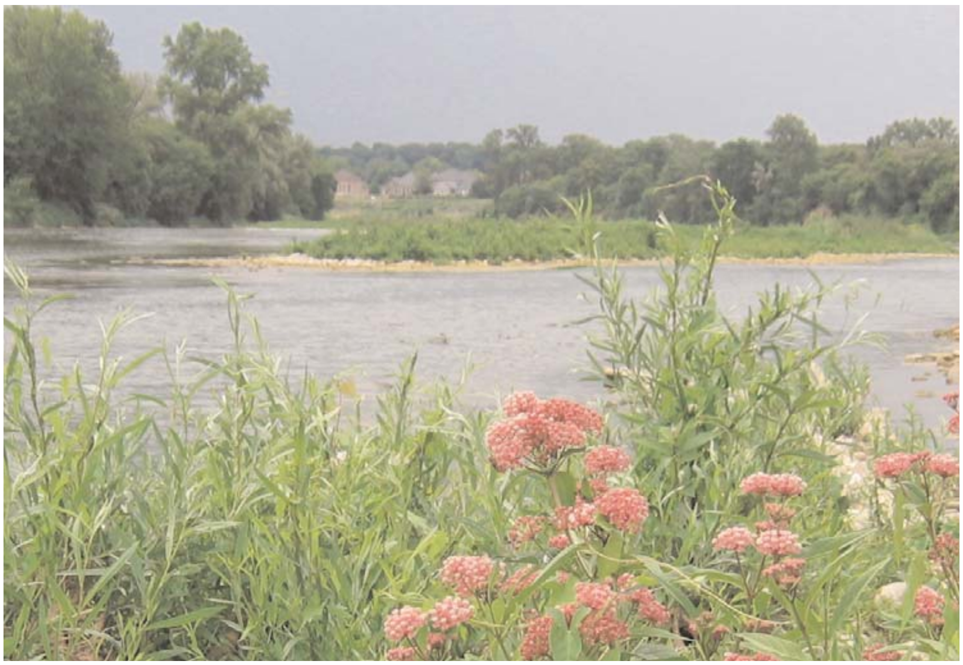
7.1 Vegetation

The Exceptional Waters zone is only a short distance south of boreal habitat and some of the older bogs and wetlands have residual populations of species such as black spruce and tamarack. A major challenge in boundary vegetation is preserving small rare plant communities and keeping them isolated from urban development and intrusion by over curious visitors. These vegetative populations also need a critical mass to provide for the sustaining existence of the habitat. Traditional methods of maintaining these areas included natural burns, usually from lightning storms. Some of these methods are difficult to practice in developed urban areas.

Another factor in retaining rare vegetative populations is holding an unbroken band of vegetation. Isolated areas, separated by urban development and industrial subdivisions do not allow the free flow of the bird and insect populations that do much to propagate the plant species. The Grand River watershed and stream corridor includes this type of contiguous unbroken vegetation zone. To maintain these vegetative communities and populations, habitat modification needs to be restricted and municipalities need to recognize the benefit to the human population in retaining these zones. Benefits can include recreational pursuits such as hiking, biking, canoeing, fishing and the enjoyment and study of the natural habitat as well as the preservation of the water quality and quantity.

In the Exceptional Waters reach we find two significant habitats considered rare: remnant tall grass prairie; and a perched fen.

Tall grass prairie, originally maintained through natural fire, is currently maintained through man generated controlled burns. Due to the proximity of built up areas this type of management requires careful planning and cannot always be activated at appropriate times for the prairie. There are a number of small patches of Tall Grass Prairie under management by the GRCA and the City of Brantford.



The Exceptional Waters area has a healthy river valley with a diversity of vegetation and wildlife.

The second rare habitat, the perched fen, is a natural wetland. Wetlands occur when the geological and soil composition of the landscape creates an opportunity for the retention or discharge of water, creating wet soils. A perched fen exists because of gravel deposits with the right composition of sand and gravel releasing the water slowly and constantly down the face of a slope. The constant release of moisture provides a habitat for vegetation usually found in flat, low-lying areas rather than on the face of a steep slope. The perched fen is a sensitive habitat and can be destroyed by the removal of gravel a considerable distance away. This removes the moisture holding base, thereby lowering the water table it needs for its constant water supply. The movement of people through a perched fen is destructive to its fragile structure and plants. Guarding this special environment from development is important to a community. Brantford is fortunate to have a perched fen within its boundaries.

7.2 Wildlife

There is an abundance of wildlife in the Grand River corridor. The river and its riparian zones provide a significant amount of suitable habitat for a wide range of animal and bird life. It is very common to see white tail deer, raccoon, black and grey squirrels. A conscientious observer will also spot red and flying squirrels, chipmunks and other rare or nocturnal habitants. Not as evident but present are red fox, coyotes, mink and weasel. Beaver and muskrat populate the marshes and streams. Also noticeable are skunks and opossums. The above list includes only a few of the mammals' common to the area.

As a consequence of the existence of these animals in our urbanized areas, we unfortunately see most of them as road kill adjacent to or on our modern superhighways and many connecting roads.

The bird population, especially raptors, has made a significant recovery in the watershed. Two species in particular, the bald eagle and the osprey depend on healthy, low contaminant fish populations. These two species once more reside in the Grand River watershed. They are especially noticeable in the Exceptional Waters reach and efforts are being made to establish nesting sites for these two species.

Many other raptors are now common residents. Other fish seeking birds, the Great Blue Heron and Kingfisher in particular, are well established. A significant heronry has been established within the area. Great egrets and least bittern can also be found in the reach but are currently considered threatened in a broader area of the province and country. The reintroduction of wild turkeys has been very successful and they are now considered common throughout the valley.

Some avian populations are challenged by habitat changes. If either a food source or a cover type is lost over time, a species of bird will be lost with it. Examples of bird species at risk in this area include the prothonotary warbler, king rail and red shouldered hawk.

Reptiles also have representatives on the "at risk lists". In the Exceptional Water's area the queen snake, Jefferson salamander, map turtle and Fowlers toad are of concern and interest. There have been reported sightings of the queen snake in sections of the Grand and Whitemans Creek in this reach of the watershed. This is one of the few areas of concentrations of the species in Ontario. Sightings of the spiny soft shell and Blanding's turtles are occasionally made at Brant Park.

8.0 Human Usage

The Grand River is used by a wide variety of people for many purposes. These people are canoeing and fishing along the river.

The Grand River is the major source of drinking water for Brantford and Six Nations and unfortunately is also a disposal destination for rural and urban runoff and for treated effluent from wastewater treatment systems. The ability of technology and land use practices to improve the quality of the river by reducing the level of effluent additions can be a redeeming factor with respect to quality. Improved rural land management practices, especially relating to agricultural, are also contributing to improved water quality.

8.1 Recreational

Since the river improved recreation activities have begun to return to the Grand. The improvement in water quality increased fish populations. This attracted anglers. A more pleasant and esthetically pleasing appearance to the river corridor made surface travel by canoe, kayak and rafts more pleasing. Managed water flows provided an adequate depth to make the experience pleasurable. The Grand River and especially the Exceptional Waters reach are gaining a well-deserved reputation as a destination of choice for a very pleasurable water experience. FitzGibbon and Plummer from the University of Guelph conducted a user survey in 2000. Their findings are listed below:

- Estimated that approx. 7963 people used the Paris-Brantford section in 2000 (approx. 498 people/km or 4 persons/day/km);
- Strong use during the "shoulder months" of May, June and September;
- Greatest Primary reasons for trip were: canoeing (50%); hiking (40%); fishing (30.9%) and cycling (18.1%);
- Greatest targeted fish species is Smallmouth Bass;
- Expenditures presently are on travel and food and beverages

The number of people using this section of the river has likely increased since 2000.

8.1.1 Water

Within the Exceptional Waters three local and a number of nearby outfitters provide guides and equipment for consumers to experience the reach by canoeing, kayaking, rafting and fishing. In excess of 25,000 people have visited the river for an on water experience between Cambridge and Brantford in each of the past two seasons. Many others own their own watercraft and utilize the resource on their own schedule. Fishing is increasing as a recreational activity as the reputation of the quality of the Grand River spreads.

8.1.2 Trails

Organizations such as the Trans Canada Trails and Brant Waterways Foundation with support from the Grand River Conservation Authority and local Parks and Recreation Departments have established an extensive system of trails. Along the Grand some use old rail right-of-ways and others dikes and natural pathways. The rail trail system in the Exceptional Waters reach runs adjacent to the river from Cambridge to Brantford and then overland to Dundas. There are numerous side trails connected to the system and more in the development stages. The river corridor exhibits a variety of landscape and habitat types, some quite rare. Reference to a perched fen, long grasses prairie habitat and unique wetlands are highlighted in the trail guide for the Gordon Glaves Memorial Pathway, an adjunct to the Trans Canada Trail. Over 30 kilometers of trail can be found within the Exceptional Waters reach.

9.0 Issues and Threats Affecting Exceptional Waters

Major progress has been made in identifying challenges and improving water management and quality since the inception of the Grand River Commission in 1934. A significant bank of data has been collected to aid in determining what actions would best benefit the watershed and its populations. The river is no longer considered an open cesspool. Measurements show where we have improved the management of the resource. These same measurements demonstrate areas where more improvement is needed. While we have made significant progress in many areas we can also identify areas where we have reached a plateau and in some situations are moving in a backwards direction. New challenges are being identified and new practices being developed to address the challenges.

We have reached a plateau with respect to phosphorus. The removal of phosphates from laundry detergents in 1974 provided a major drop in their levels. A slow drop has continued but we are still over twice what the Provincial Water Quality Objectives have as a target. Chlorides have shown an increase, especially in the spring. This is attributed to the use of road salt over the winter. New practices are being explored to use alternate means of melting snow or alternate methods of application of salts that would significantly reduce the levels used. A secondary source of chlorides is water softeners. Nitrates and ammonia levels are remaining somewhat constant although in a small number of the 28 testing stations are increasing. Suspended solids are remaining more or less constant. Farm practices, such as conservation tillage and more careful application of chemicals have led to some of the improvements. Implementing Rural Water Quality programs along with continuing improving chemical application practices will help to continue improving water quality. Each little stream or small wetland ultimately impacts on the quality of the water reaching the main stem of the watershed. The fewer contaminates we add means less to remove.

Over time we have viewed wetlands as a nuisance and a detriment to development. It is apparent that by destroying major amounts of wetland we have hindered our ability to control our water quality. In addition to acting as reservoirs for the water they also act as primary treatment plants in removing contaminants. Contaminants move into the wetlands and minor streamlets from surface water runoff and storm sewers.

9.1 Urban Surface Water

Roads and storm sewers can also create their own water quality and quantity problems. In some urban systems virtually all natural wetlands and streamlets have been removed or buried. They are no longer available to gather and process surface moisture from rain and snow. These run-offs are now diverted to storm sewers, most which traditionally are then directly piped to the streams and rivers with no primary treatment. This runoff can contain nutrients and chemicals and animal feces that are gathered by run-off from rain and snow from lawns, sidewalks and roads. As well, this run-off can also collect oils and tire residues from the roads, chlorine from pool backwashing, paint and other wastes that some residents dispose of through the storm drains, leaf and grass clippings that get pushed to the roadside and sand, silt and dust that collect to ultimately join together in the underground piping where they are mixed into a nutrient and contaminate rich mixture that goes directly to the river. As it enters the river it become fish and wildlife habitat and is taken into our water treatment plant inlets. This major challenge is being addressed by building storm water retention ponds that collect the water and let nature start to work at cleaning it up and settling out the solids before it reached the river. This begins to address the problem in new construction areas but does nothing for the older developed parts of an urban area.

9.2 Agricultural Runoff and Irrigation

The rural water quality program encourages agribusiness to implement riparian zones along the many small waterways that crisscross their fields and provides financial assistance in this endeavour. Many farm businesses have adopted this program to their own benefit. Tremendous loads of silt and chemical residue enter out waterways via these small streams. Providing a buffer zone and keeping livestock out of the feeder streams will go a long way towards improving water quality. The cost of taking the land out of production to accommodate this conservation practice has a long-term benefit to agribusiness that helps compensate for this change in land management practices.

In parts of the Grand River watershed irrigation is a significant crop requirement. This needs to be managed to protect the water quality. Reducing the flow via direct irrigation can significantly increase the temperature of the water. This has a very negative impact on the cold-water species that inhabit these small, cool streams and increases the populations of unfavourable invertebrates. A number of farms taking irrigation water on the same small stretch of stream can have a substantial negative impact.

9.3 Emerging Issues

As we become more familiar with the river as a complex entity new issues are introduced. These need to be evaluated to determine to what extent they could impact the water quality. In some instances we may not have developed the tools to be able to confidently do the evaluation. Scientists are now finding traces of some pharmaceutical products in surface water. They are of a class that are not metabolized by our bodies nor impacted by treatment processes. Additionally, small amounts of endocrine disruptors and previously undetected pesticide contaminates such as glyphosate have been recognized in samples. The presence of pathogens including cryptosporidium, giardia and campylobacter will also lead to new projects to evaluate their potential impact on overall water quality. Currently we don't know what impact we can expect.

We also need to develop tools to allow us to evaluate the cumulative impact of multiple point and non point sources of new contaminants. At the present time the tools are not available. Programs such as the recently introduced Source Water Protection Plan in Ontario will likely lead to more exploration in these areas in more detail. It will also deal with the impact of an increasing population density in our urban areas and how we can have development and a safe water supply.

10. Summary

We have taken our water for granted forever. It was there to be used, a limitless resource. How could all the water in those Great Lakes and rivers ever not sustain us? We are now finding out that water is not a limitless resource, especially if we want it clean. We started to learn in the early 1900's that we needed to manage quantity to avoid flooding and drought. We are now learning very quickly that we must manage quality if it is not to become a hazard to life with a very expensive process to make it useable. We are learning too that not only surface water but also ground water can be contaminated by neglect, over use and ignorance. Contaminates in surface water will ultimately make their way into the groundwater. This message needs to be reinforced to our residents, local politicians and administrators.

One of the magic things about water is when we stop contaminating it nature will eventually clean it up. Plants, dissolved oxygen and microorganisms, given time, will improve the quality. To allow that to happen we need to stop challenging our water resource, whether it is a trickle, a roaring river, great lake or ocean.

The Grand River is a true jewel upon the landscape.

Smallmouth Bass are a popular fish species for anglers in the Exceptional Waters area.

Local school children use the river to learn and about their local environment.

Community volunteers help ensure the river is clean and free of trash.

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Penman's Dam in Paris is the upper limit of the Exceptional Waters area.

Canoeing is a popular activity in the Exceptional Waters reach of river.

Some businesses guide anglers and other s provide canoe livery services.

Appendix I

Community volunteers Doug Knowles, Larry Mellors and Jim Stobbs are collecting aquatic invertebrates to help monitor water quality.

Fish Surveys - Exceptional Water Area 1966-2002

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(Seines and electro shocker)
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(Seine)
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(Same sampling methods as above i.)
k.Holm, E. 2001. The Eastern Sand Darter in the Grand River, Ontario. Report on Fieldwork in 1999 and 2000. Royal Ontario Museum. 24 pp. (Bag seines and dip nets.)
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FISHERIES
MANAGEMENT PLAN

Exceptional Waters
Paris to Brantford
Funders/Partners

The Exceptional Waters, Paris to Brantford, Community Advisory Committee wishes to gratefully acknowledge its funders and partners for their support of the Exceptional Waters project.

The Ontario Trillium Foundation, grant in support of the Community Coordinator
Brantford Community Foundation
Bell City Anglers
Brant Field Naturalists
Brant Resource Stewardship Network
Brant Rod & Gun Club
Brant Waterways Foundation
Brantford Steelheaders
Canada Department of Fisheries and Oceans
City of Brantford
County of Brant
Grand Experiences
Grand River Conservation Authority
Grand River Conservation Foundation
Grand River Fisheries Management Plan, Implementation Committee
Grand Valley Trails Association
Ontario Ministry of Natural Resources
Ontario Steelheaders
S.C. Johnson, a Family Company
Six Nations-EcoCentre
Trout Unlimited Canada
Trout Unlimited, Middle Grand Chapter
University of Guelph, School of Rural Planning & Development