Grand River Conservation Authority

Ontario

Ministry of
Natural Resources

Technical Background Report for the Grand River Fisheries Management Plan

Draft Report
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With the co-operation and support from the Grand River Fisheries Management Plan Implementation Committee.

Brantford Steelheaders **Caledonia Bait & Tackle** **Department of Fisheries & Oceans Canada** **Dunnville Hunters and Anglers** **Friends of the Grand River** **Izaak Walton Fly Fishing Club** **Ontario Federation of Anglers and Hunters** **Ontario Steelheaders** **Ontario Streams** **Six Nations (Wildlife Management)** **Trout Unlimited Canada**

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1.0 INTRODUCTION

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Preamble

Interest in the Grand River watershed and in the fish resource found therein is increasing. The recent designation of the Grand as a "Heritage River" has heightened interest in the watershed as a whole as have earlier media articles, which extolled the fishing opportunities on this river. An article that appeared in an Ontario outdoors magazine called the *Grand River fishery, "A Waiting Giant"* (Ontario Out of Doors 1984) increased interest in the watershed and in its fisheries. This led to the development of plans to help ensure that the watershed and all its attributes are managed properly. The Grand River Fisheries Management Plan was completed in 1998 - a fisheries plan developed through a community-based process within a watershed context.

1.1 Purpose of the Document

The Grand River Fisheries Management Plan (GRFMP) has elicited a great deal of interest since its completion in 1998. Other communities and watershed associations have expressed an interest in learning how the GRFMP was developed, the processes used and the technical information applied.

In order to provide sound supporting documentation to the GRFMP, the technical background report for the GRFMP must be completed. The GRFMP was completed in 1998 with very limited resources that forced the committee to focus on the final plan and leave documentation to a later date. This background document provides the foundation, rationale and science behind the decisions made by the Grand River Fisheries Management Plan Implementation Committee (GRFMPIC). It also provides the GRFMPIC the tools to evaluate the implementation of the Plan in the future and for others to apply the process if they so choose.

1.2 Purpose of the Plan

The GRFMP provides direction at both a broad and local level on how the fish resource in the Grand River watershed and the habitat upon which this resource depends can be managed. It contains background information to support the range of direction given in the Plan (i.e., current and potential distribution of various fish species, related habitat requirements, linkages to land features that create habitat features, direct and indirect impacts of land-based activities on fisheries, etc).

The GRFMP was prepared in response to a growing public interest in the fish resource of the Grand River and the proper management of natural resources in the watershed. This Plan builds upon the direction provided in the fisheries management plans developed previously (i.e., Ministry of Natural Resources (MNR) District Fisheries Management Plans for Cambridge, Niagara, Owen Sound, Wingham and Simcoe Districts), although, these earlier Plans were prepared on the basis of administrative boundaries. In many instances the GRFMP sets new direction that is more sensitive to the inter-relationships with other users and stressors (i.e., non-consumptive users, landuse management, water management). Consequently, another reason for developing the Grand River plan is to consolidate information specific to this watershed from that which was originally segmented across several previous administrative/political boundaries.

One key point coming from this planning exercise is that the Grand River and the fish resources is intricately inter-twined with the entire watershed, its sub-basins and Lake Erie and with all the human activities that occur within it.

This fisheries plan was developed to form a component of the overall Grand River Watershed Plan (i.e., part of the Grand Strategy), which is being facilitated by the Grand River Conservation Authority (GRCA) in conjunction with all its municipalities, related Provincial and Federal agencies and public partners. This will ensure that those land-based features that the fish resources of the Grand River depend upon are managed in the broader watershed management plan.

Input from the Lake Erie Management Unit (LEMU) was extremely important in pointing out the significance of the Grand River to the East Basin of Lake Erie. Analyses completed by the LEMU suggests that the Grand River plays a critical role to the fish stocks of the East Basin of Lake Erie and the river in turn is affected by the fish community in the lake. Some of these interactions include species introduced into the lake. With the opening of Dunnville Fishway in 1994 this inter-relationship was further cause for development of the GRFMP. It was important to regard the Fisheries Management Plan as a plan needed to address Lake Erie issues as well.

1.3 Scope of the Plan

The Fisheries Management Plan Background Report has been prepared to provide direction to a broad audience. Information contained in the GRFMP can be used by resource management agencies (i.e., MNR, GRCA, DFO), municipalities (both upper and lower tier), the academic community, a variety of non-government organizations (NGO), and by anyone who is interested in protecting and enhancing the fisheries and fish habitat.

The Plan itself provides management direction at both a broad (i.e., Watershed and subwatershed) and local level (i.e., sites within sub-basins). Resource managers and municipal officials should receive sufficient direction to enable them to make decisions that will protect the fish resource of the Grand River or ideally improve that which currently exists through a variety of mechanisms including landuse management and water management. At a more detailed level of scale, specific direction is provided which can be applied to a local level to improve fish habitat and /or the fishery itself through recommendations for stream and riparian restoration. Consequently, the plan does have a broad geographic base (i.e., the Grand River watershed) yet contains details at a local level that enables work to be identified and undertaken.

The GRFMP must be considered as a dynamic document. It provides an overview of current conditions and factors affecting them. As well, it lays out a strategy on how to manage the fisheries effectively.

In order for the Plan to be remain relevant, it must be reviewed at periodic intervals with the partners to ensure that the information on which the management decisions are based is still valid. Consequently, there is a commitment to review the GRFMP at five-year intervals.

Although the Plan is designed to provide both broad and local direction for fish community and habitat management, it does recognize the need for additional, more detailed local planning initiatives in certain program areas and sub-basins (i.e., Migratory Fish and Tailwater Fisheries Management Plans).

1.4 Relationship of this Plan to the Overall Grand Strategy

The Grand Strategy (the strategy document which is a requisite once the Grand River was designated as a National Heritage River) and the Grand River Watershed Management Plan were developed, in part, to "provide the framework for collective actions that strengthen the knowledge, stewardship and enjoyment of the water resources of the Grand River valley". The Grand River Fisheries Management Plan is a component of both the Grand Strategy and the Grand River Watershed Management Plan. These are links between the fisheries management plan and the watershed management plan that ensures that many of the attributes that the fish resource depends upon will be afforded appropriate level of protection. The specific links to the watershed plan and to the various components of that plan will be documented.

1.5 General Principles

The plan was formulated by a partnership arrangement involving resource management agencies, various interest groups and the general public. Several basic principles were adhered to and incorporated into the management direction provided. These principles follow:

- the principles outlined in the Strategic Plan for Ontario Fisheries (SPOF II), must be adhered to as these provide the provincial direction regarding the management of fisheries in the province. Specifically, the five guiding principles for managing fisheries include: *sustainable development* (sustainable development requires that adverse impacts on natural elements such as air, land, and water, be minimized to ensure the aquatic ecosystem's overall integrity); *limit to resource* (there is a limit to the natural productive capacity of aquatic ecosystems and, hence, a limit to the amount of fish that can be harvested from them); *natural reproduction* (naturally reproducing fish communities, based on native fish populations, provide predictable and sustainable benefits with minimal long-term cost to society); *knowledge* (good fisheries management is scientifically based and relies on the acquisition and use of the best available knowledge); and *social benefits* (resource management decisions, including allocation, shall be based on ecological, social, cultural and economic benefits and costs to society, both present and future);

- an ecosystem based approach was adopted (i.e., the fish resource of the Grand River watershed is part of an ecosystem and those links with other parts of this ecosystem must be considered);
- the capability and capacity of the resource to produce the fish being managed must not be exceeded (i.e., must manage within the overall capability of the ecosystem being considered);
- direction presented in the plan can be implemented (i.e., no direction is provided where there is an unwillingness to implement);
- this fisheries management plan was formulated from the bottom up and although it considered that which preceded it, any new concept was open for consideration (i.e., a clean slate approach);
- participation in this planning process was open to the public and comments received were reviewed and considered when the management plan was developed;
- all partners involved in preparing this fisheries management plan adopted a common purpose which is to ensure that the fish resource of the Grand River watershed is maintained and improved and that such management be done within the context of an ecosystem approach which recognizes broader values.
- all decisions needed to be justified scientifically and supported by the public.

1.6 Products Achieved

A variety of products have already been generated through the original planning process that began in the fall of 1995 and was completed in November 1998.

Grand River Fisheries Management Plan: Provides direction on managing fisheries within the Grand River watershed along with background information on the fish resource, users, land-based activities and features and relationship to the river. One of the key features of this plan is that it outlines the "best bets" for work that has been undertaken by the resource management agencies and/or various partners.

"Summary of comments at the Five Town Hall Meetings on a Grand River Fisheries Management Plan" (CR Communications 1996): Public response and comments provided at various open forums which were held during the fisheries management planning process are documented.

Best Bets and associated Regulation Changes: Managing for “exceptional waters”, sustainable development, increased angling opportunities and increased protection of vulnerable fish stocks.

Stewardship and Partnerships: The GRFMP indicates how the resource should be managed and what activities should be undertaken to ensure that this resource is maintained and improved. This plan, by indicating the importance of the fisheries of the Grand River will heighten awareness of this resource, which could result in increased stewardship of the resource by those who reside in the area. The plan also identifies many opportunities for partnership arrangements to be developed. These partnership arrangements can be broad in scope whereby partners assist in the development of management strategies (i.e., this planning exercise) or can be localized to the extent that interested parties can actually undertake specific tasks (i.e., habitat rehabilitation through Community Fisheries and Wildlife Involvement Program - CFWIP).

Marketing Strategy: Completion of the Grand River Fisheries Management Plan and subsequent implementation will increase the profile of the fisheries of the Grand River. This can result in increased use and pressure on the resource. Economic benefits to the area will increase as more anglers and non-anglers use the area. “Getting involved in a Natural Opportunity” is an example of a marketing booklet which has been prepared by MNR and GRCA in response to growing public interest for information on how they can become involved in enhancing fisheries in the Grand River. Reaction from public meetings also suggested that more private sponsorship and investment could and should be focused on this resource. Further marketing strategies will be developed to sustain fisheries and habitat enhancement projects in the watershed.

Intangible Benefits: A variety of intangible benefits have likely occurred as a result of the original planning process for the GRFMP. These include:

- renewed cooperation among partners;
- renewed sense of optimism;
- increased awareness, particularly on an ecosystem watershed basis;
- value on resource (i.e., Regional Municipality of Waterloo is committing $1.5 million over next 4 years to address non-point sources of pollution; about $1.1 million was generated by the fishery in a 30km stretch of river near Fergus and Elora);
- understanding of fish/aquatic resources as an indication of watershed health;
- understanding of fish/aquatic resources in the context of land based natural resources and human activity.

Guiding Document for Multiple purposes: The GRFMP document has become a useful document for a variety of initiatives presently underway in the Grand River watershed. These include:

- recreation and tourism;
- water quality objectives;

- standards for the Grand River Watershed Technical Committees;
- sets objectives for land-use planning initiatives, environmental protection areas and areas of natural and scientific interest (i.e., through municipalities, stewardship councils);
- increases profile of vulnerable, threatened or endangered (VTE) species and species at risk;
- raises profile of large rivers in Southern Ontario from social and economic perspectives;
- places a value on the Grand River watershed and on the fish resource found there.

Internet Applications: The GRCA website provides access to a Year 2000 Edition Progress Report from the GRFMPIC. Highlights found are as follows: Rewarded for Excellence; Fish Populations and Management; Baitfish; Fish Habitat; Angler Education; and an update on the implementation of the "Best Bets". The address is www.grandriver.ca (the 2001 version is currently being prepared).

2.0 PROCESS

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Preamble

The process of developing a new fisheries management plan for the Grand River system was a complex combination of science, sentiment and the experiences and insights of people who actually use the river system. The goal was to develop a plan, based upon sound science, in partnership with interested individuals and organizations that would result in a community supported, diverse and sustainable fishery, as part of a healthy aquatic ecosystem.

It was envisioned that the fisheries plan would be both a stand-alone document and also represent one major component to the Grand Strategy: the overall watershed planning process for the Grand River Watershed. The Grand Strategy committee represents all sectors of interest on the Grand River and is the planning and implementation forum for all resource management work on the Grand River.

The Grand River Fisheries Management Plan is the product of a planning process involving the Ontario Ministry of Natural Resources (OMNR), the Grand River Conservation Authority (GRCA) and 12 partners representing organized stakeholders groups, other agencies and one academic institution. Although fisheries management plans for the general area were in existence at the start of this effort, these previous plans were based upon artificial boundaries (i.e. MNR District Boundaries) and were perceived to reflect the best opinions and directions of fisheries specialists, not necessarily the angling public. The planning team took a new approach as requested by the public. It started with a clean slate to avoid any possible built-in biases created by the previous District Fisheries Management Plan. Within the Grand River Watershed there have been several relevant District Fisheries Management Plans which include the following: Simcoe, Niagara, Cambridge, Wingham, Owen Sound, Huronia, and Maple Districts.

The partners involved in this new planning process made significant contributions not only by taking active part in all the meetings but also by providing comments during the preparation of the plan. The Partners also hosted two sets of public meetings (11 in total) which were held to solicit comments from, and present interim findings to the general public.

Technical information and examples of other strategic scientific management planning processes were provided to the committee and partners at the onset and all the way through of the planning process. Examples of scientific and technical strategic planning documents, such as the SPOF II (Strategic Plan for Ontario Fisheries 1990) document were provided to the committee in order to scope principles for the management process. Technical information was developed for the committee to provide a context on the biophysical relationships operating within the watershed and its' sub-basins.

2.1 Development of the Management Plan Team and Participants

The partnership began in the fall of 1995 as a co-operative undertaking of the MNR and the GRCA. The committee itself was initiated in January 1996. The first step was to put together a working group, or steering committee of "partners" who would be representative of fishery users to provide advise and direction through every step of the process.

To find these partners, MNR and the GRCA turned to organizations and individuals that had publicly expressed or demonstrated their concern for the river system and the need for its enhancement. It was understood there would be contradictory and opposing philosophies and views among the working group members. This was seen as a healthy reflection of the river system's users as a whole.

The Steering Committee/Working Group was created in September of 1995 representing broad interests along the Grand River (i.e., partnership approach). The committee membership was designed to be inclusive in nature and reflect the geographical and tackle/species oriented interests of the angling community throughout the watershed.

There was a joint leadership – Felix Barbetti, 1995-1998 (former Area Supervisor, Fonthill, MNR) and Warren Yerex (GRCA) were Co-Chairs. (Drew Cherry, Area Supervisor, Guelph, MNR replaced Felix Barbetti in 1998 and Drew Cherry has recently been replaced by Mitch Wilson, acting Area Supervisor, Guelph, MNR)

Names and affiliations of the original participants involved in the preparation of the Grand River Fisheries Management Plan are as follows:

Partners:	**Representing:**
Mr. Gary Allen	Trout Unlimited/Izaak Walton Fly Fishers' Club
Mr. Ken Collins/Mr. Doug Ratz	Friends of the Grand River
Mr. Walt Crawford	Ontario Streams
Mr. Rob Culp	Dunnville District Anglers and Hunters
Mr. Paul General	Six Nations (Wildlife Management)
Mr. Larry Mellors	Ontario Steelheaders
Mr. Mike Pettigrew	Caledonia Bait & Tackle
Mr. Russ Piper	Ontario Federation of Anglers and Hunters
Dr. Geoff Power	University of Waterloo
Mr. Gerry Rand	Brantford Steelheaders

Agencies:	**Representing:**
Mr. Felix Barbetti	MNR - Guelph District
Mr. Drew Cherry	MNR - Guelph District

Mr. Daryl Coulson	MNR - Guelph District
Dr. D.P. Dodge	MNR - Great Lakes Branch
Mr. Brad Gerrie	MNR - Guelph District
Mr. Larry Halyk	MNR - Lake Erie Management Unit
Mr. Mark Hartley	GRCA - Watershed Resources
Mr. Jack Imhof	MNR - Fish &Wildlife/Science Development & Transfer Branches
Mr. Serge Metikosh/Mr. Ed DeBruyn	DFO - Fish and Habitat Management
Mr. Bill Murch	MNR - Guelph District
Ms. Trish Nash	GRCA - Watershed Resources
Mr. Charlie Ross	Ross Communications
Mr. Norm Smith	MNR - Southcentral Science & Technology Unit
Mr. Art Timmerman	MNR - Guelph District
Mr. Warren Yerex	GRCA - Watershed Resources

It was recognized early on that a team approach involving various agencies and client groups was essential in developing the plan. The team approach leads to ownership, which was crucial to the Plan's success. Agencies were present because of their respected mandates for various aspects of fisheries and environmental management. Although some of the resulting plan would likely have elements that would have to be implemented by various agencies, agency staff were there to provide a supporting (technical and expertise), not directional role to discussions on the management plan. The community/angler groups were there to determine the best fit between biophysical opportunities, fish community objectives and angler interests.

The draft Fisheries Plan was formulated based on input from committee participants and the general public through two series of Public Meetings.

The key principle adopted from the beginning was the plan for the Grand would start from "scratch" (i.e. would not start from the existing MNR District Fisheries Management Plans). The Grand River is the largest watershed in southern Ontario, where the MNR Districts individually only cover part of the watershed. The new Fisheries Plan was going to encompass the entire watershed.

The key roles of the management plan team and participants were:

- to host public participation meetings and communicate the planning progress to their respective groups and communities;
- to be actively involved in the overall drafting of the Plan;
- review and comment on template layout and technical information;
- participate in working retreats and focussed discussions; and
- to facilitate, support and co-ordinate the implementation of the Plan.

The involvement of the partners did not stop when the plan was completed as all shared the common goal to work together towards implementing this plan across the watershed.

2.2 Public Process

The steering committee wanted a plan that was designed from the bottom up. It had to have public input and involvement before hard and fast decisions were made. The committee recognized that, while the health of the river system was rapidly improving, the gains were not the result of any one organization or agency. They were the result of partnerships and co-operation from government, organizations and individuals.

If this trend was to continue and grow, the plan had to meet public needs which meant the public had to be involved from the very beginning of the process. Necessary rules, regulations and projects that depend on volunteer efforts would only be successful if the river system's users supported and accepted them. If the public was to agree with the management directions and decisions, they had to meet public needs and desires as much as possible.

Also recognized was the need to demonstrate that this planning process was being supported and directed by the anglers themselves. Therefore, in order to involve the public, MNR and GRCA assisted the angler organizations in an effort to host two series of five public meetings throughout the watershed. They were hosted and chaired by the local angling association in each of the specific towns. These meetings took place from January through March in 1996 and 1997 and are referred to as Phase I and Phase II Public Involvement. The Steering Committee arranged meeting locations in each of the communities and informed their members of the meeting dates. News releases and meeting notices were issued, with most media receiving at least two notices.

Phase I: January – February, 1996

Approach: sought input from the public on the fishery that currently existed, observed changes, issues and kind of fishery desired.

Objective: was to engage the public, generate interest, awareness, and input from interested individuals and organizations.

The format of all Phase I series of public meetings began with a welcome and introduction by the meeting chair and an outline of the agenda for the meeting. The chair for each meeting was a representative of the host, local angling association. The chair introduced all presenters and then introduced the first presentation. This presentation was delivered by MNR biologist Larry Halyk and provided an overview of the current fisheries situation on the entire length of the Grand River system.

The participants then split into groups to discuss five questions on the past, present and future of the Grand River system. The GRCA prepared a series of watershed maps, which showed the distribution of various species, based on the best information that was available. The anglers were asked to review the maps and identify omissions, discrepancies, additions and other information. They were asked to provide comments on the maps, by writing directly on them.

When the breakout sessions concluded, participants had a question-and-answer session with GRCA and MNR staff and steering committee members. At the conclusion, participants were given an overview of their comments recorded during the breakout sessions. This was summarized at each meeting by Charles Ross (Charles Ross Communications, CRC) to further distance any perception of agency or group bias. Charles Ross also provided publicity and media liaison related to these meetings.

There was also a question period between the break out sessions and summary comment sheets were made available for those who could not attend the meeting, which could be returned to the GRCA at a later date. The comments represented individual perceptions of the situation and differing conditions along the entire 300-kilometre length of the Grand River itself, as well as its many tributaries. These comments were grouped according to the five questions asked at the breakout sessions.

The public input which was supported by an estimated 300 participants was then reviewed by CRC. They were hired to compile and examine all the comments made by the public from the breakout and question and answer sessions. A *Summary of Comments* report was drafted in March of 1996 by CRC, which abridged all of the comments, based on the five groups of questions asked (See Appendix 5). This public input was then incorporated into the plan, which made it more comprehensive and complete. In order to ensure that all information was included and represented in the plan, a two-day retreat was held by the committee in order to work through all information provided by the public and to draft a first plan for the watershed.

Phase II: February – March, 1997

Approach: templates were generated from the input from the Phase I public meetings and were used to present information at the Phase II public meetings.

Objective: was to find out from the public how their prior comments were incorporated and how the plan was being developed (errors and omissions were welcomed).

It was felt that the public would want to know how their suggestions (which were raised from the first set of meetings) were addressed and how “their” water body was going to be managed.

Template – The watershed was broken down into 7 sub-basins on the mainstem into Upper, Middle and Lower Grand Sections with addition to the Nith, Conestogo, Speed and Horner/Whiteman’s Creek Sub-watersheds. Within each area, sections were further broken down into main stem, coldwater tributaries, mixed water tributaries, warmwater tributaries, ponds and reservoirs.

A further refinement of the template included the identification of three major geological units that created specific opportunities and constraints on proposed fish community and habitat objectives (see Section 2.3 and Chapter 5). For each of these categories, information was presented on fish community objectives, issues, and management options and tactics.

The Phase II meetings were organized in the same format as that used in Phase I meetings. Warren Yerex (GRCA) and Jack Imhof (MNR, Guelph) gave a brief overview of the physical limitations, desired outcomes and principles of the fisheries plan. A flow chart of the draft plan and a draft Options Paper was presented to the public. They were arranged into groups where they were given the opportunity to comment and give their input on the overall template and management options drafted thus far. Comments and concerns from the public were recorded and later reviewed to evaluate if further adjustments were needed for the plan to move forward.

Supplementary to the Phase I and Phase II public meetings, there were 29 additional presentations made to groups for example Caledonia Hunters and Anglers, Muskies Canada (Hamilton and Kitchener), Fort Erie and Dunnville Conservation Clubs, and Ontario Streams symposia.

2.3 Technical Information

A variety of sources of information were used for the development of the Grand River Fisheries Management Plan. Although the previous MNR District Fisheries Management Plans were not used in this process, the technical information amassed by these plans was still useful and was provided to the committee.

In addition to summary information on known species distributions on the Grand River, it was felt that more contextual information was necessary in order to identify both the potential and limitations of the watershed for various fish communities and species. With this in mind, the surficial or Quaternary Geology of the Grand River was used to determine the likely distribution of opportunities/constraints for various fish communities and species within the watershed. This information was assessed in relationship to landuse patterns within the watershed. Opportunities/constraints were then summarized under the following components:

- Flow regime characteristics (permanent vs intermittent flows, magnitudes, consistency of flows, etc);
- Relative groundwater importance to baseflow and temperatures (i.e. likelihood of coldwater habitat, etc);
- Overall channel form and by inference habitat characteristics;
- Substrate composition;
- Landuse activities and potential impacts on riparian zones, channel, nutrients and habitat;
- Likely historical characteristics in comparison to present circumstances.

In addition to technical information on biophysical relationships, the committee and public were presented with information related to previous strategic planning initiatives, new science and new information. Some of the technical information provided to the committee and public included:

- Guiding principles and rationale from the SPOF II process;
- Information on habitat usage by various fish species;
- Recent science on the impacts of hatchery fish on wild populations (behavioural, genetic and pathogen studies);
- Studies on inter-specific competition between salmonids;
- Climate change scenarios and implications;
- Dam operations and constraints on fisheries;
- Information on migratory fish distribution and use of the Lower Grand River (anecdotal and technical);
- Technical information on fishway usage;
- Initial summary of VTE species;
- Lake Erie Fisheries information given by the Lake Erie Management Unit (LEMU).

All this information was provided to the committee for review and discussion with technical specialists. The overall objective was to ensure the participants in the process had all the relevant information and understanding possible in order to make informed decisions. To this end, technical specialists were made available to answer questions, discuss research findings and their implications and to discuss and explain these findings with the partners.

2.4 Finalizing the Plan and Moving it Forward

After the second major set of public meetings, all information, comments and opinions expressed by the public were summarized and incorporated into the working draft templates. At this point, a working list of all issues, fish community objectives, management strategies and tactics was identified. This information was then used as the input to a second two-day committee retreat with the objective of developing the final plan, based upon committee and community input.

Once the semi-final plan was completed, a few committee members took on the intensive task of reviewing all issues, community objectives, strategies and tactics in order to refine the lists and ensure a standard wording and listing of all elements and themes. This information also provided valuable information on over-arching issues, strategies and tactics and provided the foundation for the selection of the short-term “Best Bets” for the plan.

Once the lists were reviewed and standardized, the templates were revised and circulated to all members of the committee for final review. Included with each sub-basin were maps of the coverage, surficial geology and a descriptor table of important information explaining the characteristics of the sub-basin, opportunities and constraints to fisheries management.

Upon completion of the plan, formal endorsement of the plan by the partners and the two agencies was sought. Once the plan was formally endorsed and printed, formal presentations were organized to the Board of the Grand River Conservation Authority, the Grand Strategy Committee and then to all major municipal councils within the watershed.

Presentations of the plan and its' implications were also made to various organizational units (including the Executive Committee) within the Ministry of Natural Resources.

Perhaps the most important presentations were to the Grand Strategy committee and to several of the sub-committees of the Strategy. The presentation to the Water Managers sub-committee of the Grand Strategy elicited strong endorsement and support. The major issues and targets for the Fisheries Plan supported the major water management issues and tactics identified by the water managers (i.e. nutrient inputs, soil erosion, channel degradation, flooding and drought issues). The Fisheries Plan demonstrated the inter-relationships between water management, groundwater management, non-point source pollution management and fisheries management and made all planning processes of the Grand Strategy stronger and more integrated.

2.5 Development of the Structure of the Implementation Committee

The Grand River Fisheries Management Plan Committee met in February of 1998 to discuss the implementation of the Plan. The technical committee members were "polled" to determine interest in participating on an implementation committee. All members at the table unanimously agreed to continue as a team in implementing the plan.

It was recognized that it was important to continue the momentum generated by developing the plan into the implementation of the plan. Both the agencies and groups were determined to meet the goals (timing and projects) outlined in the "Best Bets".
A decision was made to develop a structure where all members would continue to meet as an implementation committee. It was agreed upon that there would be two sub committees that would focus on 1) Marketing and Fundraising and 2) Community Action. The Action Committee was further divided into upper, middle and lower sub-groups. Chairs for the two sub-committees and subgroups were elected with regular reports communicated to the Implementation Committee. An alliance was formed with the Grand River Foundation to allow for administration of funds.

A series of public workshops were held throughout the watershed by the Action Committee to inform the public of project ideas and to solicit representation from local interest groups and municipalities. The Action Committee developed a program for submission of local project proposals and criteria for review and approval. The Marketing Committee worked with the agencies to develop an integrated approach to fundraising and a consultant was hired to develop a marketing strategy. A list of corporations was then compiled and approached for funding.

Figure 2.1: Members of the GRFMP Implementation Committee in 1999.
From left to right standing: Al Murray, Paul General, Dan Thompson, Felix Barbetti, Terry Ryckman, Gary Allen, Warren Yerex, Walt Crawford, Ed DeBrun, Drew Cherry, Otto Lemke, Norm Smith, Art Timmerman, Shelly Dunn, Mike Pettigrew, Joad Durst, Trish Nash, and Russ Piper. From left to right kneeling: Brad Gerrie, Ken Collins and Jack Imhof. Missing from photo: Anne Yagi, Bill Murch, Daryl Coulson, Larry Mellors, Sean Geddes, Larry Halyk, Craig Selby, and Rob Culp (member of the planning committee).

3.0 HISTORICAL PERSPECTIVE AND OVERVIEW

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Preamble

Settlement and development activities in the Grand River watershed since 1781 have brought about great changes to the forests, soils, and watercourses. Such changes to the landscape have brought about alterations to fish habitat ranging from minute (i.e. some small spring-fed tributaries in remote cedar swamps) to major changes causing significant degradation, alteration or elimination of fish habitat (i.e. streams in agricultural and urban landscapes).

A review of such settlement patterns and development activities in the Grand River watershed can provide an understanding of what the stream and river habitats have endured, the resulting effects upon fish habitat, and an improved understanding of the context of our existing fisheries. Although volumes could be written on the intriguing landuse changes within the Grand River basin, it is hoped that this brief review will provide the reader with, i) a greater appreciation and understanding of the river from a historical perspective as it relates to fisheries, and ii) an improved environmental ethic in our individual and collective ongoing management of this special river and its fishery.

3.1 The Grand River Watershed Circa 1600 - 1780

First Nation settlements are known to have occurred throughout the Grand River watershed, as is evident from various archaeological evidence. Their settlement occurrence and distribution was closely associated with streams and rivers since this provided potable water, source of food (fish, riparian mammals), and was associated with their transportation corridors (waters and/or valleys). Settlement of the First Nations occurred long before the section of land known as the Haldimand tract was granted to the Six Nations. Alteration of rivers and streams was relatively minor, and today, only the very discerning eye can detect any evidence at all of the past occupation by native peoples.

The First Nation people left behind very little evidence of many centuries of occupation and use of the rivers. Archaeological digs have found a variety of evidence indicating fish were often utilized. A diverse variety of fish were available year round and others were harvested during their spawning runs. Methods for obtaining fish were dependant upon the species sought and whether or not the species was spawning. Fish were hooked, speared, netted and captured in weirs.

In the years that France claimed the territory of New France, which included the Grand River watershed, there was little to no use of the Grand River and its fishery. Apart from the probable brief encampments of the French and their Native Indian allies at the river crossings on routes between Fort Montreal and Fort Detroit in the Brantford area, little else is recorded.

The British conquest of New France in the Seven Years' War (1763) marked the start of the beginning of change in the Grand River watershed. With British recognition of French systems of land tenure and civil law, British immigration and development was very slow up until about 1783. At that time, the British Government took action to provide support for thousands of those that were loyal to the Crown and were forced by the American Revolution to take exile in the Province of Quebec (at that time included southern Ontario and the Grand River watershed).

Prior to European colonization, the watershed was densely forested with some prairies and oak savannahs at locations with lighter soils (Brant County). Wetlands, primarily swamps, were extensive throughout the watershed, especially in headwater areas in Wellington, Dufferin and Oxford Counties. The area of the watershed upstream of the present town of Grand Valley was referred to as the Great Swamp.

Wetlands and forest cover served to maintain ground and surface water levels and stream flows during drought periods, as well as to minimize the frequency of flash floods. Flows were high, but not extreme during the snow melt period. Floodplains in the middle and lower reaches of the Grand River and larger tributaries were inundated for extended periods in the spring and early summer. This promoted the development of complex floodplain pool systems, which provided spawning and nursery habitat for a variety of warm and coolwater fishes such as pike, muskellunge and bass.

Forest cover minimized erosion and stabilized banks so that channels were generally narrow and deep. Stream and river channels in all but extreme headwaters and lower reaches were composed primarily of gravel, rubble and sand with low sediment bedload and relatively little siltation.

A large wetland system from the river mouth upstream to Cayuga provided spawning and nursery habitat for Lake Erie fishes. The lower portion of this wetland was strongly influenced and rejuvenated by changing water levels in Lake Erie and was characterised by extensive and diverse stands of submergent and emergent aquatic vegetation.

Extensive wetlands and forests maintained water quality and quantity throughout the watershed. Water storage was maintained in the headwaters and water quality (in terms of temperature,
transparency, and sediment load) was moderated in the lower reaches despite the fact that both the extreme upper reaches and lower reaches of the watershed where composed of clay tills that had a high potential for run off and elevated suspended solid levels.

Brook trout were the only native salmonid present. Even during prehistoric times, their distribution would have been limited by groundwater availability. They were probably found throughout the Speed River watershed and the lower Nith River watershed downstream of New Hamburg, but absent from most of the Conestogo River watershed. Adults probably inhabited the main river at least seasonally from Grand Valley to Brantford.

Bass, sturgeon, walleye, mooneye, suckers, redhorse, pike, muskellunge and other species from Lake Erie utilized spawning and nursery habitat on the lower Grand River. Upstream penetration of Lake Erie fishes is unknown, and was probably dependent on each individual species habitat needs since there were no dams, waterfalls, or other barriers to upstream migration below the Elora Gorge. Some of these species established river resident as well as lake run populations.

Neutrals inhabited the watershed in the south and Hurons in the north until about 1650, when both Nations were destroyed or dispersed by the Iroquois. Thereafter for approximately 100 years, the watershed was largely uninhabited. Excavations of prehistoric native encampments of the lower river show that First Nations people utilized sturgeon, suckers, bass, perch, walleye, burbot, whitefish (probably migrants from Lake Erie) and esocids (both pike and muskellunge). The fish were dried and smoked and carried inland for use during the winter months. No salmonid bones have been recovered at lower river encampments, which confirms that trout probably did not inhabit the lower reaches of the Grand River.

In 1783, 7000 - 8000 Six Nations Indians led by Joseph Brant settled along the Grand River near Brantford. In 1793, the crown granted the Six Nations a tract of land six miles wide on either bank of the Grand River from source to mouth. However, substantial clearing and development of these lands did not take place until the early 1800s, when large parcels of this land grant were sold or leased to others.

When the Six Nations first settled on the Grand River, fishing was unlimited and plentiful. as There were no dams to prevent fish from migrating from the lake into the river to spawn. In fact during the first years of occupying the area, fishing was the primary food source for the entire Six Nations community until crops were later planted and harvested.

3.2 Changes Between 1780 and 1930

European settlement of the watershed began with a series of Treaties with occupying First Nations over a period of some 55 years from 1781 - 1836. The first was on the east side of the Grand River watershed with a Treaty in 1781 with Mississaugas and Chippewas as part of the lands of the Niagara Peninsula. This was followed by treaties covering the central and western side of the watershed with Treaty No. 3 in December 1792, with Mississaugas. Then the British Crown gave the Grand River (6 miles each side from mouth to source) to the Six Nations in 1793. Finally, the headwaters which involved parts of several treaties - No. 18 and 19, Oct 1818 with Chippewas, No. 27 ½ Apr 1825 with Ojibways and Chippewas, and Treaty No. 45 ½ Aug 1836 were granted, with Saugeens agreeing to leave.

In 1791 the British Parliament divided the old province of Quebec into Upper and Lower Canada. The Grand River was now part of Upper Canada and allowed British law, land tenure and customs to prevail, on those lands ceded by the First Nations people. This began the period of British based agricultural development practices, which greatly influenced the settlement patterns, the use of the land and the resulting effects upon the Grand River and fish habitat.

The Start of Agricultural and Industrial Development

The main influx of loyalists to British territory was in the period of 1783 to 1797. The loyal Six Nations were given a large tract of land along both side of the Grand River by the British government. This area was selected by Joseph Brant, who reportedly was familiar with the area from his travels and had noted its similarity to the Mohawk River valley in New York State. The first true developments of settlements in the Grand River basin of Upper Canada were therefore those of the loyal Iroquois nations and associates. Small villages and towns began to develop along the main-stem of the Grand River, which was used as the transportation corridor.

Joseph Brant entered into 999 year leases of land to friends and relatives, having been forbidden by the British government to sell lands. Apparently, Joseph Brant planned to have some of these leases situated to place favorable and knowledgeable farmers in close proximity to the Iroquois nations, thus enabling them to gain insight into agricultural practices that they themselves could employ. Thus, began the widespread clearing of the forested land to make way for agriculture.

At first, agricultural occupation by British subjects in the Grand River watershed was very limited due to the holdings of the Six Nations. Then, as large blocks of land were sold or leased, the establishment of agricultural farms brought other associated businesses and small towns.

Land was utilized at first for agricultural self-sustenance, then for lumber products and agricultural products. By 1850, virtually every lot within the lower Grand River basin was occupied and had significant clearings of forest cover for its wood products and agricultural use of land. Development and occupation in the central basin and particularly the headwaters was slightly slower than the lower basin, however lands were quickly occupied by waves of immigrants from England, Scotland, Germany, and the United States in the 1850's and 1860's.

Land use activities which greatly influenced the Grand River and its tributaries, directly and indirectly, included:

- Forest clearing for lumber and fuel wood;
- Gypsum Mines (mills, raceways, waste rock);
- Navigation Companies;
- Tanneries located on streams for easy discharge of liquid waste;
- Building of dams for Saw Mills, Grist Mills, Textile Mills – leading to reduction or elimination of fish migration;
- Towns / Cities with wastes discharged to waters or deposited in flood plains (animal waste, human waste, garbage);
- Industrialization (World War I and II resulted in increased industrial activities and relaxed environmental standards, leading to discharge of industrial wastes, toxins, etc. into river valley landfills and watercourses);
- Agricultural Drainage c1900 to 1950's in particular, some drainage projects continue to date;
- Lack of landuse documentation and poor planning has resulted in impacts such as leaching landfill contaminants and industrial waste storage on top of abandoned mines, and groundwater aquifer contamination and depletion.

Deforestation and clearing of land for agriculture were accompanied by the construction of numerous dams to supply waterpower for grist and saw mills. Mill dams were built on the main river and tributaries at virtually every site with suitable bank and gradient conditions. The initial impact of deforestation and land clearing was to increase erosion and sedimentation rates, reduce ground and surface water storage, and elevate summer water temperatures. Mill dams further elevated temperatures, destroyed spawning habitat and blocked fish migration.

During the early part of the 1800s, plans to dam the river at Dunnville were proposed. In 1812, the Six Nations council expressed its concern over these plans because they believed a dam would result in the loss of the fishery, which had been so important to their settlement. Between the years of 1812 and 1870, there was protest by the Six Nations to construct the Dunnville Dam along with future dams, however, the dams remained with only minor attempts to augment the fishery by installing fish ladders.

The Dunnville Dam (1827) was the first dam built on the lower river. Its primary purpose was to divert water to a feeder canal to move boat traffic from Lake Erie upstream to the first shallow riffles in the vicinity of Cayuga. The dam was destroyed by floods and rebuilt or repaired several times. By the mid 1800s, it was recognized that the Dunnville Dam was having a serious effect on spawning migrations of Lake Erie fish. A fishway was constructed in 1865, but its performance was unsatisfactory (Kerr, 1867). Several modifications were attempted and a second fishway was constructed in 1903 with modest results, but fish populations never regained former abundance levels.

The Grand River Navigation Company was established in 1829 to facilitate boat and barge transportation from Lake Erie upstream to Brantford. A series of five dams and a lock and canal system were constructed between Mount Healey and Caledonia. These structures inundated floodplains and destroyed spawning riffles and further restricted fish migration. Despite concerns for fisheries impacts by the Government Fisheries Officer, the Clerk of Haldimand County and the Six Nations, the Grand River Navigation Company ignored letters requesting that fishways be constructed to mitigate impacts to fish migration. By 1874, the Secretary of the Navigation Company received a notice from the crown to construct fishways. By this time, the company was in financial difficulty and unable to comply.

By the late 1800s, following removal of forest cover, and during the process of cultivation, large scale clearing and draining of swampland began. Deforestation and wetland drainage affected stream flows to the point that many small tributaries were reduced to a trickle or dried up completely. Flash flooding destroyed many mill dams in the late 1800s and early 1900s. Dams were destroyed by successive floods and replaced several times at some sites. Low summer flows made waterpower unreliable in many of the remaining mills.

The marshes downstream of the Dunnville Dam, while accessible to Lake Erie fishes were severely degraded by land settlement activities. High turbidity levels and sedimentation degraded conditions for aquatic vegetation communities that provided valuable food, cover, and spawning/nursery habitat for a wide variety of fishes. The introduction of carp in the late 1800s compounded the problem due to their habit of stirring up sediments.

Around the turn of the century, cities and towns grew rapidly in and around Brantford, Guelph, Kitchener (Berlin) and present day Cambridge. Furniture and textile manufacturing, associated heavy industries and the communities (i.e. tanneries) used the river for waste disposal.

As a result of degradation of habitat and water quality associated with urban and agricultural development, brook trout were eliminated from most of their native range in the Grand River watershed between 1850 and 1880. However, remnant populations persisted in headwater streams draining swamps that were not cleared for agriculture and in first and second order streams on sandplains or kame areas that received abundant groundwater discharge despite deforestation.

During the pioneer era, fishing was carried out at a subsistence level with spears and hook and line, with commercial fisheries being established on the lower Grand River by the 1850s. Dip nets were the most common gear used in the late 1800s and early 1900s, but as fish became less abundant, more efficient seine and entrapment gear (hoop and pound nets) were used.

Fish harvested commercially in the Grand River in the late 1800s included pike, muskellunge, channel catfish, walleye, sturgeon, bass, suckers, mullet (redhorse) and whitefish. Donavan (1918) reported that in the spring of 1858, sturgeons were stacked on the bank of the lower Grand River like cordwood. In fact, sturgeon were so common in the mid to late 1800s that farm labourers insisted that their employers should not feed them sturgeon daily (Lambert, 1967).

During the period of the middle to late 1880's, there was settlement of headwater wetlands, industrialization of the middle section of the watershed, and incremental increases in floods and property damage (Imhof and Plummer, 1999). As a result the community initiated structural flood protection projects.

In the early 1890's, the Grand River was thought of as an "ineffectual malodorous sewer" (Dunham, 1945). There was also a general concern for ravaging floods and summer low flows, which led to the establishment of the Grand River Improvement Association.

There was a significant flood in 1929, and over the next two years the community demanded better protection against flooding events, and the first analysis considering water problems occurred. The construction of three dams was recommended to provide for the disposal of water supply, sewage and trade waste. Also during this period, the Grand Valley Board of Trade was established to enhance business interests, prevent floods and to stimulate tourism.

Refer to Table 3.1 for a Summary of the historical background covering the years 1781 to 1905 related to the Grand River watershed.

By the 1930s, sturgeon and muskellunge were only rarely caught commercially and harvest of carp, suckers and other coarse fish increased. Overharvest seems to have played a role in the decline of important game and commercial fish on the lower Grand River, but habitat destruction in the form of sedimentation and turbidity, wetland loss, and the blocking of spawning migration routes and the destruction of riverine and wetland spawning habitat probably played a more important role.

3.3 Changes Between 1930 and the Present

Deforestation, wetland drainage, intensive crop farming, and discharge of partly treated industrial and municipal waste by 1930 resulted in major impacts to water quality and fish habitat in all but the smallest headwater streams. The pace of destruction increased during and immediately after the Second World War.

Damaging spring floods and extremely low summer flow levels were characteristic of the Grand River during the late 1800s and early 1900s. In order to address the water flow impacts brought on by land development, the Grand River Conservation Commission (a precursor to the Grand River Conservation Authority) was formed in 1934.

The first dam constructed in Canada for flood protection control was the Shand Dam. It was constructed on the Grand River near Fergus in 1942 to control spring floods and augment low summer flow to enhance water quality through dilution of sewage effluent. Additional dams were constructed for flood control and low flow augmentation on the Grand River at Luther (1952), on the Conestogo River near Drayton (1957) and on the Speed River at Guelph (1976).

The purpose of these large water management reservoirs was to provide the water storage capacity lost with the destruction of pre-settlement wetlands and forest cover. Grand River Basin studies were done in 1970 and 1980, which resulted in low flow targets being established. Summer flows improved substantially with the establishment of minimum flow targets. Complete replication of pre-settlement spring runoff flows alone was unachievable due to insufficient water storage capacity and encroachment of human development into the floodplain.

Today, spring and early summer flows do not reach pre-settlement levels in terms of peak flow and flow duration. As a result, channel form in the lower and middle reaches of the Grand River are not rejuvenated by periodic flood events. Floodplain pools no longer remain connected to the river channel long enough to allow production from spawning fishes (pike, bass, minnows) to enter the river.

In the years since the dams were constructed, the dams have had the affect predicted by the Six Nations back in 1812 - a loss of the fishery resulting in a loss of social and economic culture. The Six Nations also feel that the dams have had a negative impact on the fish populations of Lake Erie to an extent, which may never be known. They are aware that many other factors may have influenced the fish populations in the river but they still consider the dams to be an irritant to both the fish and to their community.

In more recent times, the Six Nations have attempted to maintain their fishing culture by continuing to harvest as their ancestors did. They are using hooks and spears along with more modern fishing methods. Fishing is still carried out by the Six Nation's members not as an economic activity but as a food source, cultural event and even a rite of spring. Evidence suggests that there was a spawning run of walleye, whitefish and pike into the Grand River tributaries. The Six Nations Elders also remember catching and observing sturgeon in the river, with the last sturgeon reportedly being caught in Brantford in the late 1960s.

Some improvements were initiated in municipal and industrial waste water treatment following World War II but the rapid pace of development in the 1950s, 1960s and early 1970s resulted in an overall dramatic increase in loading to the river from urban areas. The intensity of agricultural land development also increased dramatically during this time period. Other land use impacts associated with this increased economic activity included road and highway construction, gravel extraction, municipal drains dredged from natural water courses, tiling of fields, and storm water runoff from urban areas. These also had a negative impact on water quality and fish habitat.

Floods associated with Hurricane Hazel on October 15, 1954 were responsible for the removal of many old mill dams in the watershed. While in the short term, the storm and its associated erosion and sedimentation may have been destructive to fish populations and habitat, in the long term it had a beneficial effect. Many streams saw restored fish migration, increased bedload movement, reduced summer temperatures and improved water quality. Unfortunately, many of these dams were replaced to restore community ponds, which were traditionally thought to be both aesthetically pleasing and environmentally beneficial.

Habitat and water quality conditions were at their worst by the late 1960s. A 1966 Ministry of Environment survey indicated that smallmouth bass and Northern Pike were absent from the Grand River upstream of Brantford, presumably due to low dissolved oxygen levels. Periodic fish kills were common in the Grand River in the Cambridge area, and in the Speed River downstream of Guelph.

As a result of the signing of the Great Lakes Water Quality Agreement in 1972, significant improvements were made to municipal and industrial sewage treatment plants, which continue to the present day. Nutrient and contaminant loading from urban point sources were reduced dramatically and water quality improved significantly to the point that bass, pike and other species that require moderately high dissolved oxygen conditions returned to the mid reaches of the Grand and Speed rivers.

Gradual improvements have been made related to the impacts of farming practises (i.e., retirement of marginal lands, no till farming, manure management) but nutrient and sediment loading from rural agricultural sources continue to be problematic and are the main factors limiting aquatic productivity at many locations in the Grand River watershed.

A large flood in 1974 resulted in the Royal Commission recommending a comprehensive water management plan for the watershed. The Grand River Basin Water Management Study was released in 1984. The study strongly recommended floodplain management, structural controls and links to landuse planning for water quality and quantity management.

During the period of 1989 to 1995, a study was initiated to nominate the Grand River as a Canadian Heritage River, a holistic approach to watershed management developed, and several subwatershed plans with active community input were completed. The first subwatershed study in Ontario was completed in the Grand River. Community interest groups, municipalities and agencies began to co-operate for common interests. Water quality became the priority due to the reliance for drinking water as a source.

The Grand River was designated a Canadian Heritage River in 1994. This initiated the establishment of the watershed-wide Grand Strategy, and involved agencies, business, municipalities, interest groups, industry and individuals and facilitated by the GRCA. All stakeholders identified emphasis on the protection and enhancement of the entire watershed as a priority.

During the mid to late 1990’s the Grand Strategy Committee began developing a series of management plans, including the Grand River Fisheries Management Plan, published in 1998. The Fisheries Management Plan was a unique process involving the public from the very start. The recommendations from the Fisheries Plan have been an ongoing priority for implementation. They represent a co-operative community-based watershed approach to managing the fishery and aquatic habitats. This has also required partnership development with other groups i.e. Water Managers.

3.4 History of Fisheries Management

In the late 1800's and early 1900's, fisheries management on the Grand River was restricted to monitoring the commercial catch and placing overly generous limits on sport fish harvest.

By the early and middle 1900's, fish culture technology had advanced sufficiently to see large scale rearing and stocking of game fish in an attempt to mitigate losses due to habitat destruction and over fishing. Large numbers of fish of several species were stocked throughout the watershed (Appendix 2).

During the 1940 - 1965 period, brook trout were stocked in almost every small stream in Waterloo, Wellington, and Brant Counties. Most were no longer capable of supporting self sustaining trout populations, while wild brook trout in the better streams no doubt suffered from competitive interactions and genetic impacts from hatchery fish, as well as increased fishing effort.

Brown trout were introduced into the watershed in 1913 and were reproducing in some streams by the 1940s. Stocking was discontinued in 1960. The Grand River, in the Fergus and Elora areas, was stocked from 1933 to 1959. Despite anecdotal observations of trout redds in the river in the early 1980s, spawning was not successful.

Catchable size (8 to 14 inch) rainbow trout were widely stocked in ponds and reservoirs and below major dams (Shand and Conestogo), starting about 1971. Successful natural reproduction of rainbow trout in the watershed was not confirmed until the late 1980s. Migratory rainbow trout from Lake Erie were able to colonize coldwater streams in the Grand and Nith River watersheds (Whitemans Creek, Alder Creek, Falkland Creek, etc.) after the removal of the Lorne Dam in Brantford in 1989. In general, dams also act as a barrier to exotic species such as those introduced into the Great Lakes (i.e., smelt, sea lamprey, coho salmon and zebra mussels).

Walleye and muskellunge were stocked in the Nith River watershed in the 1930s and smallmouth bass were stocked throughout the watershed between 1928 and the late 1950s. The stocking of walleye and muskellunge was initially thought to be unsuccessful, but a small but viable walleye population was confirmed by MNR and the GRCA in the Ayr to New Hamburg area in the late 1980s. Recent anecdotal accounts of muskellunge in the Nith River may indicate that muskellunge may also be present in low numbers.

The release of the Strategic Plan for Ontario Fisheries (SPOF) in the late 1970s heralded a new era in fisheries management in the Grand River watershed. There was increased emphasis on the importance of habitat in maintaining healthy fish populations. Stream rehabilitation was conducted on several coldwater streams and consisted primarily of bank stabilization, structure placement and removal of obstructions to flow. Streams such as Mill Creek near Cambridge responded positively to rehabilitation efforts.

Early rehabilitation was restricted to site specific instream and near bank techniques. The late 1980s placed increasing emphasis on land use and watershed management as a long-term means of rehabilitating aquatic ecosystems. The GRCA, MNR, and local municipalities have developed a number of watershed plans for urban and urbanizing streams and community based subwatershed implementation plans in the 1990's, and continue to do so. Agency staff also spent considerable effort working directly with municipalities, landowners and proponents of development in order to ensure that land development does not have a detrimental impact on fish habitat.

3.5 Legislative History of Fisheries Management in Ontario and the Grand River Basin

In Upper Canada, the Act of 1821 established closed seasons to protect the spawning periods of game fish. The administration of the law unfortunately, was left to local magistrates, which resulted, for the most part, in little to no enforcement.

In 1857 a new piece of legislation passed the legislature, the Fisheries Act. A significant feature of this was that the Act required the Crown Lands Department to appoint a fishing superintendent and fifteen overseers in each section of the Province. These appointees would have full authority to enforce the Statute. Also, the Act provided for the starting of fish hatcheries to artificially boost the depleting fisheries. "The Fisheries Act of 1857 then was the first practical piece of conservation legislation passed and enforced in Upper Canada" (Lambert, 1967).

In 1892 game and fish laws were rewritten - game fish angling seasons and creel limits were imposed, regulation began for commercial fisheries, penalties were increased, and the first full-time paid game wardens (4) were employed.

The British North America Act (1867) had given jurisdiction over fisheries to the federal government. In 1885, Ontario passed a Fisheries Act placing control of inland waters under the Department of Lands & Forests. However, progress could not be made until the Dominion-Provincial jurisdictional and constitutional disputes in this area were resolved in 1898. The driving forces were the Grand River basin residents, Dr. G. A. MacCallum (Dunnville) and various sportsmen-naturalists. In 1890 the Ontario government appointed a Royal Commission on Game & Fish under Dr. MacCallum's chairmanship. At that time a large portion of fisheries jurisdiction was returned to the Province. "By this time conditions in both game and fish had become so bad as to arouse acute anxiety about the whole future of wildlife (and fisheries) resources in the Province" (Lambert, 1967).

In 1898, following the Dominion-Provincial jurisdictional dispute over fisheries, a Fisheries Branch was established in the Public Works Department with its own commissioner, L.R. Latchford.

In 1907, the Fish and Game Department (2 inspectors and 7 wardens) were recombined and in 1914, the first Deputy Minister of Game and Fisheries was appointed. For the period 1907-1946, this reorganized Game & Fisheries Department made significant progress in improving and enforcing conservation laws. A growing tourist trade provided new incentives for management of game fish in the Province.

Here are some of the highlights of regulations relative to fisheries management in the Province. In 1885 the establishment of a closed season on brook trout began management of gamefish. In 1887, non-resident anglers required a $5.00 license. In 1932, the release of baitfish into any waters except from where they were taken was prohibited. In 1903, the sale of all game fish was also prohibited.

The Game and Fish Department gave attention to re-stocking of Ontario waters by establishing the Fish Culture Branch, which acquired approximately 20 hatcheries. For about 100 years, great faith and reliance on artificial fish breeding to balance overfishing resulted in Federal and Provincial operated hatcheries. It came to be realized in latter years that hatchery fish could be beneficial only if used properly.

Habitat Inventory and Assessment

There was little effort towards fish habitat inventory and assessment in the period prior to 1970 within the Grand River basin. Starting in the early 1970's, significant effort was undertaken to inventory aquatic habitats in the Grand River basin through lake/pond surveys and stream surveys. The original design and intent of such studies was to assess the suitability of the waters for fish stocking purposes. Aquatic inventory assessments were also a useful tool as a measure of river water quality. Tracking river water quality was of particular importance given that there was redesign and reconstruction of Sewage Treatment Plants (STP’s) and reservoirs in the 1960’ and 1970’s. However, into the mid-1980’s the emphasis began to shift towards a more holistic approach to fisheries management, with the focus changing to protection and management of aquatic habitats.

In recent years, much effort has been put forward in the collection of data, and with public consultation, development of information databases, and digital mapping of aquatic /water quality habitat and fish communities thus contributing to the development of fish habitat objectives in the basin. However, although efforts continue with habitat inventory and assessment, and information management, many waters are still unsurveyed.

Management Planning

In 1925, a biological department was established and biological studies of Provincial waters were initiated. In 1928 the Biological and Fish Culture Branch was established which united biological study activities and fish stocking activities.

In 1946 the Department of Game & Fish was amalgamated with the Department of Lands & Forests. The merging of forestry to game and fish personnel would prove to have a profound influence on game and fish management in the Province. The emphasis from such a union thus shifted from protection and conservation to a scientific management approach, which the Provincial foresters had previously adopted in the 1880's and 1890's. The principles of such an approach were further emphasized in 1961 through the release by Dr. C.H.D. Clarke of a policy with specific objectives, which can be summarized as follows:

> i) principle of sustained yield through maintenance of stock that would produce a sustainable annual harvest.
>
> ii) every effort would be made to harvest this annual yield,

iii) needs of fish production carefully considered in relation to planning other forms of land & water use in Province,

iv) plans, programs, legislation must be directed to promote and encourage public use rather than restricting or discouraging such use.

These principles of fisheries management are, in the general sense, still evident today.

The first formal fisheries management plans in the Grand River watershed, were those prepared by MNR in the late 1980’s. These plans were developed with public input and prepared on the basis of MNR Administrative Districts rather than watersheds, which resulted in at least 5 plans covering a portion of the Grand River watershed.

With the watershed plan approach gaining favour in the early 1990's, this ultimately led to the development of a Grand River Watershed Plan. The fisheries management plan as a component of the Grand River watershed plan, was thus prepared on a collaborative basis with public and contributing partners participation.

Table 3.1: Summary of the Human Historical Background from the Grand River Watershed covering 1781 - 1905.

Year	Date	Location	History
1781		Eastern edge of Grand River basin	British government signs treaty with Mississaugas and Chippewas for lands in Niagara Peninsula including lands in extreme eastern portion of Grand River basin.
1783		Grand River	7,000-8,000 Six Nations Indians settle
1784	October 25	Grand River	deed of tract to Mohawks
1792	December	Central and western portion of Grand River basin.	British government signs treaty No.3 with Mississaugas for lands in central and western portions of Grand River basin.
1793		Central portion of Grand River Basin	British government grants land six miles wide along both sides of Grand River to Six Nations Indians from New York State.
1809	Feb.- Mar. 9	York UC	first session of fifth Parliament of Upper Canada allocates funds for bridge over Grand River
1812			Six Nations expresses distress at the damming of the Grand River, resulting in loss of fishery
1815		Pt. Maitland	Royal Navy begins building Grand River Naval Depot
1818	October	Headwater portion of Grand River basin	British government signs treaties No. 18 and 19 with Chippewas for lands, which include portions of Grand River headwaters.
1821		Upper Canada	Act of 1821 establishes closed seasons to protect spawning periods of game fish.
1823		Paris (Forks of the Grand)	First Plaster Mine (1822) with first plaster mill and raceways constructed by Holme at Nith River and Grand River. In the period of 1822-1940, many gypsum mines were developed and operated along the Grand River from Glen Morris to Cayuga area, resulting in construction of dams, mill races, barge canals and dumping of waste rock into river or along banks.

1825	April	Headwater portion of Grand River basin	British government signs Treaty No. 27 ½ with Ojibways and Chippewas for lands which include portions of Grand River headwaters.
1825	after July 4	Grand River	Pickering sees some old vessels of war sunk and rotting at the naval depot, Gull Island near by refuge for ships
1827		Dunnville UC	work starts on Grand River dam
1834		Pt. Maitland	British abandon Grand River Naval Depot
1836	August	Headwater portion of Grand River basin	British government signs treaty No. 45 ½ with Saugeens for lands, which include portions of Grand River headwaters.
1857		Canada	Fisheries Act established in legislature. Required appointment of fishing superintendent and overseers in each section of the Province, and provided for starting of fish hatcheries.
1867		Canada	British North America Act (1867) established jurisdiction of fisheries as belonging to federal government. (see 1885)
1867	Feb. 16	Dunnville ON	Kerr finds fishway unsatisfactory
	Mar. 1		Francis Stevenson, clerk Haldimand County, sends letter asking that the Grand River Navigation Co. be compelled to provide fishways in their five or six dams, Frederick Hyne says fishway in local dam of no earthly use
	Nov. 15		Peter Wardell, fisherman threatens Kerr
	Nov. 16		Kerr approves Dunnville fishway
			registration of steam tow tug Mary Ann, 97 nt as no. 1 for year, no official number
			Barret 1974) gives Stromness Ont. as place of build and length 50’, [builder] builds for Senator McCallum, may have fished in 1868, Registry closed June 22 1933, vessel out of commission, certificate of registry not delivered up
1870	Oct. 28	Dunnville ON	Kerr issues licenses, Henry Ross pays $15 fee for 1869 and 1870 on fishery from Dunnville wharf to mouth of Grand River
	Dec. 20		Kerr gets returns
	October	Pt. Maitland	lighthouse keeper resigns
	Dec. 20		storm carries away wooden lighthouse at mouth of Grand River

			Six Nations oppose Damming River Communication and Protest of the Natives continued from the Six Nations with very little reaction or assistance from this government of this day. A motion of the Nations supports the position that Indians be exempt from Game and Fisheries Laws
1871	Mar. 16 Mar.20 May 9 June 15	Dunnville and Pt. Maitland	William M. Green and John Logan collect $1 from local fishermen dam has a fishway built since 1865 Kerr and Martin Green or Greene seize five new trap-nets of Henry Ross in Grand River fisheries Guardian David Price to return trap-net to Ross, fishing for rough fish not as good as last year, low water in the Grand River
	April Mar. 20 July 4 July 14	Brantford Galt	J.T. Gilkison, Superintendent of Indian Affairs, reports wagonloads of pickerel glutting local market dam has a fishway built since 1865 letter to William Cowan refers to the Fish Society of Galt Adam Kerr, Mayor and John W. Kerr in court, Firm of Bloomfield & McDougal gets $25.00 fine and $2.95 costs for allowing sawdust into Mill Creek (Grand River tributary)
1872		Dunnville	John W. Kerr, FO, says fishing with seine and hook and line good in Grand River
1873	Oct. 31 Dec. 22	Hamilton	Kerr submits the usual fishery statistics to Ottawa, report to follow, five license fees enclosed. Kerr again notes that statistics only to Sept. 30. Kerr requests a license for hook fishermen at the mouth (Lake outflow) of the Niagara River. Fort Erie, Black Rock and Buffalo fishermen ignore international boundary. Kerr submits report on Dunnville and Grand River dams and mills
1874	Apr. 6 Oct.	York	Adam A, Davis, Secretary Grand River Navigation Co., gets notices to build fishways Adam A. Davis claims Grand River Navigation Co. financially unable to build fishways or even make repairs to one dam
1876		Grand River	first separate Grand River Statistics
1877		Haldimand Shore and Grand River	Henry Law Fisheries Overseer, violations of the fishery laws frequent
1879		Haldimand County and Grand River	Henry Law Fisheries Overseer, reports catch decline due to prohibition against pound-nets at mouth of River, fines three parties for fishing without a license
1884	spring	Haldimand County	W. A. McCrae Fisheries Overseer, almost no seining due to late break up of ice in the Grand River

	Oct. 2	Pt. Maitland	local angler lands four black bass total 16.5 lb (DG)
1885		Ontario	Ontario passes Fisheries Act placing control of inland waters under Department of Lands & Forests. Initiated a conflict and dispute of jurisdiction over inland fisheries with Dominion which was not resolved until 1898.
1885		Haldimand County	W.A. McCrae Fisheries Overseer, reports a severe storm renders the pound-nets at the mouth of the Grand River useless
1885	Apr. 20	Lower Grand River	catfish catch: seine heavy, catfish 4 cents a lb, James A. McIndoe ships 1.5 tons to Buffalo
1887		Cayuga to Moulton Bay including Grand River	two vessels, eight tons with four men, seven boats, 21 men, 22 fathoms gill nets, six fathom seines, 50 hoop-nets and three pound-nets. Catch in lb: whitefish 1,500; sturgeon 6,800; maskinonge 450; bass 10,650; pickerel 25,650; pike 8,000; and coarse fish 30,000; and home consumption 155,600
1888		Cayuga to Moulton Bay including Grand River	three vessels, 15 tons with six men, 10 boats, 24 men, 1,545 fathoms gill-nets, 103 fathoms seines, 10 hoop-nets and three pound-nets. Catch in lb: whitefish 3,338; herring 48,820; sturgeon 9,200; maskinonge 200; bass 4,186; pickerel 47,842; pike 19,070; and coarse fish 40,800
1889		Cayuga to Moulton Bay including Grand River	three vessels, 15 tons with six men, 10 boats, 24 men, 1,545 fathoms gill-nets, 103 fathoms seines, 10 hoop-nets and three pound-nets. Catch in lb: whitefish 3,338 herring 48,820; sturgeon 9,200; maskinonge 200; bass 4,186; pickerel 48,342; pike 19,070; and coarse fish 40,800; home consumption 550. *Data almost identical to 1888.*
1890		Upper Grand River	C.W. Evans Fisheries Overseer, Cayuga.
1891		Cayuga to Low Banks including Grand River	one vessel 22 tons with four men, 21 boats, 30 men, 6,560 fathoms gill nets and 312 fathoms seines. Catch in lb: whitefish 6,650; herring 83,950; sturgeon 2,000; maskinonge 800; bass 3,725; pickerel 22,700; pike 7,300; coarse fish 45,000; and home consumption 9,600
1892		Ontario	Game and fish laws were rewritten establishing angling seasons, creel limits, and regulation of commercial fisheries. First full-time paid game wardens (4) were obtained.
1893		Grand River	17 boats, 19 men and 190 fathoms seines. Catch in lb: sturgeon 1,300; maskinonge 800; bass 3,025; pickerel 8,600; pike 5,000; and coarse fish 47,150

1894		Haldimand County and Upper Grand River	C. H. McCrae Fisheries Overseer
		Cayuga to Moulton Bay including Grand River	two vessels 35 tons with seven men, 19 boats, 30 men, 7,000 fathoms gill nets, and 200 fathoms seines. Catch in lb: trout 500; herring 7,500; sturgeon 500; maskinonge 150; bass 2,350; perch 28,200; pickerel 40,200; pike 6,900; and coarse fish 20,900.
		Dunnville	inspection of steam fishing tug 'Fanny Moore', 2 nt.
1895		Cayuga to Moulton Bay including Grand River	two vessels, 32 tons with seven men, 18 boats, 30 men, 9,000 fathoms gill0nets and 1,200 fathoms seines. Catch in lb: whitefish 400; herring 32,230; maskinonge 540; bass 2,750; perch 8,000; pickerel 13,700; pike 3,100; and coarse fish 13,100 (MM&F)
1896		Cayuga to Moulton Bay including Grand River	two vessels, 32 tons, with seven men, 18 boats, 30 men, 9,000 fathoms gill-nets and 12 seines totaling 1,200 fathoms. Catch in lb: herring 30,150; whitefish 420; bass 2,640; pickerel 13,200; pike 3,000; maskinonge 500; perch 8,520; and mixed 13,000
	Sept. 11	Pt Maitland	Will Taylor rents Ross yacht 'Enterprise' for fall fishing season,
	Sept. 12		tow all yachts to their nets, no breeze for sails
	Sept. 21		on 17th, Freeman Green's tug 'Osprey' and Martin Bros. 'Eleanor' set tug record for early fall fishing
	Oct. 16		Martins' 11 bbl best catch
	Nov. 13		on 10th, Martins alone loose 50 nets in storm
	Nov. 20		fishing poor, Martins Bros. recover several nets
	Nov. 27		poor weather, Martins two tons one day, mostly pickerel, now mostly herring
	Dec. 11		river ice stops fishing for a few days, on 10th Martins take over 1,900 lb.
	Dec. 18		navigation closes on the 15th
1897		Cayuga to Moulton Bay including Grand River	two tugs, 50 tons with five men, 10 boats, 20 men, 30 gill nets total 9,000 fathoms. Catch in lb: herring 108,100; whitefish 6,550; bass 2,025; pickerel 54,800; pike 1,00; maskinonge 200; sturgeon 300; perch 3,800; catfish 500 and mixed 18,500
1898		Ontario	Jurisdictional dispute between Dominion and Province settled for the most part with a large portion of fisheries jurisdiction being returned to the Province by the Dominion. A Fisheries Branch was established in the Province in the Public Works Department.
1904		Dunnville	gill-net tug 'F B Bradey', Owner Freeman Green, fails inspection, Fisheries Overseer Couper reports no illegal fishing, licenses 1,300 hooks for Grand River

1905		Grand River	Henry Johnston Fishery Overseer
	early summer		fish kill by alkali from starch factory (ODF)

4.0 FISHERIES/WATERSHED CHARACTERIZATION

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4.1 The 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 provides the parent rock and topography, the climate, the water and the erosive forces, which shape the weathered rock into soil. The topography of an area modifies the local climate thereby encouraging certain forms of vegetation and plant communities. These forces and processes in turn dictate the shape of the river channel, its slope, substrate, cover, and animal community. Therefore, the geology and climate of an area dictate the nature of the stream, its gradient, substrate, fertility, productivity and the animal and plant communities found adjacent and within its waters. Since all the water that is found in a river comes from the surrounding catchment or watershed, a stream and its biological life is intrinsically and directly dependent upon the stability, productivity and health of the lands draining into them from the watershed. Human landuse activities can alter these processes resulting in degraded conditions. An eminent river ecologist, Dr. H.B.N. Hynes 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 Grand River watershed is a complex system composed of various landforms (geology, soil and topography), land covers (vegetation), land uses and living communities of animals (terrestrial and aquatic). An understanding of the relationships between geology, hydrology, channel morphology and chemistry is necessary in order to understand how and why certain communities of fish are found where they are within the Grand River watershed.

4.1.1 Surficial geology

Geology and climate determine the types of surface and groundwater flow patterns and channel forms found in a watershed and ultimately the types of aquatic and terrestrial communities. Climate and the associated weather patterns can be viewed over days, years, centuries and millennium. Over short periods such as a year, climatic conditions and weather patterns provide precipitation that moves by various pathways over and through the land to generate groundwater and surface water flow regimes which in turn influence high and low flow regimes of the streams within the watershed. Over long periods of time, climate generated glacial periods that have altered the surface of the land, moving, sorting and depositing boulders, rocks, gravel, sand, silt and clays in various types of composition and forms. Therefore, over the last 20,000 years, the changes in climatic conditions have altered the surficial geology of the landscape in southern Ontario and within the Grand River watershed.

The geology of a watershed can be divided into the soils and materials overlaying the bedrock of the watershed and the bedrock materials themselves under the overburden of a watershed. The examination of the geology of a watershed is often divided into the study of the composition, extent and topography of the bedrock of the watershed and the surficial geology or overburden deposited on this bedrock by the last set of glacial periods.

The bedrock geology of the Grand River is composed of two different forms of rock: that formed by volcanic forces (i.e., igneous - granite) and that formed by sedimentary processes (i.e., limestone - dolostone). The volcanic bedrock is overlaid to variable depths by the sedimentary rock and rarely influences the functioning of the watershed. The sedimentary bedrock however is very important and provides both topography, storage capability for groundwater and contributes to the chemistry of the regional groundwater of the watershed. This sedimentary bedrock does protrude in some locations in the province (i.e., Niagara Escarpment) and within the Grand River watershed. Within the watershed, the major locations of sedimentary bedrock protrusion include Elora Gorge, Eramosa River from Everton downstream, the upper portions of Fairchild Creek, the Grand River through Cambridge and the Nith River near Paris. These locations of protrusion, given the often fractured nature of this type of bedrock, can often be locations of regional groundwater discharge to the local tributaries of the Grand watershed.

The surficial geology of the Grand River is complex both by the types of materials overlaying the bedrock as well as the distributions of these materials. The surficial soils are composed of a number of major types:

Till - largely reworked and poorly sorted soils (by glaciers of glacio-lacustrine materials) composed of silts, sandy silts, clay, gravels, rocks and occasionally boulders, although mixed with finer materials deposited in lake type environments - variable ability to infiltrate water and create active shallow groundwater systems

Clay - fine in-organic materials usually of very fine grain-size often the result of ground or "powdered" rock, usually of a relatively uniform size - extremely low infiltration with static groundwater systems

Silt - fine material composed of finely ground organic and inorganic materials and often laid down through lake deposition processes - low infiltration capability with static groundwater systems

Glacio-fluvial - these materials deposited by riverine processes such as meltwater channels. They are usually composed of well-sorted cobbles, gravels and sands - with high permeabilities and often can contain active local groundwater systems

Glacio-lucustrine - these materials are laid down by lake sedimentary processes that occurred as a result of glacial lakes being formed. They are usually composed of finely sorted depositional materials such as silts and clays. - low permeability and infiltration with static groundwater systems

Moraines - moraines are medium to high hills created by the action and movement of glaciers. Depending upon the materials being carried by the glaciers these moraines can be composed mostly of tills (i.e. till moraines), gravels and sands. - depending upon materials, may be very poor infiltration and static groundwater systems (i.e. silty till) or capable of high infiltration with associated large and active groundwater systems (i.e. kame moraines of gravel and sand).

Sedimentary bedrock is alkaline by nature. The mixture of surficial materials ground up and deposited by the last set of glaciers influences the chemistry of the water coming out of the ground within the watershed. The pH of the water is basic (i.e. pH >7.7) and quite alkaline or hard. As well, because of the rural nature of the watershed, large amounts of phosphorus enter the system from agricultural fertilizers or soil erosion. The combination of alkaline water plus abundant supplies of phosphorous creates the opportunity for high aquatic productivity if this chemistry is found in stream reaches that have healthy, stable channel forms and streambeds comprised of gravels, cobbles and boulders. Many of the river reaches in the mid-sections of the Grand River watershed have this combination of physical and chemical characteristics thereby generating extremely productive fish populations exhibiting high levels of diversity, large numbers of fish and very good growth rates. Examples of productive tributaries and reaches include Whiteman's Creek downstream of Princeton, portions of the lower Nith River and the main Grand River from Shand Dam downstream to Winterbourne.

Ultimately, the characteristics of the surface and bedrock geologies play a major role in the movement of water over and through the watershed. Where and how this water moves through the system provides opportunities for some animals and plants and constraints for others. For example, gravels and sands are highly porous to rainwater compared to silts and clays. Those portions of the Grand River watershed that are dominated by spillways or moraines of gravels and sands have very active groundwater tables that move water through the ground towards low lying areas of the basin. Sections of streams in these areas have high baseflows, cool, moderate water temperatures and habitat features and characteristics necessary for coldwater fish such as trout. An example would be the Eramosa River near Ospringe. However, portions of the watershed containing mostly clays and silts are less prone to infiltrating rainwater but rather flush the water off the land quickly as surface runoff. These portions of the watershed have very low (or in the case of headwater sections) or no baseflows, flashing high flows, high water temperatures in the summer and inappropriate habitat conditions for coldwater species but perhaps appropriate habitat for warmwater minnow species (i.e., Grand River downstream of Luther Marsh). In larger sections flowing through this type of geology, warmwater/coolwater communities dominate composed of smallmouth bass, walleye, brown bullhead, creek chub, etc. (i.e., Grand River downstream of Brantford).

In some instances, coldwater communities are found in geological zones dominated by clays, tills or silts. However in all of these circumstances examined to date, the coldwater community is associated with either a remnant deposition of spillway gravels and/or sands or are in a location where regional groundwater is discharging into the overlaying shallow surface geology.

There appear to be three major surficial geological zones within the Grand River watershed. These zones track from north-east to south-west through the watershed with the divides occurring roughly at Belwood Lake in the north part of the watershed and Brantford in the south part of the watershed (see Figure 4.8). These three zones are used in Section 4.3 for discussion of the fisheries and habitat resources of the watershed.

4.1.2 Water Flow Regimes (Groundwater and Surface water)

Water is one of the major elements and resources, which ties us to the natural world. Every animal and plant on earth requires water to sustain its' life. Where water comes from and where and how water moves over and through the landscape dictates the local ecosystems found on land and in streams. This movement of water creates the streams, wetlands, forests, water tables and environmental characteristics that sustain all of us and the natural features we enjoy. It creates the types of streams (cold or warm), the abundance of water in the streams, and the productivity or fertility of the streams. It also provides the abundance of water in the ground that communities can draw upon and the water necessary for many of our businesses and industries.

Streams, flowing through a watershed can be linked to the local water tables, regional aquifers, or both. Stream levels are usually the same as the elevation of the local watertable adjacent to the stream. At certain points in the watershed, the topography and soils combine to form water tables with steep gradients. In these areas, the steep slope of the watertable pushes groundwater actively into a stream or wetland. Because water flows slowly through the ground, it discharges gradually and more or less regularly throughout the year. The nature, volume and quality of these discharges control the animal and plant populations at the sources of discharge.

Watersheds that have deep deposits of very coarse soils infiltrate a large proportion of annual precipitation and create mounds of groundwater with very large, steep sloped water tables. Streams in these areas have a greater proportion of their stream flow derived from uniform groundwater discharges and less from surface run-off. These types of streams are often referred to as "spring creeks". Because of the limited amount of surface run-off, these streams have a very uniform flow and temperatures throughout the year. These streams, because of their pacific nature, have very large, stable baseflows. During spring run-off or heavy storm events, flow increases are moderate and prolonged, rather than large and flashy. Spring-fed creeks can be the most productive on earth for coldwater fish such as brook trout and brown trout. The locations in coldwater streams where groundwater flow is extremely high (often flowing upward through the substrate into the stream) are important trout refuges. These refuges can protect coldwater fish from very high temperatures in the summer or very low temperatures in the winter. These major upwelling or discharge areas are also critical locations for native brook trout spawning and egg incubation. These areas of coarse sand and gravel with upwelling groundwater are the waterbeds for their eggs and fry and are likely the most sensitive and rare environments within a brook trout stream. For example, within the 14km brook trout zone on the Credit River, 35% of all brook trout spawning occurs in a 100m section of stream. This 100m section of stream is dominated by very active groundwater discharges.

Figure 4.1 illustrates two major flow pathways found in watersheds: the hydrological and ecological. The hydrological pathway can also be called the water cycle. This pathway helps us understand the different ways water can move over, through and out of a watershed in its' cycle. The major pathways of the water cycle are: precipitation; evapo-transpiration; surface runoff; interflow; and groundwater movement. The geology and climate of a particular watershed dictates what proportion of water uses which pathways. Different combinations of the water cycle pathway create different opportunities for fish communities within a watershed.

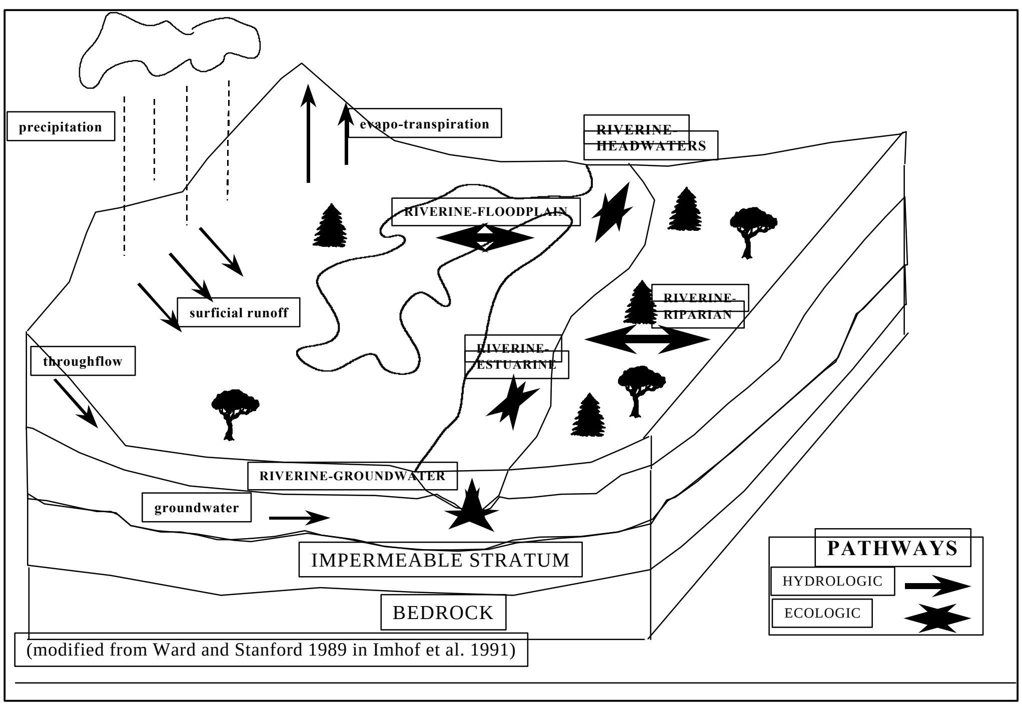


Figure 4.1: The hydrological and ecological pathways within a watershed.

The use of the water cycle is strengthened if it is used to explain similar ecological models and pathways. There are a variety of conceptual models that explain the functioning of river ecosystems. Two major and related models come to mind, the River Continuum Concept (RCC) (Vannote et al., 1982) and the Serial Discontinuity Concept (SDC) (Ward and Stanford, 1983). RCC links characteristics in fish and invertebrate community structure, trophic relationships, nutrients, energy and carbon processing to stream order. The model hypothesizes that there are gradients of change in physical, chemical and biological parameters as one moves down a river system from headwaters to mouth. The delivery of energy changes as you move down the system and concurrent changes in the fish and invertebrate community to take advantage of these shifts.

The RCC proposes that substrate in headwater systems is usually coarse and therefore contains a large variety of fish and invertebrates that can take advantage of the complexity of habitat available for them. Much of the food feeding the invertebrates in these headwater areas comes from plant material that falls into the stream from the riparian zone. As one moves down the system, the river is larger, wider, temperatures increase, substrate becomes finer, direct solar radiation becomes more important, and the biotic community becomes dominated by animals that harvest food produced in the river. Food sources are generated within the channel (i.e., autochthonous) through primary production.

The SDC is a major modifier of the RCC. It acknowledges gradients of change but also stresses the importance of discontinuities, breaks and resets in the biophysical and chemical gradients, functions and processes. The authors (Ward and Stanford, 1983) observed shifts in community composition, trophic structure, food processing and physical dynamics at various locations in river systems that were contrary to the predictions of the RCC. These serial discontinuities included geological, topographical, hydrogeological, hydrological shifts as well as manmade shifts such as reservoirs. As well as these controllers of discontinuity, Ward and Stanford (1995) also suggested interactive pathways that operated with the valley system (i.e. Ecological Pathways) and influenced the distribution and characteristics of biotic communities: river-longitudinal (headwaters to estuary); river-riparian; river-floodplain; river-groundwater). As an example, the longitudinal pathway links the mouth of the river with its sources, thereby providing the potential for two-way migration of animals within the system. Imhof et al. (1991) suggested an integration of the hydrologic pathways of a watershed (i.e. water cycle) with the ecologic pathways suggested by Ward and Stanford (1989) (Figure 4.1).

The hydrological and ecological pathways are used in this section to help explain the interaction of fish and fish communities to the movement of water and the control of valley characteristics on their productivity and distribution.

Flow Patterns and Fish Habitat

The flow patterns and flow pathways of a river system control the movement and access of migrating fish into small tributaries of large rivers (i.e., longitudinal pathway, large scale effects). There are windows of opportunity during high flow events that regulate the movement of migrating fish into small tributaries. The larger the order of the main stream in relation to the smaller tributaries, the narrower the windows become.

Windows of access also occur in relation to fish migration and movement into and out of floodplain areas and are defined as the river: floodplain pathway. Many species of fish and invertebrates use floodplain areas for reproduction. In order for this to occur, there must be active channel connections between the floodplain and the river. Flow stages during flooding must be sustained over a time period long enough (2-3 wks) to allow the movement, reproduction and incubation to proceed before water levels drop and the floodplains become isolated once more. It is not surprising that many warmwater species have evolved to take advantage of floodplains since they provide ideal habitat for spawning away from predators and are physically complex in comparison to the channel itself. Since larger rivers have longer flood durations than headwater systems, aquatic animals take advantage of these hydrographic and physical characteristics.

On an annual basis, the characteristics of the flow regime will act as a qualifier of habitat availability and suitability within the channel. It is important to examine the watershed hydrology as an aid to determine habitat characteristics for a particular reach of stream. Although a stream channel may contain the same surface area of spawning gravels, between spawning periods, it is the annual flow regime that will determine the overall habitat availability for all life stages. An analysis of BOTH hydrological event characteristics AND flow regime characteristics is important to understand the ability of the channel/valley system to provide all requirements of various life stages. Life stage requirements are not only dependent on the order of the stream within the watershed, but also on the type of stream channel within the watershed.

High Flow Regimes and Fish

High flows in most stream systems are a natural occurrence. High flows occur when large quantities of water swell river channels because of specific weather conditions such as severe storm events and rapid melting of winter snows. These flows result when the land no longer has sufficient ability to hold, absorb or store the water. During the most frequent weather conditions, the amount of high flow in a watershed will be governed by a number of factors including the surficial geology and soils of the watershed, the topography of the land, the land cover and land uses of the watershed. These factors then influence the relative importance of the individual components of the hydrological pathway (i.e., surface run-off; evapo-transpiration; interflow; groundwater recharge/discharge).

Streams with a high proportion of surface run-off respond quickly to storm events, rising rapidly and creating dangerous flood and erosion conditions. Because more of their hydrologic pathway is lost as surface run-off, less goes into the ground and therefore they have lower and more irregular flows during periods of time when no rain falls. These streams are much less productive and also much more dangerous and unstable for fish, bugs and people.

Streams flowing through areas that have predominantly fine textured soils such as silts, silty-sands, silty-clays or clays are usually more responsive to rainfall events compared to stream or stream sections flowing through areas of gravel and sand. Topography also can exacerbate the response of "tight" textured soils to runoff from storm events, while wetland volume and type can offset the inherent responsiveness of a clayey watershed to runoff generation. Landuse practices such as drainage and urbanization can make a stream or watershed that had moderate high flow regimes more responsive to storm events by improving the "efficiency" by which rainwater flows off the land into a surface water receiving channel or structure.

Changes in the overall water budget of the watershed or sub-basin can have repercussions on channel morphology, bank stability, flood elevations, flood frequencies, water quality, aquatic habitat and fish communities. In general, the more quickly a stream section, sub-basin or watershed responds to storm events, the more likely the watershed is to lose important fish communities, de-stabilize the channel, banks and floodplain and degrade water quality.

Stress can be placed upon fish through natural extreme fluctuations in flow both from an event standpoint (i.e., 1:25yr flood; 1:25yr drought baseflow) and from a regime standpoint (i.e., changes in the "normal" daily, seasonal or annual flow characteristics of frequency, magnitude and duration). Headwater streams of lst and 2nd order are more sensitive to daily and seasonal fluctuations in flow because of the characteristics of their channel structure (i.e., relatively shallow pools and refuge areas). If minimum low flow events occur more frequently (compared to historical trends - i.e., changing from irregular to frequent events) this can lead to loss of spawning success, loss of juvenile fish and depletion of adult fish. In effect, the annual minimum baseflow ultimately controls the maximum potential productivity of a stream or river system by determining the annual minimum living space for aquatic biota.

Medium order streams (3-4 order) usually have deeper water refugia and because flow is contributed by a larger stream network, they may have more variability in flow but low flow characteristics are not as variable in relation to channel characteristics than in headwater systems. Large order streams (i.e., 5-8 order) have dampened flow patterns that generate longer high and low flow durations. Major droughts also affect these channels but the return periods are less frequent (i.e., 20-50 year for 5- 8 order streams vs 2 - 5 years for 1 - 2 order streams). Therefore, small coldwater tributaries and to a certain degree mixed water tributaries on the Grand River, are very susceptible to alterations of their annual lowflow or baseflow (i.e., Butler Cr.; Swan Cr.; Hanlon Cr.). Larger coldwater streams and subwatersheds are less susceptible to occasional annual lowflow extremes but are vulnerable to larger, longer-term lowflows (i.e., Eramosa R.; Blue Springs Cr.; Whiteman's Cr.).

Groundwater Regimes and Fish

For many years, stream biologists have observed a strong positive relationship between the discharge of groundwater to streams and stream fish (Blackport et al., 1995). Nevertheless, only recently have the relationships been explored scientifically. Some recent work in this area includes work done Bowlby and Roff, 1986, Cunjak and Power 1986, Sowden and Power, 1985, and Witzel and MacCrimmon, 1983. In addition to fish, groundwater has also been identified as important, in general, to stream health (Hynes, 1983; Bilby, 1984; Meisner et al., 1988).

While there is still much to learn, several important relationships between fish and groundwater have been demonstrated, including:

A) Groundwater discharge creates and maintains baseflow in streams, and hence controls the quantity of living space, cover and food for fish.

B) Site-specific groundwater discharge patterns generate opportunity for reproduction and provide thermal refugia during temperature extremes.

C) Groundwater moderates stream temperatures during critical times of year (midsummer and midwinter), and maintains temperatures to a level suitable for thermally sensitive fish species.

Many factors control the "productivity" of fish and related communities in streams:

- quantity of water and its source (i.e., surface vs shallow groundwater vs regional groundwater);
- its delivery to the stream;
- its affect upon water quality;
- the frequency of various flow patterns;
- the magnitude of exceptional flow patterns; and
- the duration of these exceptional patterns

All these elements have a major control on fish habitat and aquatic communities. Stream flow is a combination of overland flow, interflow (flow below the ground surface but above the water table) and groundwater discharge. However, it is the constant discharge of groundwater that maintains baseflow in streams during periods of little or no precipitation.

As mentioned previously, research in recent years has demonstrated that some of the most productive streams are spring-fed streams, especially those that derive a significant amount of their baseflow from regional groundwater systems (i.e., limestone bedrock). Groundwater, the source of water that generates these conditions, has been shown in a number of studies to be highly correlated to fish biomass and productivity (i.e., Bowlby and Roff, 1986).

In portions of the Grand River watershed, the Amabel Dolostone formation exists and comes close to the surface of the surrounding land. The Amabel formation is a form of limestone dolostone that is very porous and highly fractured. It is a very active and substantial bedrock aquifer. It comes close to the surface of the landscape in several areas of the Grand watershed and where it does come close to the surface, it discharges substantial amounts of stable, cold groundwater. These bedrock groundwater discharges occurs in subwatersheds such as Blue Springs Creek near Acton and the Eramosa River near Everton. Both of these subwatersheds exhibit little major fluctuation in baseflow pattern on an annual basis.

Relationships of Groundwater to Fish Spawning and Nursery Habitat

Groundwater discharge may have a major influence on spawning and nursery habitat potential for many fish species. For instance, Cunjak and Power (1986) demonstrated that brook trout (*Salvelinus fontinalis*) require groundwater discharge areas for spawning, nursery and juvenile habitat. Latta (1965) also found higher juvenile survivorship in areas having active groundwater discharges. Localized groundwater discharge through streambeds ("upwelling") provides a stable flow of clean water through salmonid redds, and is critical in many instances for egg and embryo survival. A positive correlation between salmonid embryo survival and groundwater discharge has been clearly demonstrated in many scientific studies (i.e., Benson, 1953, Wickett, 1954, Sowden and Power, 1985). As groundwater discharge temperatures are relatively warm in winter relative to "surface water', groundwater flow through redds promotes rapid egg development and prevents mortality due to freezing and anchor ice development.

Once they emerge from the gravel, salmonid fry inhabit the slower, shallow stream margins where temperatures in these important microhabitats may be expected to be subject to extremes (depending on fluctuations in air temperatures). As groundwater upwelling pressures are greatest at stream margins relative to the centre of a stream (Sowden and Power, 1985), temperatures along stream margins will be moderated by groundwater discharge, thereby maintaining thermal conditions suitable for salmonid fry.

Wetlands provide extremely important spawning and nursery habitat for many fish species and they are also important habitat for waterfowl and wildlife. Some wetlands may serve as important groundwater recharge areas (i.e., wetlands on higher ground), whereas others in low-lying areas are discharge areas and receptors for significant amounts of groundwater. Because of the dependence of the wetland plant community on the water table level and groundwater flow, changing the discharge patterns of groundwater or lowering the water table in these areas may substantially influence the wetland and all the organisms depending on it.

Relationship between Geology, Baseflow and Fish Communities

Certain geological settings, given their inherent characteristics, create specific opportunities of various fish communities and sensitive species within these communities. Geology acts both as a control on the baseflow/groundwater characteristics on a sub-basin or zone scale but can also act as a modifier on the local, tributary or reach scale. For example, on the upper mainstem of the Grand River upstream of Grand Valley, the clayey geology of the system tends towards a channel flow that has rapid, high peaks and very low baseflows with very warm temperatures in the summer. These characteristics in conjunction with some of the wetland remnants in the upper watershed tend to favour coolwater species such as northern pike and creek chub. These conditions are not likely to change for high and lowflow regime unless more of the upper watershed is re-established as wetland (i.e., swamp and marsh wetlands). Even if flow regimes were moderated, the lack of groundwater intrusion would maintain the fish community of this portion of the upper watershed as a mixed water/warmwater community.

Downstream of Grand Valley, a major area of sand deposition south and southwest of Marsville touches the mainstem of the Grand River just upstream of Belwood. The stream tributary flowing into this portion of the Grand River does contain a coldwater community and provides a cooling component to the mainstem of the Grand River. This cooling trend actually begins just downstream of Grand Valley, as the valley flows through an old gravel outwash spillway. These two features create a potential for the development of a modest coldwater community downstream of Grand Valley despite the limitations for a coldwater community upstream of Grand Valley.

Geology and groundwater activity can also explain apparent contradictory distributions of fish species in larger portions of the Grand River watershed. The Grand River downstream of Cambridge, between Cambridge and Brantford flows through a deep valley incising large deposits of gravels and sands, especially on the western side of the river. Nearer to Brantford the river also incises the northeasterly limits of the Norfolk sandplain. The presence of these surficial deposits in conjunction with the depth of the valley appears to provide a major zone of groundwater discharge into the main river channel in some sections and major discharges into certain tributaries in other sections (i.e., Whiteman's Creek). Although the river's size and its tendencies favour a coolwater/warmwater fish community, the distribution and volumes of groundwater discharges also make portions of the mainstem suitable for juvenile and adult life stages of certain coldwater fish such as rainbow trout and brown trout. Similar fish community distribution patterns are seen in the lower portions of the Nith River.

4.1.3 Channel Form and Habitat Relationships

River channels are dynamic systems that in unaltered watersheds create forms that enable them to dissipate energy during high flow events while retaining a relatively stable structure. Water flows downhill if a slope is present. This means that a river must contend with the potential energy created by slope. Healthy rivers do this by dissipating energy during high flow events in two dimensions: vertically and horizontally. Vertical dissipation creates riffle:pool or step:pool structures, horizontal dissipation creates meanders or bends.

Longitudinal shifts in fish community structure (i.e., presence/absence, population structure, dominance, abundance) have been explained by the RCC and SDC (see section 4.1.2). At a large scale, distribution of fish communities appears to be controlled by the watershed's geology and climate. However, the specific distribution of individual species within a particular community appears to be controlled by stream order, the location of the stream section within the context of the drainage network, and structural characteristics of rivers and streams. For example, some fish species require the diverse characteristics of habitat found in headwaters, other species prefer more stable flow patterns for critical life stages found in larger rivers, while other species require floodplains for spawning. These habitat preferences are also linked to other attributes such as thermal gradients, hydraulic gradients, nutrient gradients, channel complexity and physical space. These variables are not always controlled by the size of a stream, its order or location in the watershed but often by changes in local geology, slope, groundwater intrusions, and sediment loading, etc. In this way there are strong relationships between the biota found within a channel/valley system and specific physical functions of the system.

Channel Characteristics and Fish Habitat

There are numerous characteristics within stream channels that are important for fish and fish communities. The patterns and stability of riffle:pool or step:pool sequences create habitat conditions for shelter, food, space and reproduction. The quality of pool area defined by depth, extent, location, and complexity provides shelter, feeding and over-wintering for many species of fish including, trout species, smallmouth bass, northern pike, walleye, muskellunge, sturgeon, suckers, and minnows. Riffle areas provide shelter and feeding habitat for some species like sculpins, darters, dace, hog suckers. For other species such as trout, salmon, and walleye, riffles provide feeding and reproductive habitat. Therefore the form and pattern of a river are important features in determining use and distribution of fish. This is especially important for some species of fish that appear to exhibit adaptation of body form for certain physical areas in streams in order to take advantage of preferred habitat. As habitats are simplified and the planform of the river deviates from one of stability, these specialists are often lost from the system.

The dominant flow that is the major shaper of the stream channel is called the "
or formative flow. In healthy, productive rivers, this flow has a typical reoccurrence of

1.5 - 2 years. This is the flow that adjusts channels, sorts the bottom sediments of rivers, moves materials to deepen pools and reshapes riffles. A healthy river will maintain an overall form that remains relatively constant over time. This “stability” is termed, “steady-state” equilibrium. When a channel is in steady-state equilibrium, even though the actual location and structure of pools and riffles change and adjust after every bankfull flow, the overall shape and planform (i.e., meander pattern, sinuosity, wavelength, etc.) will remain the same.

In steady-state equilibrium, a stream moves within its valley at a very slow and controlled rate, adjusting for minor variances in flows and sediments over long periods of time even though individual features within this form may be adjusted on an annual basis. This is a major natural tendency of a healthy river. In this way, given the valley slope, soils and other controls, the river maintains the appropriate shape and form of channel that is the most efficient to move and store both water and sediment at all flows. Given this natural tendency of rivers (which are based on the laws of physics), it is not surprising that fish species that reside in rivers, appear to have evolved strategies that do the best in healthy river systems.

A variety of stream classification systems have been developed in order to assist our understanding of the types of channel forms to be expected under certain valley and watershed characteristics. One popular classification system has been developed by Rosgen (1994, 1996) is illustrated in Figure 4.2. Stream types demonstrate certain similar characteristics of slope, width and depth and sinuousity based upon analysis during the bankfull flows of a river. Recently the Rosgen classification system has been tested using 47 streams in southern Ontario (Annable, 1996a, b). The results of the test suggest that if we use the controlling variables used in Rosgen’s classification, southern Ontario streams do fit into his classification.

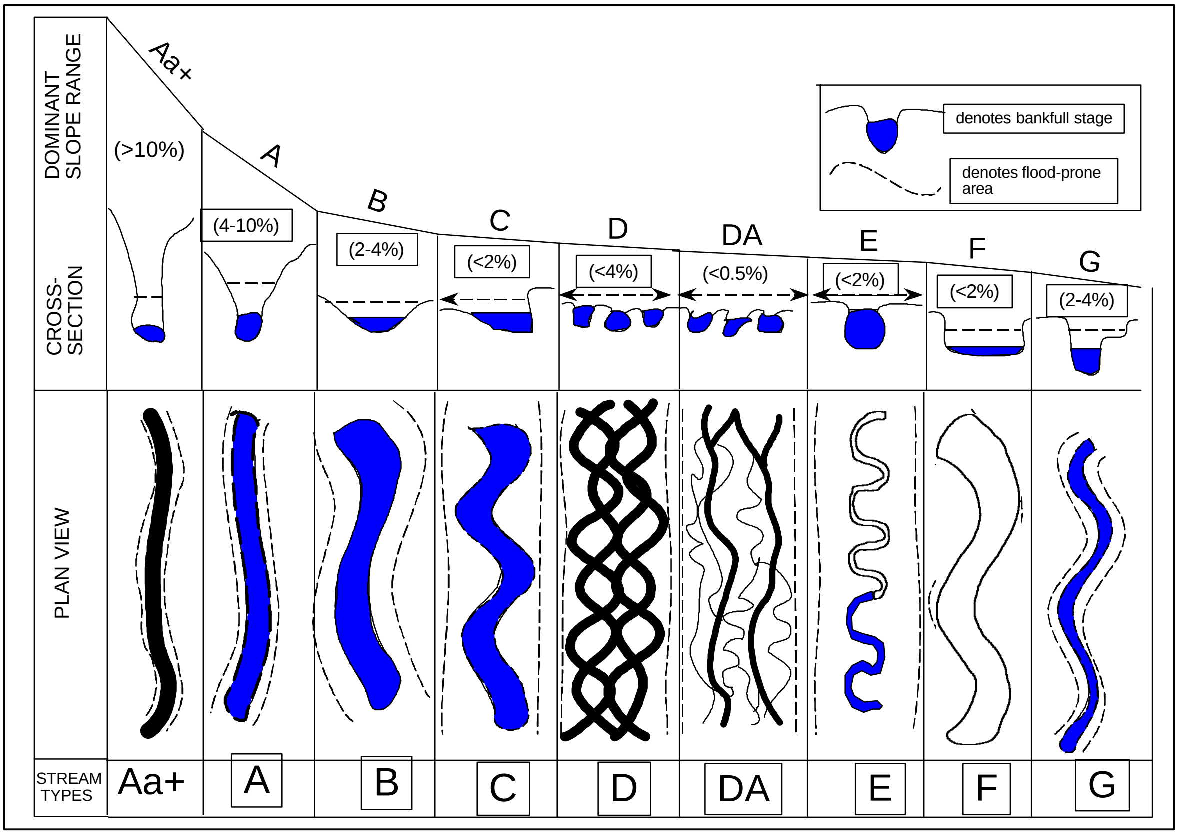


Figure 4.2: Rosgen (1996) Classification system as discussed in the text.

Stream form and types are determined by a length of reach of stream that has the appropriate form and substrate for the specific classification criteria. Form is identified by the width: depth ratio and the sinuousness or channel pattern over a long distance. There are 7 basic forms identified by Rosgen and these run from A – G. Slope, width: depth ratio sinuosity and entrenchment are the dominant determinants of form.

The other part of the classification is the identification of the average substrate size of the riverbed. There are six particle sizes:

- Type1 is bedrock;
- Type 2 is boulder (250mm or bigger);
- Type 3 is cobble (62.5 - 250mm);
- Type 4 is gravel (2.0-62mm);
- Type 5 is sand (0.062-2.0mm);
- Type 6 is silt (<0.062mm).

A stream type is classified by the form it takes (i.e., A-G) in combination with the average particle size type. Therefore, a C4 channel has a modest meander pattern, a mild gradient, active floodplain and has a streambed with gravel as the average size particle.

Sediment composition tells us a great deal about how the river functions physically and biologically. The sediment found on the bottom of streams is there as a result of transport down the channel during high flow periods. Depending upon the gradient and form of the stream and its discharge, materials in transport during floods can range in size from silt to large boulders. This sediment comes from various sources and can include eroding banks, eroded bed material and overland runoff. The average particle size found in the riffles indicates the maximum size of material that is moved during annual high flows. Larger particles than the average (i.e., D_{50}) are only moved by exceptional high flows (i.e., 5-10yr return periods or higher).

The sorting of gravels and cobbles in riffles during bank-full discharges is an important process for the "conditioning" of riffles for aquatic bug production and fish spawning. During high flows the areas of the stream with the greatest erosion is usually in the pools, that is why pools are deep, and the areas of greatest sorting and deposition of substrate are the riffles. Point bars and floodplains are the locations of deposition and storage of medium and finer materials respectively.

Most anglers are familiar with three basic types of streams: pocket water streams; riffle:pool streams; and meadow creeks or spring creeks. These overlap the scientific stream types developed by Rosgen (See Figure 4.2). Pocket water streams fall into the "A", "B", and sometimes "G" stream types. Riffle:pool streams fall into the "C" and "F" and lower slope "B" types and meandering meadow and spring creeks fall in the "E" stream type.

The "A" and "B" type streams are typical mountain or escarpment streams, tumbling down a mountain side in a more or less straight line. In A and B channels a step:pool sequence repeats itself every 1-5 bankfull channel widths (depending upon slope). The A type streams have steep sides, a bottom of bedrock or boulders and create high energy pocket water, referred by hydrologists as step:pool sequences (Figure 4.2). There do not appear to be any "A" form channels in the Grand River watershed.

The "B" channels are also steep although not as steep as "A" streams and have a "bowl shaped" channel when viewed in cross-section rather than steep slopes. These channels can have boulders and cobble and can range from pocket water to modest pools and riffles (i.e., the Credit River from below Cataract downstream to below the Forks and portions of the Grand River through portions of Elora Gorge). "B" type channels have a relatively straight form and create boulder steps that form plunge pools and pocket water below them. They have a sharply undulating bed as the channel moves downstream.

These channel forms have a very rough bed ideal for species of fish that like to use physical structures for habitat. These types of fish (i.e., trout, bass, hog suckers, darters) can be found almost anywhere in these streams utilizing the stream for shelter and feeding. However these stream types often do not have the range or forms of habitat required for all stages of the life cycle of trout or bass. Reproduction sites such as riffles of coarse gravels, are often absent from these stream types because of the nature of the stream type, its slope and channel dynamics. In order for these "A" or "B" stream types to be fully exploited and productive habitats for fish such as trout, there also needs to be "C" channel reaches available and accessible in the same watershed in order to provide spawning and early nursery habitat. There are relatively few examples of “B” channels in the Grand River watershed.

By far the most common river class in southern Ontario is the "C" type channel, specifically the C3 (cobble) or C4 (gravel) channels such as the Grand River below Elora Gorge, the Saugeen River below Durham, the Credit River above and below Inglewood, and the Maitland River below Wingham. These streams are the classic riffle:pool streams common to all areas of the world where you find a modestly wide valley, good soils, and modest valley and stream gradient. The C channels along with E, F and G channels have riffle, and pool sequences, which occur every 3-7 bankfull channel widths as you move down the stream. These are the streams that meander in a mild fashion through their landscape. The outside bends have the pools and steepish sides, often with logjams and protruding root wads, the inside bends have point bars with sorted gravels and sands plus a shallow floodplain behind them. The riffles are found half way between the pools. Theses stream types have a gentle meandering form typically with logjams and wood debris at the bends and at the edges of the channel. The bed of these streams undulates in a gentler manner with a wider spacing between deep sections (pools) than found in the high energy, high gradient A and B streams. Pools may be wider spaced but they are usually much deeper than in A and B channels.

A healthy "C" channel has all the important requirements for some fish such as trout (i.e., temperature dependent). This stream type is also ideal for bass as long as the stream is large enough to have pools >2m deep with high levels of complexity. Although C channels do not have as much "usable" habitat throughout the channel, the pools often make up for it. The depth, size and complexity of habitat within a pool, especially pools with logjams, root wads and undercuts can hold surprising numbers of juvenile and adult fish. The “C” channel form is the most common form of channel in the Grand River watershed.

Many of the most common spring creeks in Ontario such as the Sydenham upstream of Chatsworth, as well as the more interesting ones in Montana such as O'Dell Creek and Flat Creek in Wyoming are called "E" channels (see Figure 4.2). These streams have extreme meanders that seem to loop back and forth with wild abandon. They are extremely deep for their width, often with a width depth ratio of less than one. These types of streams occur in wide, shallow valleys often called "water meadows". They have very low gradients. The sinuousness and character of these streams are controlled completely by the vegetation along the banks. This control also creates the incredible undercut banks found in these streams. These streams have almost as much usable linear habitat for fish as the "B" channel and they have more volume of habitat because of their greater depth. This stream type can occur in groundwater rich discharge valleys such as the Eramosa upstream of Everton, Blue Springs Creek near Eden Mills or in large wetland bottomed till plains such as Mackenzie Cr. in the Six Nations. Coldwater "E" channels appear to provide ideal habitat for all life stages of brook trout while providing poor habitat for other trout such as brown trout and rainbow trout (because of the lack of spawning riffles typical to "C" channels). In mixed water "E" channels, habitat is ideal for mixed water fish such as northern pike. There are numerous mixed water “E” channels in the Nith sub-watershed and in Fairchild Cr. sub-basin.

A few of the other channel forms are less common in Ontario, although some are present. The Colorado River flowing through the Grand Canyon is classified as an "F" channel. These are streams with a low gradient, mild sinuosity and relatively flat channel cross-section. Southern Ontario has a few "F" type channels, the most familiar being the Grand River through Elora Gorge and the Maitland River downstream of the Falls Conservation Area. These channel forms can provide good habitat for coldwater and mixed water species (i.e., especially F2, F3 and F4) but often lack good spawning habitat because the substrate is not as well sorted as in "C" channels. This poor sorting is due to the confined nature of the stream type (i.e., highly entrenched means higher shear stress and less sorting of substrates).

4.1.4 Chemistry

Rivers and streams by surface area are 5-20 times as productive as lakes. The reason for this difference in productivity is the way in which nutrients are made available for animals to use to build body tissue (i.e., biomass often measures as $kg.ha^{-1}$). Nutrients are the building blocks of life and include phosphorus, nitrogen, potassium, etc. In lakes, nutrients are associated with soil, leaves, twigs, bacteria, and animal tissue. If the nutrients entering a lake are not used by the algae, animals and bugs in a lake, they sink to the bottom and are trapped in the bottom sediments, lost to the animals of the lake except for periods when climatic or other events stir up the lake bottom and re-suspend the nutrients. This loss to the bottom is why lakes are often called "nutrient sinks".

Rivers, as every angler knows, are constantly in motion. Every molecule of water and the nutrients they carry are constantly being circulated from surface to substrate as the water flows downhill towards the sea. Because rivers are much shallower than lakes and because water in rivers is constantly circulated and mixed, nutrients are always available to the algae, bacteria, fungus, plants, bugs and fish of a stream. Nutrients that are in suspension in streams are rapidly captured by the animals and plants of the stream and put into tissue production. Depending upon who or how those nutrients are captured, that particular nutrient may not be re-released to the stream for days, months or years. This circulation, capture, release and recapture of nutrients is figuratively called "nutrient spiralling". Stream ecologists often speak of rapid and slow nutrient spiralling. Since nutrients enter the stream from a large variety of natural and manmade sources, spiralling occurs in all our streams at various levels and speeds depending upon the geology and climate of an area, modified by man's landuses.

The length of time nutrients move down a stream before capture (by something living), the amount of nutrients that can be captured and used by life in a stream and the length of time these nutrients are retained by life in a stream are dependent upon a variety of things such as the number and diversity of organisms in the stream, physical habitat diversity, local geology, climate and latitude and human landuses.

Capture and retention time for a nutrient in a stream can vary from a few hours to several years. If a bacterium or algae captures the nutrient, it will likely be retained in tissue until the bacterium of algae dies....a matter of hours or days. If the nutrient moves up the food chain as each animal or organism is subsequently ingested by an animal from the next food chain level above, it may eventually end up in fish tissue and be held for 1 - 10 years. The amount of nutrients and other materials a river's life can capture and retain is often called the "assimilative capacity" of the stream. This capacity is highest in streams that are physically diverse and which contain a very high mix of animal and plant species. Therefore, the streams relative productive and assimilative potential is a function of the geologic and climatic region the stream is found within, the actual physical diversity of the stream (riffles, runs, flats, pools, floodplains, islands, back-eddies, log-jams, etc.) and the animal and plant populations within the stream.

Channel form and the composition of its substrate are therefore very important factors in the productivity of a watershed and its water quality. Channel forms with highly variable but relatively stable forms and features, moderate slopes, accessible floodplains in conjunction with a channel bed mixture of gravels and cobbles are likely to be ideal for capture, assimilation, production and storage of nutrients. Where channel forms become unstable, beds become packed with silts, sands or clays or are naturally composed of fine beds, nutrient assimilation, storage and productivity suffer unless the nutrient rich water has access to riparian wetlands. Where all these features have been lost, the aquatic system is highly degraded in a physical, chemical and biological sense.

4.1.5 Landuse patterns (limits)

Changes in the use of land over time can have a major impact upon the water budget of a watershed, changing productive spring creeks into less productive, flashy spate streams. Figure 4.3 illustrates the typical changes in water budgets as land moves from forest, to agriculture to urban. In forested watersheds, run-off is rare because up to 60% of precipitation on an annual basis is pumped back into the atmosphere by trees and other vegetation. Streams in forested areas are small and stable with narrow, deep channels. In the same watershed after clearing of the land for agriculture and ultimately modifying it for urban development, much more water is available for overland run-off. In agricultural areas, farmers expect dry land in the spring as early as possible in order to obtain a sufficient growing season for their crops. This is done by burying tile drains in an efficient pattern under their fields. These drains capture infiltrating rainwater and quickly shunt it through the system into an outlet drain or stream, thereby drying the surface soils but also reducing infiltration to the watertable.

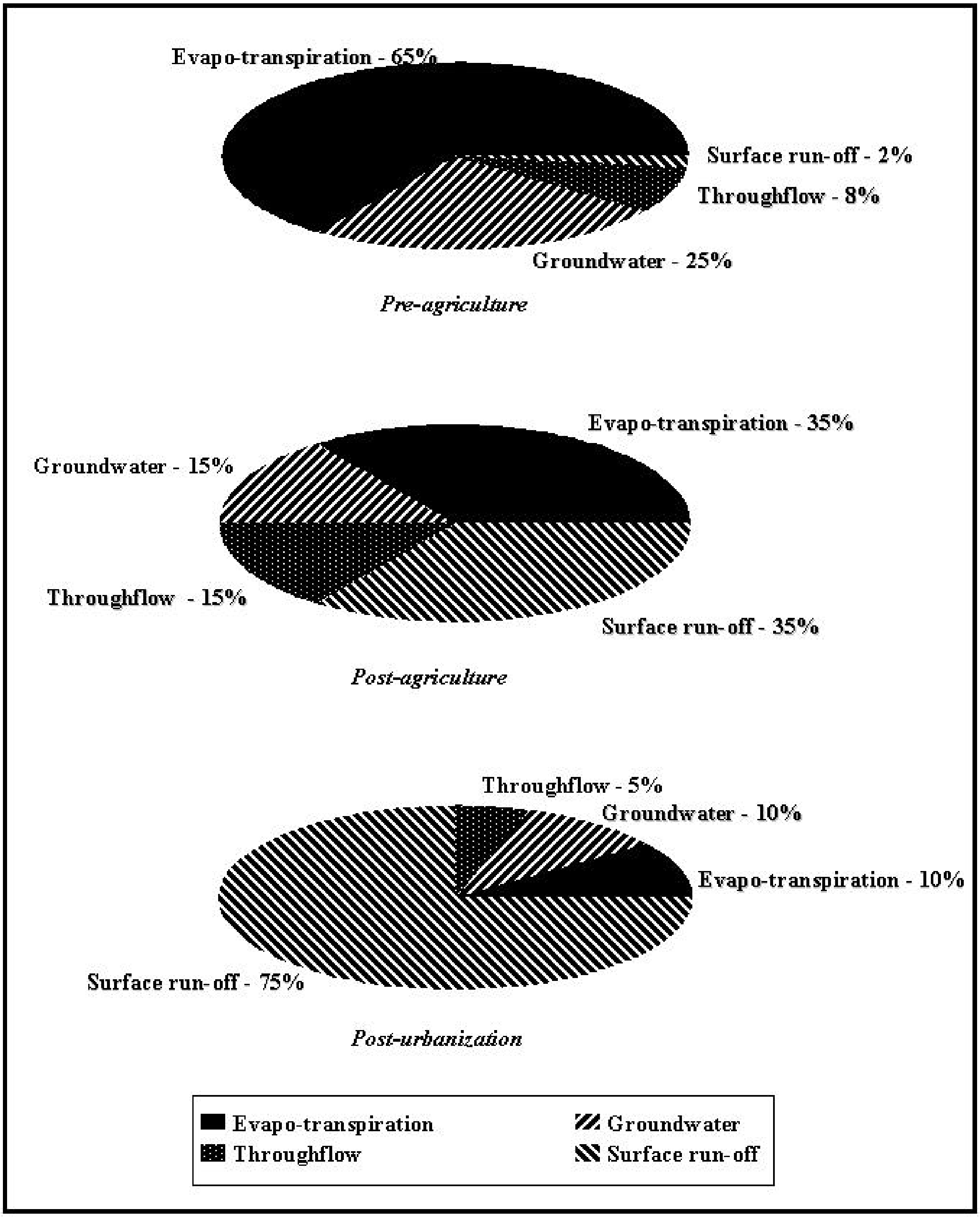


Figure 4.3: Change in Watershed Water Budget over time – pre-agriculture to post-conventional urbanization.

In urban areas much of the lands that once infiltrated water or grew trees are now paved and therefore impervious to infiltration. As imperviousness increases in a watershed, precipitation has less of a chance to infiltrate or evapo-transpirate. Instead rainwater is directed off property and forced by curbs and gutters into manholes, then into storm sewers and then, usually straight into a formally healthy stream. It has little opportunity to evaporate, transpire or soak into the ground. Therefore, by modifying the land, we alter the water budget.

Alteration of the water budget by traditional urbanization results in:

- streams that flood rapidly and often;
- are very wide and very shallow;
- have higher erosion potential;
- have increased sedimentation rates (especially exacerbated during the construction phase);
- have little flow between storms and if water remains, have few fish, bugs or animals residing in them any more;
- due to the enrichment coming from lawn fertilizers, pet feces, etc., turn green, yellow and brown and release bad odours several days after a storm; and
- contamination due to industrial waste and chemical runoff.

Once these former healthy streams become flashy, highly eroding and noxious, society has traditionally considered them a liability, buried them in pipes and sent them straight o a large lake or river. This has been the history of watersheds and streams throughout much of the world.

Figure 4.4 presents 4 water budget illustrations. There is one example each for Zone 1 and Zone 3 and two examples for Zone 2. These water budget pie charts demonstrate that the glacial outwash zone of the Grand River (i.e. Zone 2, Alder Cr. and Blue Springs Cr.) functions fundamentally differently than do Zones 1 and 3 (Mitchell Cr. and Big Creek respectively). The illustrations demonstrate that geology does control how water moves over and through the watershed and the important role of evapo-transpiration in the overall water budget. Although we can do little about surficial geology, we can, to a certain degree, effect changes in the water budget by modifying the quantity of evapo-transpiration. However, the responses of Zone 1 and 3 would likely be different than Zone 2.

For example, increases in evapo-transpiration in Zones 1 and 3 would likely change the volumes and magnitudes of surface run-off (i.e. moderate peak flows and modestly help improve baseflows). Increases in evapo-transpieration in the two illustrated tributaries of Zone 2 would likely increase baseflows and increase regional recharge. Although there would might be changes in high flows, these may not be as noticeable as they would be in Zones 1 and 2. From a fisheries perspective, some of the endpoints of improvements in evapo-transpiration may be similar. These changes would be potentially higher or more constant baseflow conditions, and more moderate flood characteristics. In Zone 2, an added benefit would be higher volumes of groundwater discharge to streams in addition to an

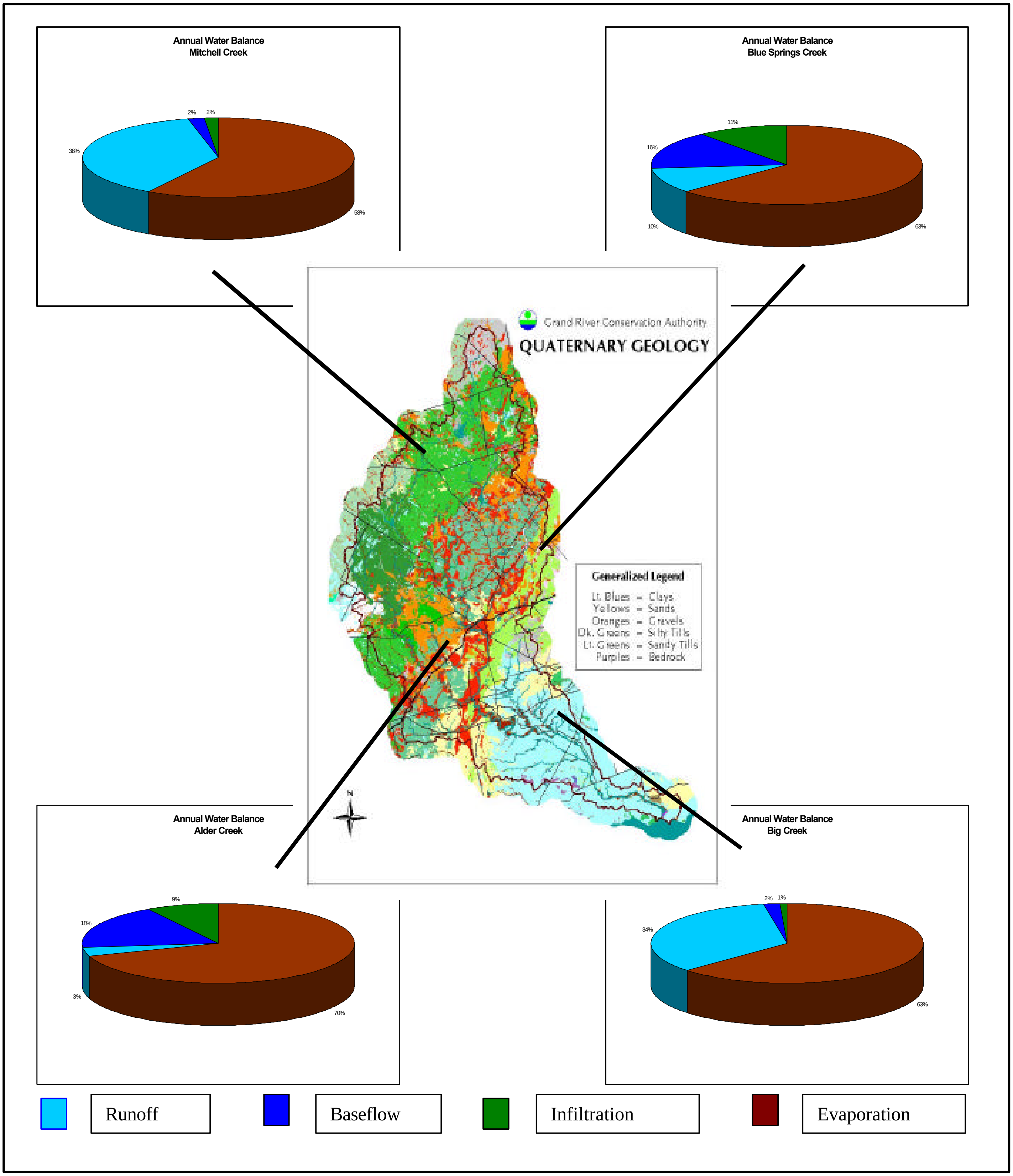


Figure 4.4: Illustration of the Annual Water Balance (including runoff, baseflow, infiltration and evaporation) across the Grand River Watershed, specifically Alder Creek, Big Creek, Blue Springs Creek and Mitchell Creek.

increased stability of baseflow conditions. Since most fish communities benefit from moderate regime conditions, these changes would benefit all fish communities throughout the watershed and sub-basins.

To summarize, it is the characteristics of the watershed that control the volume, timing and duration of high flow patterns that are important in maintaining the physical and biological functions of our streams. These flow patterns when combined with a watershed's soil characteristics, valley slopes and streamside or riparian vegetation generate the dynamically stable channel forms we see. If the characteristics of the watershed and valley stay the same over time, stream sections retain their form and character. If through landuse change, the watersheds water flow characteristics and sediment supply changes, the stream will begin to adjust. If the process of change is very slow, the rate of change will be gradual and controlled naturally. If the changes are rapid such as massive urban development without significant sediment control and stormwater control, the stream adjustments will occur so rapidly that the stream's form will become unstable and erosion, flooding and channel degradation will occur. As this happens fish habitat will be lost, fish communities will change then collapse and water quality will severely deteriorate. We have many examples of these processes in southern Ontario.

Many of our streams in Ontario are in the process of transition and adjustment from one type of stream to another. It is often difficult to determine what stream type the reach was historically and to what type of stream form it is trying to evolve into. However, the direction of the evolution of the stream can be best determined through careful analysis and measurement of the stream's geometry, slope, new flow and sediment conditions. This information can then be used with the classification system to determine the dynamically stable type the reach should be, given the new conditions. The Natural Channel System initiative being developed in Ontario provides planning and analytical tools for managing and restoring stream systems.

4.2 Overview of Species and Habitat Requirements

4.2.1 The Fish Community of the Grand River Basin

The Grand River watershed is rich. Rich in the diversity of fish species found in its' waters. As of 1999, there were 83 confirmed (confirmed by specimens sent to Royal Ontario Museum) species of fish in the Grand River watershed. There are 13 possible species but not confirmed, 2 species that are apparently extirpated (i.e., Blue pike – *Stizostedion vitreum glaucum*), 2 species that are occasional escapes from Aquaculture facilities and 3 species that are occasional migrants. Table 4.1 presents all these species by common and scientific name plus a note on which of the three community types they belong (i.e., coldwater; mixed water and warmwater).

For the purpose of the report, the three major community types are defined below:

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 fish species that can tolerate more variable water temperatures and conditions. This will include species that are coolwater 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).

Table 4.1: Fish Species Representation, Status, and Temperature Regime for the Grand River Watershed.

Common Name	*Scientific Name*	Status	Grand River Watershed	Preferred Temperature	Fish Community Designation
American brook lamprey	*Lampetra appendix*		x	5 - 20	coldwater
northern brook lamprey	*Ichthyomyzon fossor*	VUL	x	n/a	coldwater
silver lamprey	*Ichthyomyzon unicuspis*		?	n/a	coldwater
sea lamprey	*Petromyzon marinus*	inf	x	5 - 20	mixed water
lake sturgeon	*Acipenser fulvescens*	r	H?	17	migratory
longnose gar	*Lepisosteus osseus*	r	x	12 - 20	warmwater
bowfin	*Amia calva*		x	30	warmwater
alewife	*Alosa pseudoharengus*		?	n/a	migratory
gizzard shad	*Dorosoma cepedianum*		x	31.5	migratory
pink salmon	*Oncorhynchus gorbuscha*		o	12	warmwater
coho salmon	*Oncorhynchus kisutch*		o	12	migratory
chinook salmon	*Oncorhynchus tshawytscha*		o	12	migratory
rainbow trout	*Oncorhynchus mykiss*		x	17 - 21	migratory
Atlantic salmon	*Salmo salar*	VUL	A	16	coldwater
brown trout	*Salmo trutta*		x	15 - 24	coldwater
Arctic charr	*Salvelinus alpinus*		A	4 - 16	coldwater
brook trout	*Salvelinus fontinalis*		x	13 - 16	coldwater
tiger trout	*S. fontinalis X S. trutta*		x	n/a	coldwater
lake whitefish	*Coregonus clupeaformis*		?	12	coldwater
rainbow smelt	*Osmerus mordax*		?	7 - 15	migratory
northern pike	*Esox lucius*		x	19 - 21	mixed water
muskellenge	*Esox masquinongy*	r	x	24 - 26	mixed water

Common Name	*Scientific Name*	Status	Grand River Watershed	Preferred Temperature	Fish Community Designation
central mudminnow	*Umbra limi*		x	17 - 22	coldwater
mooneye	*Hiodon tergisus*		x	24	warmwater
quillback	*Carpiodes cyprinus*		x	n/a	warmwater
white sucker	*Catostomus commersoni*		x	19 - 21	mixed water
northern hog sucker	*Hypenteliumnigricans*		x	n/a	mixed water
buffalo sp.	*Ictiobus sp.*	VUL	x	n/a	warmwater
silver redhorse	*Moxostoma anisurum*		x	n/a	mixed water
black redhorse	*Moxostoma duquesnei*	THR, r	x	n/a	mixed water
golden redhorse	*Moxostoma erythrurum*		x	n/a	mixed water
shorthead redhorse	*Moxostoma macrolepidotum*		x	n/a	mixed water
greater redhorse	*Moxostoma valenciennesi*		x	n/a	mixed water
river redhorse	*Moxostoma carinatum*	VUL	x	n/a	mixed water
goldfish	*Carassius auratus*	inf	x	0 - 41	warmwater
northern redbelly dace	*Phoxinus eos*		x	n/a	mixed water
finescale dace	*Phoxinus neogaeus*		x	n/a	mixed water
redside dace	*Clinostomus elongatus*	VUL	x	n/a	mixed water
common carp	*Cyprinus carpio*		x	30	mixed water
brassy minnow	*Hybognathus hankinsoni*		x	n/a	mixed water
silver chub	*Macrhybopsis storeriana*	VUL	?	n/a	n/a
hornyhead chub	*Nocomis biguttatus*		x	n/a	mixed water
river chub	*Nocomis micropogon*		x	n/a	mixed water
golden shiner	*Notemigonus crysoleucas*		x	0 - 35	mixed water
emerald shiner	*Notropis atherinoides*		x	0 - 31	mixed water
common shiner	*Luxilus cornutus*		x	0 - 31	mixed water
blackchin shiner	*Notropis heterodon*	r	?	n/a	mixed water
blacknose shiner	*Notropis hererolepis*		x	n/a	mixed water
spottail shiner	*Notropis hudsonius*	r?	x	10 - 24	mixed water
rosyface shiner	*Notropis rubellus*		x	5 - 24	mixed water
spotfin shiner	*Cyprinella spiloptera*		x	n/a	n/a
sand shiner	*Notropis stramineus*		?	n/a	warmwater
redfin shiner	*Lythrurus umbratilis*	r?	?	n/a	n/a
mimic shiner	*Notropis volucellus*		x	n/a	mixed water
bluntnose minnow	*Pimephales notatus*		x	0 - 33	mixed water
fathead minnow	*Pimephales promelas*		x	0 - 33	mixed water
blacknose dace	*Rhinichthys atratulus*		x	0 - 29	mixed water
longnose dace	*Rhinichthys cataractae*		x	4 - 16	mixed water
creek chub	*Semotilus atromaculatus*		x	0 - 30	mixed water
pearl dace	*Semotilus margarita*		x	n/a	mixed water
silver shiner	*Notropis photogenis*	VUL	x	n/a	mixed water
central stoneroller	*Campostoma anomalum*	VUL	x	n/a	mixed water
striped shiner	*Luxilus chrysocephalus*		x	n/a	n/a
black bullhead	*Ameiurus melas*		x	23 - 35	warmwater
yellow bullhead	*Ameiurusnatalis*	inf?	x	5 - 15	warmwater
brown bullhead	*Ameiurus nebulosus*		x	31	warmwater
channel catfish	*Ictalurus punctatus*		x	25	warmwater
stonecat	*Noturus flavus*		x	5 - 23	warmwater
tadpole madtom	*Noturus gyrinus*	r?	x	n/a	warmwater

Common Name	*Scientific Name*	Status	Grand River Watershed	Preferred Temperature	Fish Community Designation
brindled madtom	*Noturus miurus*		x	n/a	warmwater
American eel	*Anguilla rostrata*	r?	x	21	n/a
banded killifish	*Fundulus diaphanus*	r?	x	10 - 25	warmwater
burbot	*Lota lota*	inf?	x	15 - 18	coldwater
brook stickleback	*Culaea inconstans*		x	4 - 18	mixed water
threespine stickleback	*Gasterosteus aculeatus*	inf?	?	4 - 20	mixed water
trout-perch	*Percopsis omiscomaycus*		?	n/a	mixed water
white bass	*Morone chrysops*	inf?	?	28	warmwater
rock bass	*Ambloplites rupestris*		x	25 - 29	warmwater
green sunfish	*Lepomis cyanellus*	r?	x	28.2	warmwater
pumpkinseed	*Lepomis gibbosus*		x	31-31.5	warmwater
bluegill	*Lepomis macrochirus*		x	31-32.5	warmwater
longear sunfish	*Lepomis megalotis*	r	x	n/a	warmwater
smallmouth bass	*Micropterus dolomieui*		x	19.4 - 21.7	warmwater
largemouth bass	*Micropterus salmoides*		x	26.6 - 27.7	warmwater
white crappie	*Pomoxis annularis*		x	22	warmwater
black crappie	*Pomoxis nigromaculatus*		x	22-30.5	warmwater
yellow perch	*Perca flavescens*		x	19-22	mixed water
sauger	*Stizostedion canadense*		?	18 - 19	migratory
blue pike (blue pickerel)	*Stizostedion vitreum glaucum*	EXT	H?	29	migratory
walleye (yellow pickerel)	*Stizostedion vitreum vitreum*		x	20.6 - 23.2	mixed water
eastern sand darter	*Ammocrypta pellucida*	THR, r	x	n/a	mixed water
greenside darter	*Etheostoma blennioides*	VUL	x	4 - 18	mixed water
rainbow darter	*Etheostoma caeruleum*		x	4 - 18	mixed water
Iowa darter	*Etheostoma exile*		x	n/a	mixed water
fantail darter	*Etheostoma flabellare*		x	4 - 18	mixed water
least darter	*Etheostoma microperca*		x	10 - 22	mixed water
johnny darter	*Etheostoma nigrum*		x	4 - 18	mixed water
logperch	*Percina caprodes*		x	n/a	mixed water
blackside darter	*Percina maculata*		x	n/a	mixed water
brook silverside	*Labidesthes sicculus*	inf / r ?	x	5 - 20	warmwater
freshwater drum	*Aplodinotus grunniens*		x	24	warmwater
mottled sculpin	*Cottus bairdi*		x	n/a	coldwater
slimy sculpin	*Cottus cognatus*	inf / r ?	x	4 - 16	coldwater

PRESENCE

x: present / verified (83 species)

?: possible though unconfirmed or unverified (13 species)

H?: apparently extirpated natural stocks (2 species)

A: Aquaculture facilities only; occasional escapes (2 species)

o: occasional migrant (3 species)

n/a: information not available

STATUS

r: rare in watershed

?:unknown status in watershed

inf: infrequent in watershed

VUL: vulnerable status in Canada

THR: threatened status in Canada

END: endangered status in Canada

It is evident by the information in Tables 4.1, that the three fish community types are well represented by a wide range of species in the Grand River basin.

The Grand River is also host to a number of species that are considered vulnerable or threatened. Vulnerable and Threatened fish species as classified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) found in the Grand River watershed include the following:

Vulnerable: species that are of special concern because of characteristics that make them particularly sensitive to human activities or natural events (indigenous species that are at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, or for some other reason, but is not a threatened species).

Threatened: indigenous species that are likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed.

The Fish Sub-Committee of the Committee on the Status of Species at Risk in Ontario (COSSARO) has been reviewing the status of several fish species in Ontario (including those listed by COSEWIC). The committee recommends status designations for various fish species in the Province (i.e., including those which occur in the Grand River watershed). This represents fine-tuning of designations from a national to a provincial level. Table 4.1 includes the results COSEWIC released from its latest species assessment meeting in Osoyoo, B.C. on May 3, 2001.

A combination of neglect, abuse and unusual habitat requirements has created the situation in the Grand River where some of these species are at risk. A specific management plan will likely have to be prepared in order to determine how to manage these species in the future and what critical habitat characteristics need to be protected and where possible enhanced.

Table 4.2 illustrates how diverse the fish species assemblage is in the Grand River basin. This table is a summary of information from Scott and Crossman (1971). Table 4.2 demonstrates that the Grand River has a very diverse species assemblage, especially when 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 Ontario.

Table 4.2: Summary of species richness of the Grand River Basin in comparison to other Geographic areas of Canada (from Scott and Crossman 1971).

Geographic Area	Number of Species	% of Total
Canada	181	100
Atlantic Basin	142	78
Ontario	132	73
Grand River Basin (confirmed)	80	44 (61)*
Grand River Basin (confirmed + probable)	92	51 (70)*

(brackets) are the percentage in relationship to all species in Ontario.

The range of species in the Grand River basin is even more impressive when you consider that the river has had a long history of neglect and abuse (see Chapter 3). 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.

Another source of very valuable information on the fishes of the Grand River is provided in Appendix 3. This document is titled, *"The Autecology of Grand River Fishes"* (Coulson, 2000). The document provides a valuable source of summary information on:

- Habitat descriptions (basic);
- Reproductive guilds;
- Spawning and Nursery habitat requirements;
- Maturity;
- Longevity;
- Preferred Temperatures;
- Food preferences by year class; and
- Other notes

The full document is too long to be included in the body of the text, but is provided as a tool in the Appendices.

4.2.2 Habitat Characterization and Species Requirements

Habitat is a combination of physical, and chemical attributes that are important to the life stage or state of a species over the course of its' life. Habitat can vary both spatially and temporally which often makes the characterization of habitat difficult for some animals. Most habitat characterization has occurred at the site or microhabitat levels, whereas the controls on a species and its' fish community often occur at a larger scale.

Table 4.3 is reproduced from Imhof et al. (1996) and is a revision of original ideas proposed by Frissell et al. (1986). The table demonstrates that scale is important for describing the distribution and use of habitat of fish communities, species and individuals. The challenge is to use the appropriate physical scale for the appropriate biotic scale.

For example, determination of the potential distribution of fish communities within a watershed is based on the premise that certain physical functions of the watershed, controlled by geology and topography create certain opportunities for specific communities of fish. At a watershed scale, these functions and processes create the potential conditions or habitat that can then be exploited by specific communities of fish that require or can tolerate those functions and conditions. Therefore, geological analysis is the first step in determining the potential for specific fish communities within a particular watershed. Once this potential is identified, the extent of the usage of the portion of the basin by that community will likely be controlled by valley structure, stream gradient, form and type, vegetative characteristics and adjacent landuses. This step in fish habitat analyses would likely occur at the valley reach level. Site level analysis is then used to determine if specific habitat requirements are available in good supply to a particular species for all life cycle requirements.

Figure 4.5 demonstrates a somewhat simplistic example of the relationship between large scale controls and biotic assemblages:

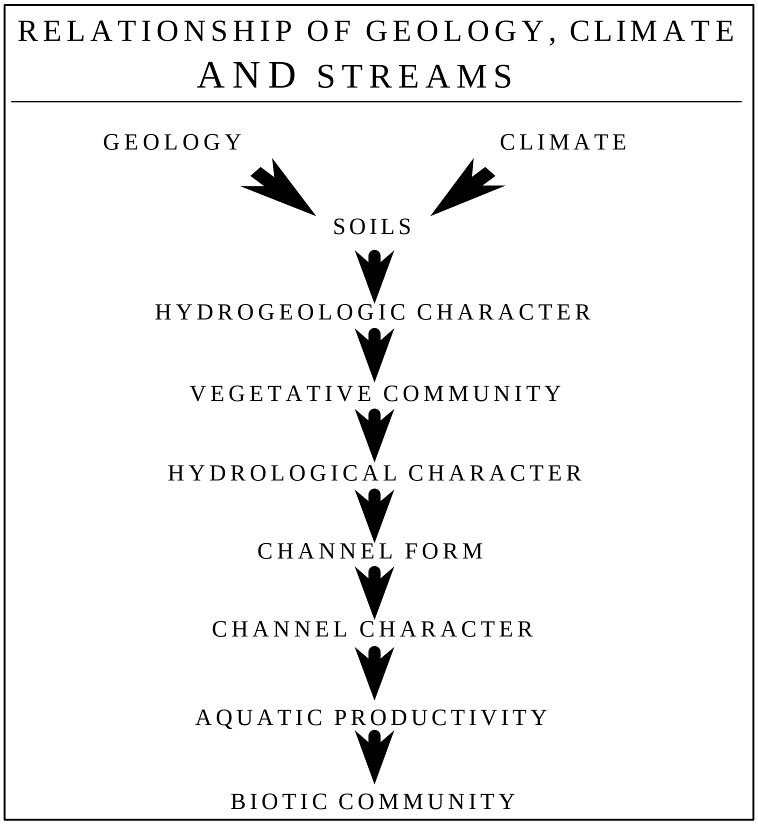


Figure 4.5: Simplified cause: response relationship between geology and fish.

Relating physical characteristics to habitat forms and uses by particular species can be quite complicated. A large body of research has already been completed over the years. Most approaches try to define habitat by what the individual of the species is using at any point in time. This historical approach focuses on habitat use at the site without an understanding of the physical landscape and larger scale processes that create and adjust these forms over time. Newbury and Gaboury (1993) suggest several spatial levels of hydraulic habitat within a watershed. Figure 4.6 illustrates their concept of how to view habitat for fish at these scales.

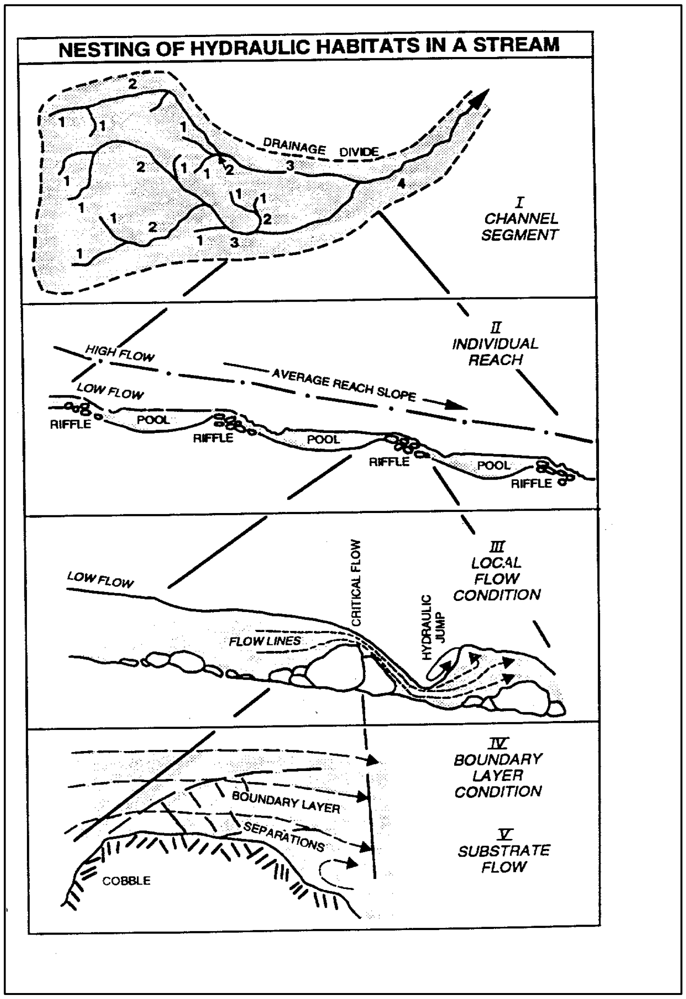


Figure 4.6: Nested hydraulic habitats in streams from Newbury and Gaboury (1993).

Imhof et al. (1996) discuss the relationships between three physical scales (i.e., watershed, reach, and site) and fish habitat. Imhof's work builds upon the work done by Frissell et al. (1986) and others. This work includes both a physical model that relates the state conditions that create habitat at three scales and then develops a habitat model for individual species that relates the needs of the species to the creation of habitat by physical processes (See Figure 4.7). A discussion of the development of a physical model and habitat model can be found both in Imhof et al. (1996) and in Stream Corridors: An Adaptive Management Approach (OMNR, 2001).

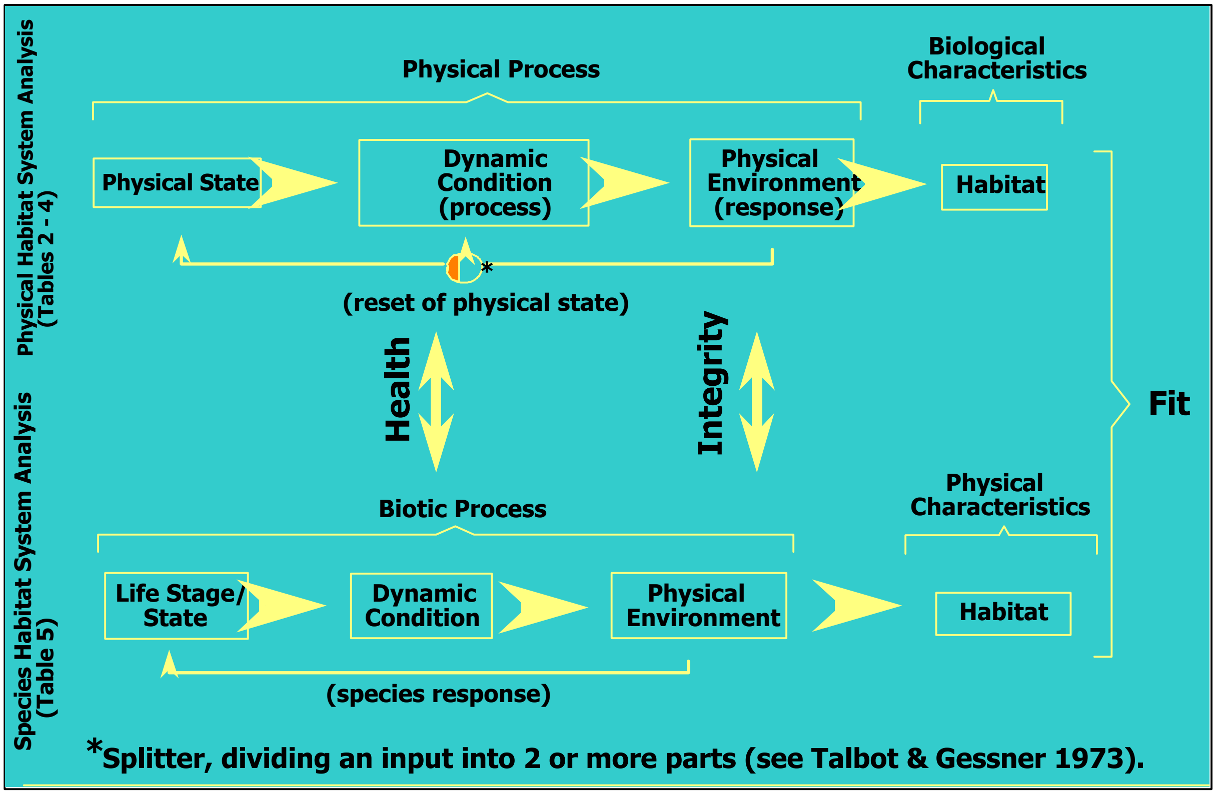


Figure 4.7: Relationship between physical model of habitat creation and species habitat model (from Imhof et al., 1996).

Two major analytical components are necessary in order to determine how well an particular species is suited to a stream within a particular watershed: knowledge of the life history requirements in space and time; and knowledge of the availability of physical habitat features in space and time. A great deal of information has been collected on various species over time and this information is extremely valuable. The difficulty with the information however is that it is not sensitive to the dynamic processes that creates these forms of habitat, nor the geological or geomorphic conditions where these habitats are likely to occur.

Habitat information has been re-organized and restructured for four species common to the Grand River basin. These species represent top level predators common to all three fish community types in the Grand River basin. Tables 4.4 - 4.7 are examples of a life stage analysis of the habitat requirements of four species.

Habitat information has been re-organized to improve the connections between habitat and biotic use. Four categories are used:

Life stage/state: Normative activity (i.e., reproduction) of a species. This includes a specific stage of a species' life cycle plus activities common but essential through the entire life cycle (i.e., feeding);

Dynamic Conditions: Those conditions that change rapidly to affect life stage/state activities;

Physical Environment: Those conditions that exist over long periods of time to both create and support habitat (i.e., hydrologic; geomorphic; hydraulic; and hydrogeologic);

Habitat: The specific definable features, which have appropriate forms and conditions to support life stages/states.

General and standard life history stages are used, similar to those used in Habitat Suitability Index models (i.e., Raleigh et al., 1984): reproduction; nursery; juvenile; adult. As well, life state variables are also used: overwinter refuge; feeding; and migration.

The strength of reorganizing information in this way is that it is possible to identify the relationships between species distributions at all three spatial scales (i.e., watershed; reach; and site). For brook trout reproduction (see Table 4.7), certain geologies are necessary to create the dynamic conditions for reproductive success. These geological types are not randomly distributed throughout the Grand River basin, but concentrated primarily in the central portion of the basin, including all or some of the following sub-basins: middle Grand River; Speed/Eramosa; Nith (lower); Whiteman's Creek (lower); Conestogo (lower). There are a few remnant or isolated brook trout communities in the upper Conestogo or Mackenzie Creek, and these are related to small but deep intrusions of glacial sands.

Northern Pike are an interesting example of the usefulness of this habitat analysis (Table 4.6). Literature identifies that pike can be found spawning in widely varying river forms. They spawn in the floodplains of very large rivers (i.e., C4), but are also found spawning in small, meandering, clay bedded wetland creeks as well (i.e., E6 channels). Pike spawn on flooded grasses and sedges, found in wetland verges along small creeks and in the floodplains of large rivers. These zones must be inundated for at least 3 weeks in order for pike eggs to incubate, hatch and for the yolk-sac fry to absorb their yolk. In the Grand River, pike can occasionally be found in the floodplain pools immediately after floods, but reproduction appears poor. Given that most of the Grand has dam regulation for flooding, the present hydroperiod of floodplain inundation is now less than 2 weeks compared to historical evidence of 3-4 weeks. The result is that pike may spawn, but the fry may not survive. The best reproduction of pike in the basin appears to occur in the small wetland creeks and adjacent drainage ditches of tributaries of basins such as the Nith, Mackenzie Cr. and others. In these locations, the channel form, flat valley floor and low gradients, all create a verge that is flooded and inundated for 3-4 weeks: long enough for incubation and yolk absorption.

Based upon the information provided in Tables 4.4 – 4.7, and with additional information from other sources, a summary of key biophysical elements for several key species of fish is summarized in Table 4.8. Table 4.8 also includes summary information from Appendix

3, *The Autecology of Grand River Fishes* (Coulson, 2000). The table is useful as a guide to determining the likelihood of the presence of these species in any particular sub-basin of the Grand River.

4.3 Watershed Zones and Relationships to Potential Fish Community Distributions

The premise for the differentiation of watersheds into biophysical zones arises from the principle that the historical (and therefore potential) and often present distribution of fish communities is controlled by the large scale geological characteristics found within the watershed. These large scale geological units, based upon their composition (materials) and structure (location, size and topography) generate certain functions within the watershed (i.e., recharge or discharge of water). These broad scale functions ultimately condition the structure and characteristics of their valleys and stream channels. This conditioning ultimately controls the living conditions for fish that wish to use the watershed.

The method for differentiating the watershed into specific biophysical units or zones uses geological characteristics and an understanding of their functions (in the management of the water cycle within the watershed) to predict likely fish community distribution at a large or coarse scale.

Section 4.2.1 discussed the definition of coldwater, mixed water and warmwater fish communities. These definitions include a combination of water temperature and flow stability (based on presence/absence and/or relative contributions of groundwater to stream flow). Determination of the distribution of fish communities and the suitability of fish communities within specific zones begins with an assessment of the geology, topography and valley cross-section of the basin. This information assists with the determination of the types of flow regimes, channel forms and chemistry likely to be found in these zones and sub-basins. This information is then used to determine the potential of the zone for specific fish communities.

The Grand River basin can be subdivided into three major geological zones, upper, middle and lower, based upon its' physiography and surficial (Quaternary) geology (See Figure 4.8, Quaternary Geology of the Grand River Watershed). These zones are:

- **Upper** - predominantly clay/till plain;
- **Middle** - outwash gravels and sands intermixed with various tills such as Catfish and Wentworth Tills;
- **Lower** - predominantly glacio-lacustrine silts and clay, naturally high s.s.

During the last glacial period the middle portion of the Grand River basin was a large spillway complex for the melting glaciers. Enormous amounts of sands, gravels and finer sediments were washed out of the glaciers, sorted and re-deposited into a series of

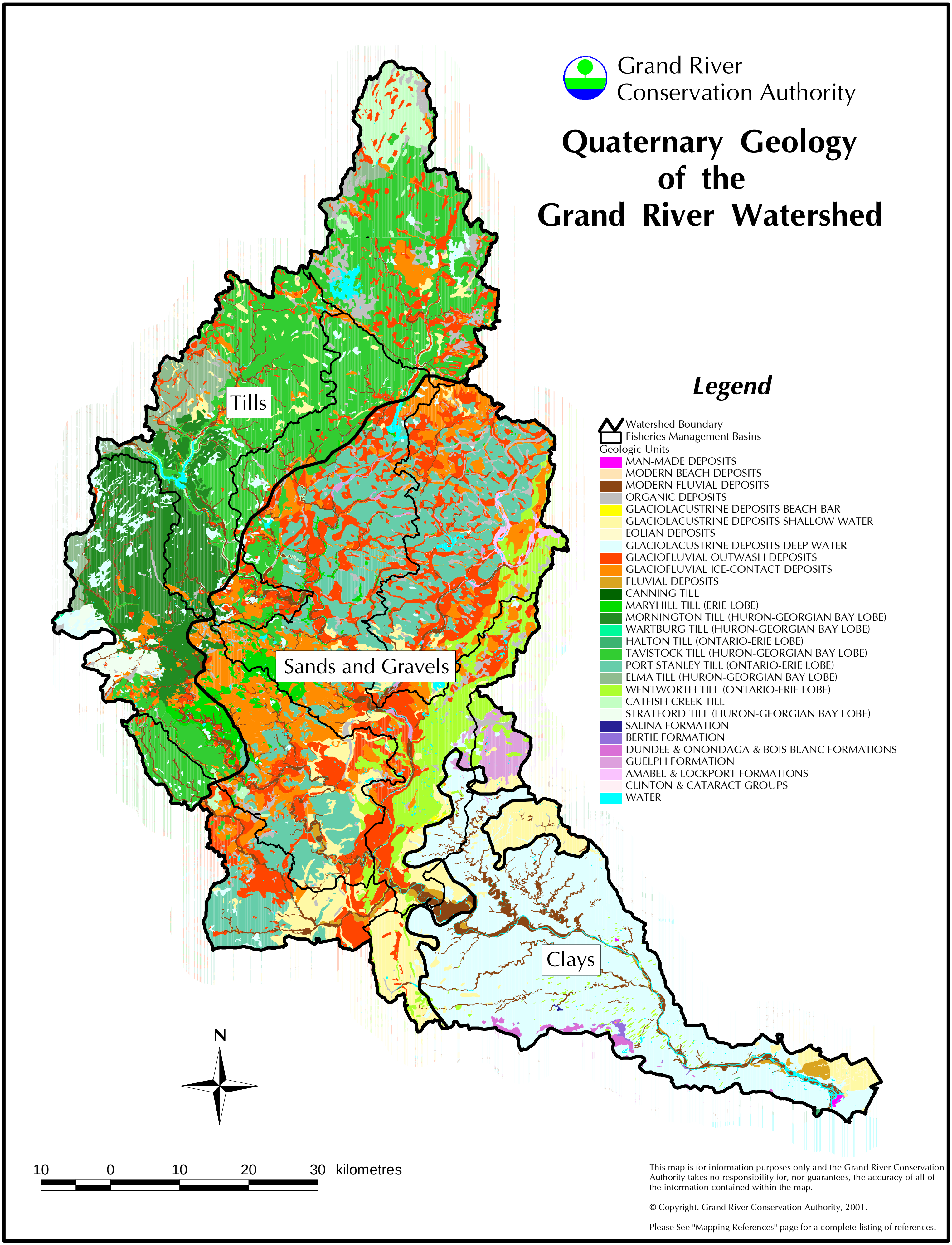


Figure 4.8: Quaternary Geology of the Grand River Watershed.

moraines, eskers, and old spillway channels. Therefore this zone has areas of till plain and till moraines interspersed with meltwater channels and moraines composed of gravels and sands and some cobbles. The upper zone was an area of deposition for finer fractions of sediments, especially the clayey fractions and silty clays and tills. The lower portion of the basin was part of the large glacial lake that included Lake Ontario and Erie. This lower zone was a source of deposition for extremely fine grained silts and clays.

Given the geological characteristics of the Upper and Lower zones of the river, it is unlikely that coldwater fish communities would exist in these zones. Examination of stream gauge data from these zones suggests streams that often dry up during years of low precipitation. These streams are also very flashy and contribute substantially to flooding of the surrounding landscape (especially in the Upper Zone). Therefore, the upper zone specifically would likely be suitable predominantly for warmwater fish communities, although some small deposits of shallow sands and sandy tills might generate enough groundwater to provide habitat for some mixed water communities as well.

The lower zone is a bit more complex. Silty clayey materials dominate the quaternary geology, but the deeper deposits from previous glacial periods include bouldery, cobbly till deposits. Tributaries of the lower Grand flow predominantly through the glacial – lacustrine materials are primarily warmwater with some mixed water communities. Channel forms include large numbers of “E” form and “F” form channels. The mainstem cuts through the recent surficial geology into the older materials. This is why the bed of the Grand River downstream of Brantford is dominated surprisingly by gravels, cobbles and some boulders. The mainstem primarily contains both mixed water and warmwater communities, with the warmwater communities predominating.

The middle zone of the Grand River basin is the most complex because of the glacial spillway and the mixture of coarse till moraines, gravel outwashes and gravel/sand moraines. All three community types are found in this zone, with coldwater and mixed water communities predominating in the smaller tributaries and mixed water and warmwater communities found in the mainstem.

These geologically based zones will be used to determine and explain the constraints and opportunities for the distribution of fish communities, landuse activities and subsequent management strategies and tactics. An understanding of the role geology plays in the management of watersheds for fish improves our capability of developing relevant and effective fisheries management and fish community plans.

4.4 Resource Uses and Management

Animals and plants that live within a watershed must share their resources with humans. The hope is that through sound resource management, we can balance the requirements and resource uses of people with the resources required to sustain natural systems and animal populations. This chapter discusses the various ways that people use watershed resources and the implications of these uses to managing healthy natural systems and specifically fisheries.

4.4.1 Land and Water Related Issues

The Grand River and its watershed is influenced by 731,741 people (1991 post censal figure). During the 20-year period from 1991 to 2011 the population living in the watershed is forecasted to increase by 35% (or 250,669 people) to 973,762 people and in the 30-year period to 2021 by 50% (or 359,359 people) to 1,082,452. It is estimated that 75% of this growth will occur in the five cities and 25% will occur in the other 48 municipalities.

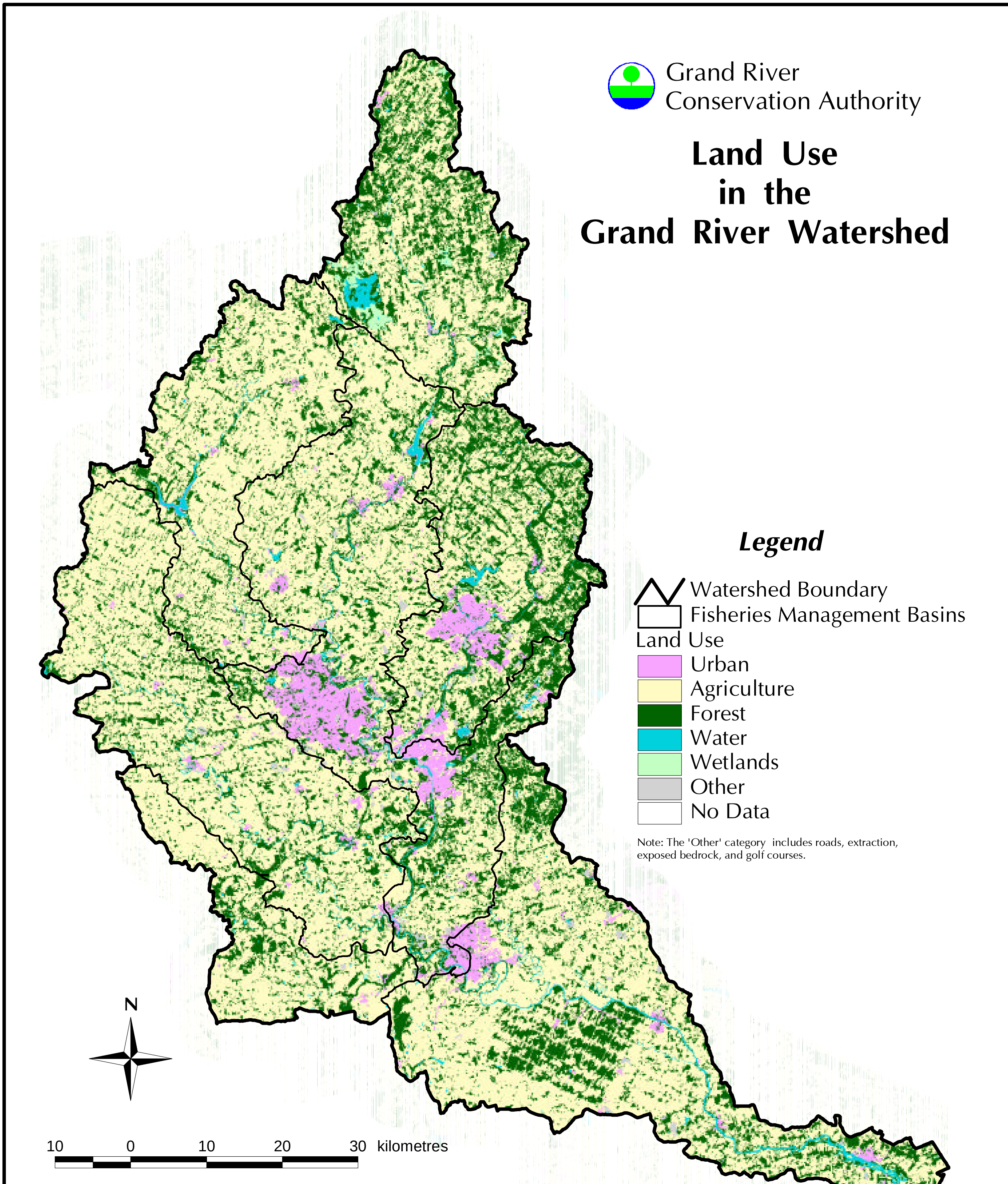
Fish and other aquatic organisms must share the water resources of the Grand River Watershed with humans and their need to use these same water resources (both surface and groundwater resources) for a variety of other purposes including: water supply; wastewater disposal; agriculture; historical/cultural reasons; and recreational purposes. These uses fall into the category of direct uses and can also be summarized in the following categories: personal use; commercial; agricultural; and industrial. The direct use of water by humans is confounded by the fact that human landuse activities can affect the quality, quantity and timing of water movement over and through the watershed.

Landuse activities can often impair the very resource that both humans and fish need. Landuse activities and human uses of the water resources have the potential to result in interactions and potential conflicts with the habitat requirements of fish.

Figure 4.9 depicts the landuse distribution of the Grand River watershed by the major sub-basins. The chart at the bottom of the figure summarizes the percent of landuse by category and by sub-basin. The major landuse in the watershed is still agriculture with “other” (roads, extraction, exposed bedrock and golf courses) being the smallest percentage. The landuses in order of land coverage are:

- Agriculture (range 53.01 – 78.5% - average 67.85%);
- Forest (range 19.17 – 36.09% - average 25.68%);
- Urban (range 0.34 – 11.04% - average 3.64%);
- Water (range 0.51 – 2.34% - average 1.57%);
- Other (range 0.16 – 1.63% - average 0.66%);
- Wetlands (range 0.08 – 3.25% - average 0.60%);

Three times the amount of land is in agriculture than in natural areas such as forests and wetlands. This demonstrates the importance of agriculture both to the economy and to the ecology of the basin.



Land Use	Upper Grand	Middle Grand	Lower Grand	Conestogo	Speed	Nith	Horner/Whitemans
Urban	0.34%	11.04%	3.02%	1.25%	8.08%	1.22%	0.55%
Agricultural	58.54%	60.35%	68.80%	77.90%	53.01%	77.83%	78.51%
Forest	35.33%	24.91%	24.87%	19.26%	36.09%	19.17%	20.12%
Water	2.18%	1.94%	2.34%	1.32%	1.65%	1.05%	0.51%
Wetlands	3.25%	0.12%	0.24%	0.11%	0.22%	0.15%	0.08%
Other	0.37%	1.63%	0.73%	0.16%	0.95%	0.58%	0.22%

This map is for information purposes only and the Grand River Conservation Authority takes no responsibility for, nor guarantees, the accuracy of all of the information contained within the map.

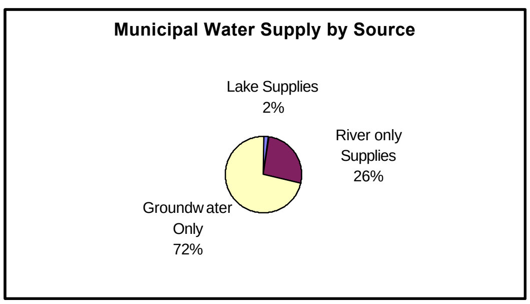
Figure 4.9: Land Use in the Grand River Watershed.

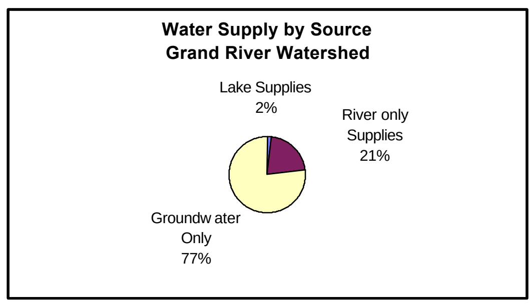
This section is sub-divided into several sections. The first sections deal with water supply, the second with water management and the third deals with the impacts of landuse types on aquatic systems.

Water Supply

The greatest consumptive use of water in the watershed is for urban and rural agricultural purposes. The major source of this water is from groundwater supplies the exceptions being

City of Brantford, Waterloo Region, City of Guelph and Six Nations, which draw all or a portion of their supplies from surface water sources. Groundwater resources are abundant in the Zone 2 of the watershed. This supply of groundwater has made the Region of Waterloo, the largest municipality in Canada that derives its predominant municipal water supply from groundwater. In Zone 3, these groundwater resources are not as available or of a quality sufficient for water supply. Therefore the communities downstream of Paris derive their predominant water supply from the Grand River itself (i.e. Brantford and Oshwegan/Six Nations). These supplies can be divided into three categories: municipal; industrial; and agricultural.





Municipal Water Supply

An average of 323,500 cubic metres per day is required to meet municipal water supply needs of the urban population within the Grand River Watershed - 28 percent of this is supplied from surface water and 72 percent from groundwater (1998). Waterloo Region and the City of Guelph depend heavily on water supplies taken directly from groundwater aquifers or recharged from the river system through an innovative recharge system near Manheim; Waterloo Region currently draws about 4 million imperial gallons per day (MIGD) from the Grand River. The City of Brantford and the Six Nations rely exclusively on the river for water supply. Almost 90% of the municipal water demand occur in the urban centres of Kitchener, Waterloo, Cambridge, Guelph and Brantford. Urban demands for municipal water supplies continue to increase on the main stem of the Grand River. This increase in demand will continue to put additional pressure on the agencies to continue to improve water supply management strategies. Since fish and other aquatic animals and their environments also require a portion of these water systems (both surface and ground), the real challenge will be to improve working relationships between municipal water managers and environmental resource managers.

Therefore management for water supply in the Grand River basin is a very complicated affair and includes management of groundwater resources for both human and ecological health purposes.

Industrial/Commercial Water Supply

In 1978, it was estimated that an average of 30% of the municipal water consumption in the major urban centres was used for industrial purposes (water consumption data for industries obtaining water from municipal sources are not compiled separately). In addition, industries not connected to a municipal water supply system withdrew about 145,000 cubic metres per day (32 MIGD). The central portion of the basin commonly referred to as the industrial triangle (Kitchener/Waterloo/Cambridge) alone has more than 650 water-using industries.

Over 60% of the water withdrawn for industrial use is obtained from ground water sources including wells and dugout ponds. Industrial uses include washing aggregates and de-watering gravel pits, industrial cooling, food processing and industrial processing, pollution control, and misc. Much of the water used in aggregate processing is generally returned to either the ground water system (through natural seepage) or to streams through surface discharge. However a sizeable portion (i.e. up to 10-15%) of the water used for washing remains in the washed aggregate and is lost to the system.

Water used for industrial cooling and processing is generally discharged to existing municipal sewer systems. The remaining 40% of industrial supply is obtained from surface water and is used mainly for mineral extraction and processing (sand, gravel, limestone). Wastewater is usually returned to a surface water source, however, on average, approximately one percent of the total volume of water used is lost through evaporation during an eight-month operation period between April and November.

More recent information (GRCA, 2000) indicates that the percentages of water use on the middle Grand River and Speed Rivers are as follows:

- Municipal water supply - 50%
- Aggregate Mining - 18%
- Golf course irrigation - 12%
- Crop irrigation - 12%
- Industrial purposes - 8%

This recent information indicates that from a commercial perspective, at least in the middle Grand River, that golf course irrigation is as significant a use of water as crop irrigation. The Middle Grand River has both the highest population density and is the location of the major aggregate resources. Therefore breakdown of water uses will vary somewhat in other sub-basins of the Grand River watershed since the density of golf courses and aggregate operations are less in other sub-basins.

Agricultural Water Supply

Within the Grand River Watershed, water is used for two main agricultural purposes: watering livestock and irrigating crops. In 1976, it was estimated that about 35,000 cubic metres per day (7.7 MIGD) was used for livestock consumption. Water supplies for feedlot and poultry farm operations were obtained primarily from groundwater (wells) while pastured cattle and mixed herds on small farms are watered from a variety of sources, including streams, ponds, springs, and drilled or dug wells. Water use for crop irrigation was once localized and concentrated in the sandy soils of the watersheds of Whiteman's, Mt. Pleasant and McKenzie Creeks where considerable areas of tobacco and market garden crops occur. Market garden crops occur within the Dunnville area as well. However, the production of fresh vegetables in areas adjacent to the major urban centres has developed and this has increased the demand for water for irrigation in other portions of the watershed. Although some of this water can make its way back to streams and wetlands through tile outfalls, much of the water is used by the crop through evapo-transpiration or is lost through evaporation as it is sprayed.

Implications to Fish and Fish Habitat

Municipal, industrial and agricultural water resources have the potential to interact with fish and fish habitat by:

- Reduction in baseflow which controls the quantity of living space, cover and food for fish;
- Alteration to groundwater discharge patterns which provide opportunities for reproduction and thermal refugia during temperature extremes;
- Reduction in groundwater discharge which moderates stream temperatures during critical times of the year (midsummer and midwinter);
- Groundwater also maintains water temperatures to a level suitable for thermally sensitive fish and maintains other water quality requirements such as dissolved oxygen;
- Entrapment of fish and other aquatic life in intakes;
- Abrupt water level fluctuations due to surface water extraction may result in direct death of fish and other aquatic life.

Water Management

Deforestation and development in the watershed have resulted in flooding, summer low flows and pollution. Surplus flows caused by heavy rainstorms that were previously restrained by woody swamps, now flood downstream areas resulting in the destruction of property and livestock. After several severe floods, public outcry lead to a provincial government investigation into low flow problems, water supply, sewage disposal, and flood control measures. In response to these issues the Grand River Conservation Commission (formed in 1938) and its successor, the Grand River Conservation Authority built seven reservoirs between 1942 and 1978.

In 1946, the Conservation Authorities Act was passed, recognising with both public and political support that land and water resources needed permanent management and protection. Shand Dam (1942) was the first reservoir built and along with the other six that have since been constructed, provided storage for floodwater and steady year-round flow. Controlling flood events also involved recognition of the value that wetlands, woodlots, and natural stream channels play in water quality improvement and natural flood protection.

Since 1966, municipal sewage treatment and industrial discharge into waterways have been regulated, and the steady release from the major dams on the Grand River and its tributaries now maintain summer flows. The diverse fishery, which is present today, is a clear sign that there has been significant improvement in the quality and quantity of the water in the Grand River since regulations have been in place.

Construction of the Dunnville Fishway in 1995 allowed for more accessible seasonal passage of migrating non-jumping species (i.e., rainbow trout, walleye, channel catfish and mooneye) from Lake Erie throughout the Grand River. The removal of the Lorne Dam in Brantford has also opened access for migratory fish species all the way to the New Hamburg area. These past developments, along with others more recent, have sparked the interest of a newly formed Migratory Fish Working Group.

Although large dams, in general, can impair the historical functions of watersheds by impeding fish migration, modifying flow regimes, changing water chemistry and altering channel processes (e.g. bedload transport), on the Grand River, the large reservoir system has likely benefited the watershed. With the loss of the large wetlands in the headwaters, the historical moderating influences of the wetlands were lost.

Implications of Water Management to Fisheries

The present large reservoirs (Luther, Belwood, Conestogo, Guelph) are multi-purpose reservoirs with two main functions: flood control/moderation; and low flow augmentation. At times in the near-drought conditions of the summer of 1999, over 95% of the river flow in Kitchener was contributed by the reservoirs. Therefore if the reservoirs had not been there, the aquatic resources of the main Grand River would have been severely compromised.

These reservoirs also support diverse warm water sport fisheries and several discharge cold water creating the potential for the development of a downstream tailwater fish community. Evidence of this is the very successful brown trout fishery located on the Grand River just downstream of Belwood Lake. In response, a *Belwood Reservoir Tailwater Fishery Management Strategy* has been drafted to focus on the management, maintenance and enhancement of the tailwater fishery and related aquatic resources from Belwood Lake down to West Montrose.

Given the above statements, dam management in the Grand River watershed is an extremely important component to the maintenance of healthy fish communities and aquatic ecosystems within the basin. Anglers cannot loose sight of the fact that one of the fundamental objectives of the reservoir system is to provide sufficient water volumes to Kitchener, Waterloo, and Brantford in order to maintain good water quality and ensure sufficient water volumes for municipal supply. This demonstrates the need for fisheries managers and water managers to work closely together to fulfil societies needs for water and healthy aquatic ecosystems and fisheries.

Further details on the Migratory Fish Working Group and the Tailwater Initiative are covered in Chapter 7.

Agricultural Landuse Impacts

Approximately 68% (range 53 – 79%) of the Grand River watershed is in agriculture of varying intensity. The nature and type of agricultural activity is reflected in the water quantity and quality of the receiving streams. Agriculture has the potential to impact on fisheries resources in various ways including water taking; drainage activities; livestock grazing; inputs of nutrients, manure, etc.; inputs of sediment from cropped lands.

Water Taking

The Ministry of the Environment is responsible for the documentation, approvals and management of water taking permits through their Permit to Take Water (PTTW) approval process. However, this process is only necessary if one is taking more than 50,000 litres of water a day from a surface or groundwater source. The present process has very limited ability to track the actual amounts of water being extracted and used for commercial and private purposes. Cumulative impacts are not assessed in many areas. There are situations in Ontario where the total amount of water allowed to be extracted in a particular stream through permit exceeds the actual supply available in the stream.

As of 1979, the MOE authorized a maximum water withdrawal rate for irrigation of about 442,400 cubic metres per day (97 MIGD) with 88 percent of this amount from surface sources. Irrigation water demands tend to coincide with the period of lowest water availability in streams and therefore represent a significant potential impact on stream flows and aquatic resources.

As a result of the low flow concerns in 1997, 1998 and 1999, a Provincial Task Force was commissioned to develop Low Flow Management Strategies for the Province. In the Grand River Watershed, the Water Managers sub-committee of the Grand Strategy have developed a

Low Flow Emergency Response Plan (GRCA, 2000). The plan demonstrates the strong support between the needs of people for water supply and the needs of the aquatic environment.

Agricultural Land Drainage

In rural Ontario, drainage improvements for agricultural lands over the last 50-100 years have likely had the greatest impacts on river systems and their watersheds since the original forest clearing for agriculture approximately 100-200 years ago. Agricultural drainage modifies flow characteristics, sediment discharge characteristics and channel and floodplain forms and features. These modifications in turn have altered the aquatic system resulting in losses of productivity and abundance of fish habitat and fish communities in these watercourses. Disruptions in the form of drain maintenance, necessary to maintain the "efficiency of the drain system", perpetuate these disruptions in a cyclical pattern that re-occurs over varying timeframes.

Healthy unaltered streams maintain their form and structure despite having to move large volumes of water and sediment under many discharges over days, months and years. Given that aquatic animals have evolved in this context, it appears logical therefore that their presence or absence in various systems is due to whether the river still has the capability of managing its flows of water and sediment in an efficient and balanced manner.

When channels are deepened through drainage and channelization, the new low flow elevation of the stream is lower than historical levels. This new elevation increases the hydraulic gradient of the water table under the riparian zone, severing the nutrient uptake capabilities of the system. Shallow groundwater moves more quickly to the stream, soil moisture drops and the riparian vegetation dies. The net result is lower water quality, lower baseflows in streams, and higher erosion potential of the newly created channel. Channel incision through drain development and maintenance creates processes within the channel that result in an inherently unstable form that tends to fail over time and require ongoing maintenance. These failures are the result of slope adjustments erosion and bank failure as well as sediment additions from poor soil management practices on farm fields.

An increase in land under drainage has been observed in poorly drained areas, specifically Melancthon Township (Dufferin County) and in Blandford-Blenheim Township (Oxford County). The concern of many farmers over apparently unrealistic and unreasonable concerns for fish and fish habitat in drains and streams flowing through their property clouds the real issues related to specific land management and agricultural drain maintenance on a farm, reach and watershed basis. If we assume that drainage for agriculture is good everywhere (and this may not be the case), then the key questions are:

- Why do our drains not maintain themselves;
- How do natural streams maintain their form over time;

- And can we manage or design streams and drains in agricultural areas to be both self-maintaining and still serve essential agricultural purposes?

Livestock Management

Cattle pasturage along streams can create a variety of problems for fish habitat. Grazing within the riparian zone and on the banks of streams can reduce the density and depth of vegetation along the stream, thereby promoting bank erosion and property loss. The pressure of the animal on the bank can also physically disturb the bank, also making it more prone to bank erosion. Feces from cattle can enter the stream either directly through the animal deficating in the stream or by manure being washed into the stream during heavy rains or floods.

Rivers respond over time to active cattle access by straightening, increasing width and decreasing depth and in some instances changing the bottom sediments from coarse gravels to fine silts. These changes can have a major impact on fish habitat over time. Examples of severe impacts of cattle on channel structure Consequences of active cattle use of riparian lands adjacent to the streams can be seen in long reaches of the Nith and Conestogo Rivers.

Sediment and Phosphorus

Run-off from agricultural lands has the potential to result in increased loads of sediment and phosphorus to receiving streams. An increase in row crop production is expected throughout the basin, replacing some small grains, hay and improved pasture. Elevated phosphorus levels have been reported to be related primarily to manure-use practises. The use of manure as a nutrient supplement will expand as the cost of chemical fertilizers increases. A gradual increase in the number of livestock is projected for the middle basin, many of which will be raised in newly constructed feedlot operations. These new intensive operations have the capability of increasing inputs of nutrients as well as pathogens into streams and rivers.

Fecal Contamination

Fecal contamination usually enters streams through run-off from moderate to high-density livestock operations, manure application and waste from wild animals appears to be the main source of bacterial contamination. Fecal coliforms occur in all living organisms. Human coliforms are destroyed through the use of septic systems or sewage treatment facilities. However, these types of facilities are rarely used for agricultural livestock management. Many of the coliforms found in livestock are relatively benign, but some are highly dangerous to other livestock and humans.

Historically, livestock waste was often managed by farmers through spreading on farm fields, often at times of the year that were inappropriate. Over and above the issue of infection, high concentrations of animal waste flowing into streams, lakes and wetlands can cause fish kills either by robbing the water column of oxygen through decomposition, and/or killing the fish due to high ammonia concentrations.

The development of the Rural Water Quality Program between farm organizations, the GRCA and the Region of Waterloo is an innovative program to reduce non-point source pollution and improve water quality of streams in Waterloo Region. The program include manure management, nutrient management programs, buffer planting and cattle exclusion from riparian areas. This program will also have major benefits to fish habitat and fish populations in the watershed. Complimentary programs such as habitat restoration in the sub-basins targeted by the RWQP may provide additional fisheries benefits over a relatively short period of time.

Implications to Fish and Fish Habitat

The construction of new drains and the maintenance of existing drains have the potential to have detrimental effects on fish habitat and fish populations. These potential impacts include:

- destruction of fish and fish eggs during the actual dredging;
- harmful alteration, disruption or destruction of fish habitat (removal of gravel or vegetation, removal of pools or riffle areas, and removal of food sources);
- changes to the normal hydrological regime of the watercourse (increased flows in the spring, decreased baseflows in the summer);
- reduction in habitat diversity;
- reduced water quality;
- reduced food supply for fish;
- elimination of riparian zone.

There are three significant effects of increased sediment load into a stream from agricultural lands:

- Increased loadings of fine sediment increase the loadings of phosphorus, heavy metals and organic compounds (i.e. pesticides) into streams. These materials are usually adsorbed to the clays and silts.
- Increased loadings of phosphorous elevate phosphorus levels, which in turn encourage the growth of aquatic plants and algae which through the photosynthesis-respiration process, produce large quantities of oxygen during the day and consume oxygen at night. This may render some fish habitats unsuitable for fish and other desirable aquatic life. In some cases, the physical choking of some reaches by dense aquatic plant growths may have a negative effect on fish habitat.
- Increased sediment loadings can aggrade the channel, increasing the amount of stress on the river banks, which in turn increases bank erosion and ultimately destroys habitat. The agradation of drains leads to drain maintenance, which is costly to both the farmer and society.

Cattle exclusion from riparian lands (where appropriate and feasible) may be a major tool to begin the process of habitat restoration. However, exclusion is only the first step. Work done on Carroll Creek near Elora suggests that although stream channel structure does respond relatively quickly to cattle exclusion, the full recovery of the stream, left to its' own devises may take up to 50-100years (Figure 4.10). This suggests that an active stream restoration plan should be part of any cattle exclusion program.

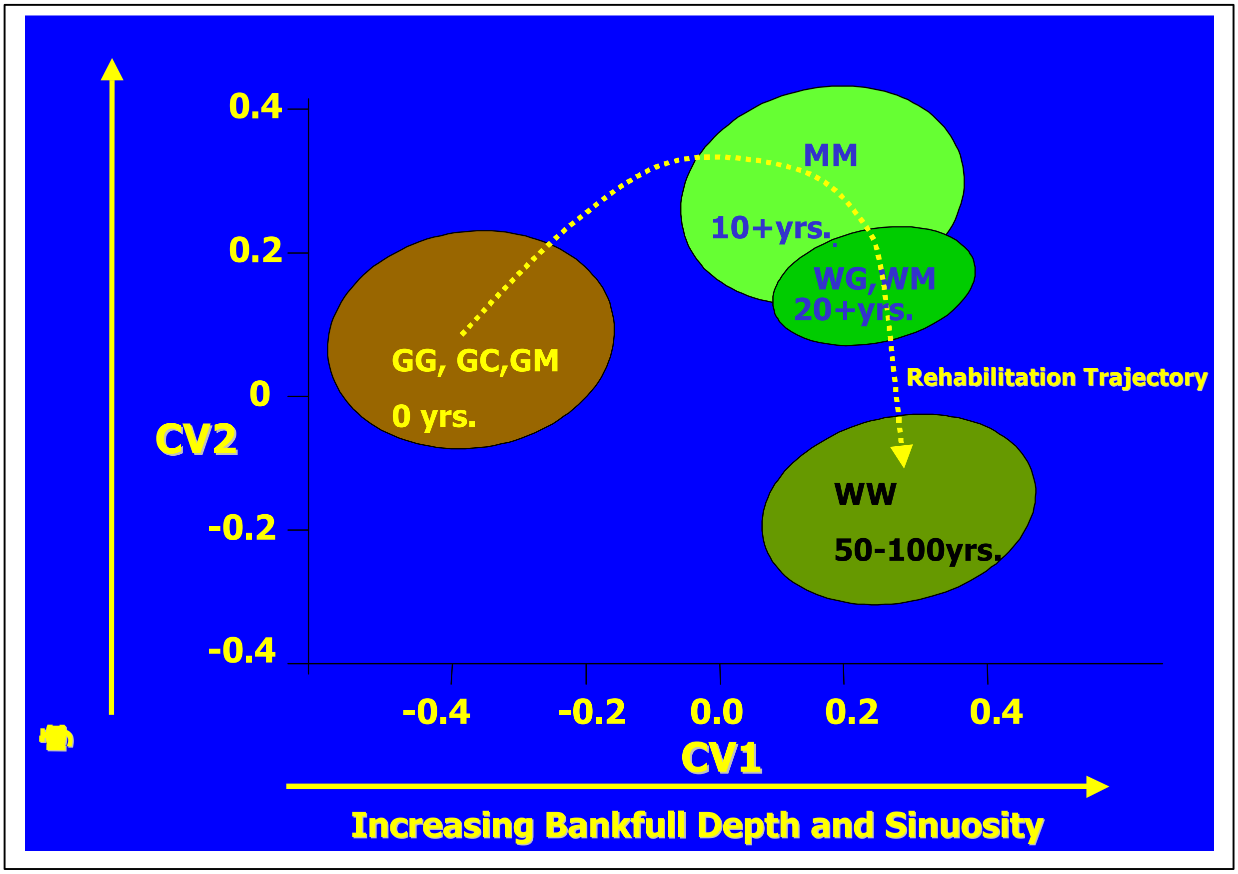


Figure 4.10: Recovery time and channel response of a stream from active grazing to fully reforested riparian system. (Carroll cr. Watershed Research Study 1995-1998) (legend refers to landuse status for both banks-i.e., gg = grazed /grazed, gc = grazed/cropped, gm = grazed/meadow, wm = wooded/meadou, etc.)

Understanding how nutrients enter streams from agricultural lands is very important for developing solutions both for the farmer and for the fisheries resource. Two major paths of movement occur. Phosphorus can enter streams by surface run-off, affixed to soil particles. Nitrates enter the stream in solution through the shallow groundwater tables. Well managed buffers in riparian zones adjacent to farm fields can dramatically reduce nutrient inputs to streams. A healthy well vegetated buffer will capture the fine soils and affixed phosphorus that flows through the buffer as surface flow. Nitrates are de-nitrified as the shallow groundwater comes into contact with the roots of riparian plants. Therefore comprehensive buffer strip development and management in riparian zones adjacent to streams and farm fields can dramatically reduce nutrient inputs.

Although buffers can be very useful in reducing nutrient inputs from farm fields, recent research suggests that some of this usefulness may be lost if the field is tile drained. Recent research from the University of Waterloo demonstrated that tile outfalls pass significant amounts of suspended solids. These solids are between 10-40 microns in size, are highly geochemically active and are topsoil. These particles move through the macropores of the soil and are captured by tiles and then shunted straight into streams, thereby by-passing the riparian buffers. This suggests we as managers must put more thought to our approach to nutrient management on agricultural landscapes.

Aquaculture

There are 21 licensed aquaculture operations in the basin (Cambridge area only). In addition to the water taking and water quality issues associated with other types of agriculture, aquaculture has a number of additional potential negative impacts on fisheries resources, which include:

- increased phosphorus and nitrogen in receiving waters can lead to reduced dissolved oxygen levels;
- unionized free ammonia can be toxic to aquatic life;
- stream baseflow and temperature effects due to surface or subsurface water extraction;
- water temperature effects due to on-stream ponds;
- potential disruption of native stock genetics;
- competition and predation on native stocks as a result of escapement.

Urban Impacts

Approximately 3.6% of the Grand River watershed is urbanized. The urban environment impacts fisheries resources in a number of ways.

Municipal Wastewater Discharges

The Grand River has the ability to accept and assimilate a certain amount of oxygen-demanding wastes and other biodegradable wastes, however, if too much organic material is discharged, oxygen resources may become severely depleted leaving insufficient oxygen for fish and other organisms. Fish already under stress from low oxygen levels, become more susceptible to the toxic effects of other substances discharged into the watercourse.
Treated wastewater from over 525,000 people (approximately 74% of the basin population) discharges into the Grand River and its tributaries. In 1993, there were 25 wastewater treatment plants discharging to the Grand River or its tributaries. Treated wastewater effluent contributes 23 – 25% to the baseflow of the Grand River downstream

of the Guelph Sewage Treatment Plan (STP) and 15 – 20% downstream of the Galt STP (GRCA 1995). Phosphorus removal was instituted in 1974 by all of the sewage treatment plants in the watershed. The most serious pollution problems in the basin are found in the vicinity of the municipalities of Waterloo, Kitchener, Cambridge and Guelph. Levels of un-ionized free ammonia and heavy metals such as copper and zinc now marginally exceed the provincial water quality objectives of fish and aquatic life in the critical area of the river between Kitchener and Paris.

On the mainstem of the Grand River between Kitchener and Paris, water quality monitoring already indicates that during extreme low flow periods and during high water temperatures, that early morning dissolved oxygen levels can dip to as low as 2-4mg.l for brief periods of time. During the same time period, afternoon levels may be as high as 13-15mg/l. These diurnal fluctuations are a result of the chronic high phosphorus levels from upstream sewage treatment plants and the abundant aquatic plant growth in this section of river. High phosphorus levels are further exacerbated by agricultural inputs as well.

Urban Storm Runoff

The final assault on a watershed is the transition from agriculture to urban (see Figure 4.3: water budget). The major factor affecting water quality and quantity in an urbanizing watershed is the percent imperviousness of the land within the urbanizing area. Work done by a variety of authors suggests that once a watershed has more than 5-10% of its' land area in imperviousness surfaces (i.e., roads, parking lots, roofs, etc.), the flow regime in the watershed and its' water budget are significantly altered. The major pollutant inputs from urban land drainage are lead, copper, zinc, PCBs and bacterial pollution.

The major pollutant inputs to receiving streams from urban drainage occur during storm events. Trace contaminants can affect the health and survival of fish and other aquatic organisms. Mercury in its methylmercury form, and other substances such as mirex and PCBs can bioaccumulate in fish. Levels of lead, zinc copper and cadmium in the Grand River slightly exceed the provincial water quality objectives for the protection of aquatic life, however, no studies have been undertaken to determine if those metals are significantly affecting the aquatic communities. PCBs have been detected at levels slightly exceeding the objective for the protection of aquatic biota and therefore may potentially interact with fish and their habitat.

Point Sources

In addition to the 25 wastewater treatment plants mentioned above, cooling, process and general purpose waters from 95 commercial, industrial and institutional sources are discharged after any required treatment to storm-sewer systems or directly to the receiving streams. The combined municipal and industrial point-source discharge is often a significant proportion of the low flow or baseflow in the Grand River.

Solid and Liquid Waste Disposal

Waste disposal practises (sanitary landfills, processed organic waste and spray irrigation) could create impairment in stream-water quality with respect to nutrients and chlorides. Waste disposal monitoring has suggested that there is minimal impact to fish and fish habitat.

Private Waste Disposal

Approximately 13% (56,000) of the urban population use private-waste disposal systems (i.e. unsewered throughout the year). A total (both urban and rural) population of 135,000 use approximately 36,000 private-waste disposal systems throughout the basin. An additional 7,000 systems are used in seasonal dwellings and their pollutant input to the watershed is minimal in relation to the permanent systems. The only pollutants of concern from private-waste disposal systems are phosphorus and to a lesser extent nitrogen. Bacterial contamination may create localized problems in receiving waters

Implications for Fish and Fish Habitat

Nutrient inputs encourage the growth of aquatic plants and algae, which produce large quantities of oxygen during the day and consume oxygen during the night. The combined effect of the above along with the physical choking of some areas create unsuitable habitat for fish and other desirable aquatic organisms.

Modification of water budgets in urban/urbanizing sub-basins of the Grand River from traditional stormwater management has a number of consequences:

- dramatic increases in run-off;
- increased flushing of sediments, nutrients, pesticides, oils, etc. off the roads and lawns;
- increased flashiness of streams;
- increased bank and bed erosion;
- property losses;
- increased flood potential;
- reduced baseflow;
- degraded channel structure.

The ultimate consequence of all these factors is loss of valued aquatic communities, degraded water quality in urban centers and a poorer quality of life for urban dwellers.

Historical and Cultural Features

European settlement of the watershed commenced in the 1790's. Numerous dams and millponds were created to provide a constant source of power for local grist and saw mills. These millponds were (and in many cases still are) focal points in the development of communities and often became treasured scenic parks and recreation areas for the townspeople. Many of these dams and associated millponds exist today. A recent GRCA survey estimated that there are presently 150 dams in the watershed. The GRCA operates 26 of these control structures. The Grand River Navigation Company was created in 1832, and some remnants of the canals, dams and locks exist today.

While some dams have value because they partition incompatible fish species, generally dams and their associated impoundments have many negative impacts on fish habitats and populations. These include:

- increased water temperatures;
- barriers to the upstream migration of fish;
- loss of baseflow due to increased evaporation from the headpond;
- alteration to normal sediment transport;
- disruption to nutrient cycling (i.e. dissolved oxygen);
- changes to the composition of the aquatic community (i.e. bacteria).

From a fisheries perspective, the removal of these dams and impoundments would be desired in most situations. However, over the life of these structures, a number of other social, aesthetic and recreational uses have become associated with these features. An interest in removing these features often comes into conflict with these other values.

Recreation

Recreation in the context of the river as defined by participants in the Grand Strategy is "the diversity of opportunities that are provided through the appreciation, stewardship and accessibility of watershed resources".

Recreational use of the Grand River and its tributaries is increasing. Canoeing and kayaking have become popular recreational sports in the reaches of the main river below Grand Valley. Tributaries including the Conestogo, Speed, Eramosa, and Nith Rivers are also navigable for canoes and kayaks over limited stretches. Canoeing on the main Grand River has been actively promoted in the Grand River by the *"Canoeing the Grand"* booklet first released by the GRCA in 1982 and an associated video released in 1994. Outlets specializing in the rental of canoes and rubber rafts are becoming increasingly popular and prevalent in the watershed. In recent years, three entrepreneurs have established businesses related to river ecotourism, which provide canoe/kayak rentals, shuttle services and guided trips.

The Grand River is navigable for powerboats for most of its reach below Brantford, however, it is segmented by dams at Caledonia and Dunnville. Power boats are permitted in the Belwood and Conestogo reservoirs and water skiing is popular in those areas as well. Power boating and water skiing are also popular on the Nith River upstream of the New Hamburg dam and on Puslinch Lake. Sail boating is also widespread on all reservoirs including Belwood, Conestogo, Guelph, Laurel Creek, Shade's Mills and Pinehurst Lake. “Tubing" with automobile tire tubes has also become a popular activity in the Elora gorge area.

Swimming activity is largely restricted to reservoirs and ponds operated by the Grand River Conservation Authority in their Conservation Areas. The water quality in the river and its tributaries are monitored on a regular basis throughout the summer months to ensure that the water is safe for body contact. The water quality is generally meets standards to permit swimming in all areas where public access is allowed. Occasionally, during hot dry spells particularly toward the end of summer, some beaches and swimming areas are required to close for health reasons.

Attempts by some landowners to increase or enhance their recreational use of tributaries often results in the creation of on-stream and by-pass ponds, which can have negative impacts on fish and fish habitats. In comparison to other land and water resource practices, recreation has shown to have relatively minor impacts on fish health and fish habitat.

4.4.2 Fisheries Related Issues

Sport Fishing

Recreational fishing has increased dramatically in popularity since water quality began to improve in the 1970s. Currently, the Grand River supports one of the most popular and diverse sport fisheries in the province. Sport fishing opportunities in the Grand River watershed can be summarised as follows:

- Angling for brook trout in small groundwater fed streams in the headwaters of the Speed and Eramosa River watershed (i.e., Blue Springs Creek), as well as in a number of other small streams that are located in the middle portion of the watershed (i.e., Cedar, Mill, Landon's McKenzie, Strasburg, Hanlon, Blair, Bechtel, Canagagigue, Washington, Alder, D'Aubigney Creeks).

- Fly, spin and baitfishing for brown trout in Whitemans and Mill Creeks, the Eramosa River system, and the Grand River in the vicinity of Fergus and Elora. The tailwater trout fishery on the Grand River between the Shand Dam and West Montrose is especially popular and attracts anglers from all over North America. Special Regulations areas (catch and release or limited harvest) have been created on Whitemans Creek and the Upper Grand River to improve opportunities to catch large "trophy" trout.

- Angling for migratory rainbow trout (steelhead) from Lake Erie in the lower and mid reaches of the Grand and Nith Rivers and tributaries such as Whitemans Creek. The trout season is currently open only from the last Saturday in April to the end of December, increasing numbers of rainbow trout are also caught and released in the lower reaches of the Grand River during the opening of walleye season in the fall and winter.

- Walleye fishing in the Nith and Conestogo Rivers, as well as in the lower and mid reaches of the Grand River. Walleye upstream of the Caledonia Dam are year round residents of the river, while at least some of the walleye caught below Caledonia are seasonal migrants from Lake Erie.

- Angling for pike in the Grand River and all major tributaries, especially in the Conestogo River, Belwood Lake, and Guelph Lake.

- Fly and spin fishing for abundant smallmouth bass populations in the Grand River and all major tributaries and reservoirs. Largemouth bass are common in the lower Grand River and most large and medium sized reservoirs and some small ponds.

- Crappies and panfish (perch, sunfish, rock bass, bullheads) are abundant in most reservoirs and small ponds, and supplement pond fisheries for bass and pike. These species are ideal for family fishing because they are often found near urban areas and are plentiful and easy to catch.

- Channel catfish, crappies, mooneye, bullheads, carp and suckers are popular in the lower river downstream of the Caledonia Dam. Carp and suckers are dip netted in the lower river in March, April and May. Mooneye provide unique fly fishing and light tackle spin fishing opportunities in May and June.

- Ice fishing for pike, crappies and yellow perch in ponds and reservoirs located within the middle portion of the watershed (i.e., Guelph, Belwood, and Shades Mills Reservoirs, and Puslinch and Pinehurst Lakes). Fluctuating water levels make ice conditions in some water management reservoirs hazardous at times.

- Tournaments do occur in the Grand River Watershed. Tournaments occur at Belwood Lake, Guelph and Conestogo Reservoirs each year, and in Kitchener and Caledonia on the Grand River as well. These events are well attended but are not as large as the major professional tournaments held in other parts of Ontario and North America each year.

Commercial Food Fishing

Commercial hoop and trap net fishing is restricted to the lower reaches of the Grand River below Cayuga. Four to seven licensees harvest carp, catfish, bullhead, suckers, bowfin, and crappies and sunfish. Sport fishes such as pike, walleye, bass, and trout must be released alive unharmed as a condition of the licence. Commercial harvest for the 1986 to 1990 period is summarized in Table 4.9.

Commercial Bait Fishing

A variety of minnow, chub and sucker species are harvested commercially in Luther Lake and from rivers and streams throughout the Grand River watershed. In addition, emerald shiners from Lake Erie are harvested from below the Dunnville Dam during the fall and early spring when they congregate in the lower river in extremely high densities.

Commercial baitfishing has not been managed aggressively by the OMNR in the past. Recently, a new business relationship (NBR) has been developed with the Baitfish Association of Ontario (BAO) and the OMNR. The goal is to better administer the commercial baitfish industry, and to a certain extent, manage the fishery. A number of problems associated with commercial baitfish harvesting have been identified and are being addressed by the NBR. These problems include: potential over harvesting (although historically, gear restrictions and restricted numbers of harvesters was enforced); impacts to non-target fishes (sport and rare or threatened species); destruction of spawning habitat; trespassing; and movement of species between watersheds. The OMNR is currently conducting a review of the commercial baitfish management programs on Lake Erie waters (including the lower Grand River below Dunnville Dam). A stakeholder committee made up of representatives from the baitfish and food fish industries, as well as the Ontario Federation of Anglers and Hunters is providing input into this review.

First Nations

Pre-historic aboriginal use of the fishery has been confirmed through archaeological evidence. More recent (post 1783) use of the fishery has not yet been described. There is currently no native fishing agreement between the Six Nations of the Grand River and the federal or provincial governments. The Six Nations have expressed an interest in developing a Grand River fishery for their people that is sustainable and is based on sound ecosystem principles, including healthy habitat and self sustaining fish populations.

Interactions Between Users

This section outlines how various types of fisheries interact with each other in terms of impacts to catch, harvest, or recreational quality. Some of the conflicts or potential conflicts identified have not been confirmed by agency staff and may in fact be more perception than reality. It should also be stressed that while there may be conflicts between some user groups, all have in common the requirement for a healthy functional aquatic ecosystem with good water quality and diverse, healthy habitats.

Anglers and Canoeists

Canoeing and fishing are not necessarily mutually exclusive. However, as canoeing becomes more popular on the Grand River, possible conflicts may arise between anglers and canoeists. Most of these conflicts will likely occur because of the numbers of canoes floating down the river and the disturbance this creates to the angler. Occasionally, without realizing, canoeists can disturb the fishing waters by floating over rising fish or through the middle of the pool the angler is fishing. Both anglers and canoeists should develop a code of behaviour so that conflicts are minimized and both types of users can enjoy the river together.

Angling Fisheries

Fisheries managers attempt to strike a balance between the desire of "elite" anglers pushing for more catch and release and gear restricted (i.e., artificials or flies only) fishing areas and others who require family consumptive, or more casual recreation. For example, the locations of catch and release trout fishing zones on the upper Grand River were chosen to avoid popular pike and family fishing areas.

Conflicts appear to exist between anglers who prefer opportunities to fish for resident trout (brook and brown trout) and those who promote expanded production and recreational opportunities for migratory rainbow trout. Since brook trout are native species that have proven to be affected negatively by rainbow trout, there is legitimate concern wherever there is the potential for rainbow trout to invade brook trout waters. In the case of rainbow/brown trout interactions, both species are not indigenous to the Grand River watershed (rainbow trout are from western North America, brown trout are from Europe), and the scientific evidence of negative effects of rainbow trout on brown trout is not clear and definitive.

Commercial Fisheries

Commercial food fishermen on the lower Grand River are regulated by a zero quota law to release all sport fish species which includes bass, pike, walleye, trout, and salmon. The method of live capture (hoop net) facilitates the safe release of fish under most circumstances. Despite this, some anglers have expressed concern regarding the impact of the commercial food fishery on angling success on the lower Grand River. Commercial fishermen relate most of the concern to the legal harvest of crappies and channel catfish. Some anglers feel that these species should be designated exclusively for sport fishing.

Anglers, naturalists, and landowners have also expressed concern regarding the potential impact of commercial bait fishing activities on fish populations and habitats throughout the watershed. The concerns most frequently mentioned are:

- seining during the spawning season destroys spawning habitat, eggs, and juveniles;
- uncontrolled harvest could reduce the forage base for sport species;
- bait harvesters could incidentally harvest rare/endangered fish species or juvenile sport fish.

First Nations Fisheries

Angling is a popular pastime of many Six Nations residents, but the commercial or sustenance harvest of Grand River fish by the Six Nations people is probably not significant at the present time. Some non-native anglers have expressed concern that if a major native fishery is established that targets preferred recreational species (walleye, pike, bass, trout), the angling fishery will decline.

Table 4.9: Commercial fish licence and harvest statistics for the lower Grand River (downstream of Cayuga), 1986 - 1990. Data from Fonthill MNR files.

Number of licences issued:

1986	1987	1988	1989	1990
4	7	4	6	4

Reported harvest (pounds):

Species	**1986**	**1987**	**1988**	**1989**	**1990**
bullhead	4585	1925	1250	2958	1290
carp	875	335	745	2775	1181
channel catfish	3360	1715	295	5804	3545
northern pike	-	-	-	-	-
white perch	-	-	-	105	-
suckers or mullet	3360	730	220	335	1126
rock bass & crappie	808	1150	475	308	65
freshwater drum	160	-	80	70	150
rainbow smelt	-	-	-	-	-
sunfish	53	10	15	10	10
white bass	-	-	-	-	-
yellow perch	-	-	-	-	-
American eel	8	35	5	10	25
dogfish (bowfin)	-	-	-	184	100

Table 4.3: A proposed hierarchy for the determination of the scale of measurement for geographic, geomorphic and biotic data collection and analysis within watershed systems based on Imhof et al. (1996)(some elements modified or adapted from Frissell et al. 1986).

System Level	Linear spatial scale (m)	Areal spatial scale (m^2)	Areal and profile boundaries	Time scale of continuous potential persistence (years)	Time scale of persistence under human disturbance patterns (years)	Biotic Assemblage Scale	Life Activity and scale (variable time)
Watershed	10^5	10^{10}	Drainage divides between tertiary watersheds	10^6-10^5	10^4-10^3	community species (migratory)	life cycle life cycle (<20 yrs.)
Subwatershed	10^4	10^8	Drainage boundaries of quaternary watersheds within tertiary drainage basins	10^4-10^3	10^2-10^1	community/ species	life cycle (1-8 yrs.)
Reach	10^4-10^1	10^5	Minimum of two full channel wavelengths, and defined by as a specific stream type based on the Rosgen (1994) classification. Active profile boundaries up to 1:20yr flow elevation, passive boundaries to 1:100yr flow elevation.	10^2-10^1	10^1-10^0	Species/ community	life cycle/ life stage (0.1-8 yrs.)
Site	10^1-10^0	10^2	Channel segment comprising either a riffle or pool, profile including bankside riparian vegetation up to bankfull elevation	10^0	10^0-10^{-1}	individual	life stage (0.1-0.4 yrs.)
Habitat element	10^0-10^{-1}	10^1	Zones of variable substrate types or characteristics, water velocity and depth within a pool, step or riffle.	10^0-10^{-1}	10^{-1}-10^{-2}	individual	activity (10^{-3}-0.1 yrs.)

Table 4.4: Life stage/state characterization for brown trout (*Salmo trutta*) in relation to dynamic processes, physical characteristics and their required habitat attributes.

Life	Physical Environment

stage/state	Dynamic Conditions	(Static Condition)	Habitat
Reproduction	- erosional zones - fall spawners...October to November $v = >30 cm.sec^{-1}$ $d = >30$ cm - interflow of water through the redd with near saturated O_2 levels through period of incubation - groundwater moderated winter flows	- outwash gravels and sands - gravel moraines - sand and gravel tills - may be limited in bedrock controlled systems - less in till/clay plains - D_{50} = 20mm (coarse gravel substrate) - less spawning in flat dominated riffle:pool systems, evident of active bedrock control	- typical in riffle:pool systems; less in step:pool systems - spawning occurs at head of riffles, often along margins with adjacent cover of logs and overhangs - >400mm depth of substrate necessary for spawning - low % fines in pavement
Nursery	- depositional zones - very low velocities	- sands and silts - shallow depths with high roughness, often with vegetation and/or woody debris and detritus	- shelter and feeding (passive[1]) - riffle margins in the lower half to third of riffles, especially at the tail of riffles - linked to spawning areas
Juvenile	- erosional zones - fast water, shallow to moderate depth	- cobble and boulder - rough bottom with structural diversity that allows good distribution of territory	- feeding and shelter (active[2]) - mid to head of riffles also at the tail out to the pool
Overwinter habitat - juvenile and adult (see also flow requirements)	- depositional zones - continuous low velocities - depth - groundwater flow regime (seepage)	- structural complexity - variable in space -best in physiographic units that allow deep pool formation and active groundwater systems	- refuge and shelter, feeding (passive) - Pools and/or cut banks adjacent to pool area - usually bottom third of pools - undercuts at cut banks, also associated with logjams with one or both cutbank and/or pool
Adult /shelter	- depositional zones (although variable) - stable depths - significant velocity gradients	- medium to high structural complexity - woody debris for shelter - variable in space -best in physiographic units that allow deep pool formation	Spatially variable: - active and passive feeding; shelter - predominantly in pools of 1-4th Order streams - Inhabit riffles with good structure in 3-6th Order streams - High roughness of bed and banks ideal - woody debris is an enhancement factor
Feeding (Active) - environments - food habitats	- erosional zones - feeding areas should support diverse prey assemblage with good biomass - macroinvertebrates major food item during early stages of life - depositional zones for minnow species (important food item in older mature fish)	- feeding areas need to be close to shelter - coarse bottom substrates in high gradient areas comprised of gravels, cobbles and boulders - substrate variable, depth and volume more important for minnow species	- Feeding is dominant in transitional zones, head of riffles during invertebrate drift or emergence and tail of pools during ovipositing - pool and shallow slow or fast areas used as foraging areas for minnow species
Migration - reproduction - seasonal habitat use	Flow regimes: high and low High flows: opportunity for movement to reproductive zones and movement of juveniles out of system Low Flows: control density and survival on an event and regime basis, depends on size/location of stream	- Drainage density an indicator of groundwater vs surface water fed systems - fine soils generate large drainage density/low baseflows compared to low drainage density and large baseflows	- ideal reproductive/nursery areas in 1-2nd Order streams with good low flows although may range up to 3-4th Order streams - juveniles & adults in 2-4 Order streams - Overwintering areas often confined to 3-5 Order

[1]Active - animal actively seeks and pursues food; [2]Passive - opportunistic feeding only

Table 4.5: Life stage/state characterization for smallmouth bass (*Micropterus dolomieui*) in relation to dynamic processes, physical characteristics and required habitat attributes and their interactions.

Life stage/state	Dynamic Conditions	Physical Environment (Static Condition)	Habitat
Reproduction - habitat	- depositional zones and margins of erosional zones v = < or = 15 cm/sec d = > 30 cm - adult male guards eggs and fry for approx. 1 month - margins need water coverage of approx. 30 cm for period of incubation and yolk sac absorption (approx. 2 wks.) before water levels drop.	- Variable locations, although usually found in units having gravel/cobble bed channels with modest incidence of boulders - Substrate composition variable (fine sand - cobble) - indented shoreline margins with coarse woody debris preferred - also occur along margins of bedrock channels	Usually reproduce in 3-7th Order streams. Occasionally in lower order streams if pool depths are sufficient - margins of pools, usually on upper or lower margin of point bars - can also be found at lower portion of riffle zones - occasionally on outside bend of shallow, poorly defined pools in bedrock controlled systems typically "C_1-C_4" type channels, occasionally "F" types
Reproduction - flows	- sufficient volume and duration to wet channel margins for 3 weeks to one month in late May to mid-June - dampened spring hydrograph	river systems with large drainage area upstream - watersheds within large moraines systems	- Lower order streams are most typical because they exhibit a dampened hydrograph with a long duration
Nursery	- depositional zones and margins of erosional zones - Same locations as spawning - nursery period of approx. 2-3 weeks in water depths from 15-40 cm ideally with some woody debris along margins as well or large boulders - warm temperatures required for optimum growth	- gravel/cobble boulder areas (with boulders) adjacent to depositional zones	- as above
Juvenile/late YOY	- erosional/depositional areas - modest flows adjacent to the main channel - velocity gradients	- substrate from cobble to boulder - Good bottom roughness - woody debris preferred	- edges of pools, bottom of pools in transition to riffles - edges of riffles in mid to lower third of riffle areas
Overwintering - juvenile/adult	- depositional zones - Deep pool areas, near over-summering locations (for YOY) - warm summer conditions for YOY to maximize fitness	- boulder material in channel	- good pool complexity, with boulders and woody debris, typical of "C" type channels; - Deep well defined pools with good complexity comprised of boulders and/or woody material
Adult - Shelter	- lateral velocity gradients	- gravel/cobble, ideally with small to moderate % boulders - depth and structural complexity including pools, runs and ledge rock areas - coarse woody debris a modifier	- Deep and extensive pools and bouldery runs with good structure and roughness in 4-7th Order streams - With extensive woody debris and deep pools, fish will be found in 3rd order streams
Feeding - environment - food habitats	- erosional and depositional features - locations having variable food items - crayfish, macroinvertebrates, amphibians and small fish all important	- substrate of cobbles and boulders ideal for most of the food items - shallow flats and runs adjacent to pools very important	- runs with coarse substrates with boulders - flats with coarse textured substrates - head and tail of pool areas for macroinvertebrates - well sorted pools ideal for minnows
Migration - reproduction and environmental	- main channel edge spawners although some movement will occur from lake to river or larger river to large tributary - movements between pools can occur under lower flows in large rivers, some constraint on movement in smaller streams during low flow periods		- easy access to larger tributaries from river system or lake

Table 4.6: Life stage/state characterization for northern pike (*Essox lucius*) in relation to dynamic processes, physical characteristics and required habitat attributes and their interactions.

Life stage/state	Dynamic Conditions	Physical Environment (Static Condition)	Habitat
Reproduction - structural	- flooded sedges and forbes at edge of stream or in floodplain v = <15 cm/sec d = <45 cm - sedges inundated to depths of 30 cm for approx. 3 weeks (minimum time for access to spawning area, deposition of eggs, incubation, emergence & yolk sac absorption).	- sedges/forbes are found on an organic base either in till/clay plains with wide shallow valleys with associated wetlands or in large floodplain streams occurring in gravel tills and moraines	-"E" type streams in till/clay plains, 2-4th Order, wetted margins maintained by both spring flood hydrograph and wetland saturation, or: - "C" type streams of 4-7th Order with extensive floodplains - floodplains with deeper channels/back bays allowing connections to floodplain terrace and vegetative communities of sedges, forbes (with modest woody shrubs) - dampened hydrograph: minimum duration of 21 days for spawning in floodplain terrace and for emigration of fry from terrace into main river
Nursery	- depositional zones allowing for macrophyte growth	- shallow/deep water with emergent vegetation in small streams or: - deeper floodplain channels adjacent to sedge terrace and back bays with emergent vegetation and/or woody debris, - floodplain pools connected to main river also suitable	- woody rough margins of "E" type channels and later into macrophytes growing in channel - floodplain back bays in "C" type channels - back margins of pools (usually bottom of point bars - side channel cut-offs)
Juvenile	- depositional zones - slow flowing water - macrophyte growth - modest depths of 0.3 - 1.5 m	- complex habitat with ample escape and ambush cover	- side margins and back eddies on edge of riffles - back bays of inside of large pools - main channel cut offs and unclosed oxbows
Overwintering -adult/young	- areas of low disturbance and low flows	- organic muck bottoms or; coarse woody areas adjacent to deep water	- floodplain verges, marshy backwaters - large pools with extensive log material on the bottom or banks
Adult - shelter	- depositional zones - variable velocity gradients	- variable; - organic bottoms hosting lush growth of macrophytes in till/clay systems; - large pools in gravel/sandbed larger rivers: vertical complexity first (e.g. macrophytes) and then depth second; - lower flows unless feeding	- side margins of large pools, especially with macrophyte growth - back bays with moderate depths as long as woody debris and/or macrophytes are present
Feeding - environment - food habits	- locations of high biomass of minnows, suckers and other smaller fish - mainly a piscivorous diet - stalks and ambushes prey	- pools, back margins with some depth and macrophyte growth - high production zones - high structural complexity and diversity	- pools, back margins with some depth and macrophyte growth - will often feed at head and tail of pools and rest in main portion of pool
Migration	- access, just after ice out, to floodplain spawning areas - sufficient high flow duration to allow for immigration of adults to area and emigration of fry - require 3 week minimum high flow period	- in Till/clay plains flows generated by both spring flood flow & saturation zone discharge laterally into adjacent wetland - in moraine units require long dampened flood pulse	- till/clay systems, extended high flows keep water in wetland margins of "E" channel for suitable time, allowing movement to spawning zones from larger river segments downstream - moraine systems, long high flow allows well connected deep floodplain channels to act as corridors into floodplain terrace

Table 4.7: Life stage/state characterization for brook trout (Salvelinus fontinalis) in relation to dynamic processes, physical characteristics and required habitat attributes and their interactions.

Life stage/state	Dynamic Conditions	Physical Environment (Static Conditions)	Habitat
Reproduction	Fall spawners - October to December v = .06 - .34 m/s Temperature 4.5 – 10 C Groundwater interflow through redd, providing near saturated O2 (min. 80%), Seepage rate >17ml^{sec} /m^2 stable temperature and stable pH level	Outwash gravels & sands, gravel moraines Glaciated drainages Sand & gravel tills, less in till/clay plains May be limited in bedrock controlled systems	Spawn near or in areas of groundwater upwelling (most important variable) Redds in slow water (e.g. pools) in certain channel types (C4, C5, E4,E5) Often in areas of high canopy cover Redds composed of coarse sand to "pea-size" gravel (0.4 - 2.0 cm) with < 5% fines
	Slightly alkaline water Depositional zones	Near headwaters Close proximity to instream cover Riffle:pool systems or spring creeks D50 = 20 mm (coarse gravel substrate) Low % of fines in pavement	In water depth usually >25 cm
Nursery	Depositional zones v = .08 - .10 m/sec Temperature 12.4 -15.4 C	Sands & silts Shallow depths with instream cover	Linked to spawning areas Water depth of < 25cm Along margins of stream, in shallow , warmer depths; adjacent to riffles Behind boulder, wood debris or macrophyte cover
Juvenile (late YOY)	Erosional zones with higher velocity	Cobble and boulder substrate or sand bottomed with active riparian zone	As YOY grow, they move from riffle margins to riffles & then move to pools, as they become yearlings. Where coarse rock in not available, rely on wood debris
Overwintering (juvenile)	Low velocity areas	gravel and sand moraines or outwash areas	Overwinter in shallow depths in side channels or in cover in pools
	Groundwater active Depositional zones	Deep pools or, side channels Low silt, substrate 10 - 40 cm typically use small order streams for overwintering unlike adult fish	Groundwater flow provides stable temperature, warmer than ambient temperature Often within 1 m of potential cover May be found 15 -30 cm beneath rubble substrate (dependent on severity of winter) or may be behind vegetative debris in riffles.
Overwintering (adult)	Moderate velocity Active Groundwater discharges Depositional zones	Best in Physiographic units that allow deep pool formation and active groundwater systems Although typically use small streams, can use large rivers as overwintering zones as long as adjacent to coldwater spawning tributaries	Found in deep pools, often with active groundwater discharge usually moving to these locations after spawning Usually found close to cover structure in pools (e.g. log jams, undercut banks) Found in location which conserves the most energy over time
Adult/shelter	Active groundwater discharges Stable water flows, v = 0.47 m/sec	Canopy cover (50 - 75 % midday shade) More than 25% of total stream with adequate cover (i.e.:	Typically in C2, C3, C4, C5, E3, E4, E5 Stream orders 1 - 5

Life stage/state	Dynamic Conditions	Physical Environment (Static Conditions)	Habitat
		overhanging vegetation, undercut banks, instream objects, rough bottom)	Prefer lateral scour pools with structural complexity
	Stable temperature regimes	Well vegetated & stable stream banks	Optimal temperature 11 - 16 C & often found near groundwater seepage when stream temperature > 20 C
	Stable depths	Pool - riffle systems or meandering spring creeks	Seldom more than 1.6 km from spring source
	Depositional zones	Best in physiographic units that allow deep pool formation	Overhead cover, side cover, undercuts and woody debris is an enhancement factor
	Intolerant of deteriorating water conditions		
Feeding (environments & food habitats)	Variable stream productivity although most abundant in alkaline systems	Feeding areas need to be close to shelter	Opportunistic sight feeders therefore feed in areas with low turbidity
	Low turbidity and low suspended sediments	Stream systems in gravel and sand moraines, outwash areas or sandy, cobble tills creating riffle:pool, step:pool or meandering stream forms	Coarse bottom substrates in high gradient areas comprised of gravels, cobbles, & boulders, or fine bottom substrates close to wood debris in low gradient systems (see stream types above)
	Erosional zones for aquatic invertebrates prey	Substrate variable, depth and volume more important for minnow species	Macroinvertebrates (aquatic & terrestrial) major food source(i.e. bottom dwelling & drifting insects)
	Depositional zones for minnow species prey		Feeding is dominant in transitional zones, head of riffles during invertebrate drift or emergence & tail end of pools during ovipositing Pool and shallow slow or fast areas used as foraging areas for minnow species
Migration (reproduction)	Change in temperature & daylight initiates spawning run	Large rivers in gravel, sand outwash areas linked to small streams in sand and gravel moraines or sandplains	Headwaters & tributaries
	High flows to allow movement to reproductive zones		Stream systems with good connection between larger channel sections and easy access to groundwater fed tributaries
Migration (environmental	Flow regimes: high & low Seasonal extreme changes in temperature (either low or high) causes movement to deeper cooler pools in coldwater portions or tributaries	Sand and gravel moraines and deep sandplains that provide Riffle - pool or meandering channel forms with deep pools	Overwintering requirements or extremes in summer temperatures cause migration to deep pools with active and substantial groundwater seepage. This provides a stable uniform temperature and year round prolific growth of macrophytes, which provides both winter and summer cover.

Table 4.8: Biophysical habitat matrix for selected fishes of the Grand River Watershed.

Species	*Surface Geology*	*Groundwater Activity*	*Temperature (sustainable range)*	*Channel Size (stream order)*	Channel Type *(reprod. and critical habitat)*	Chemistry *(TDS/D.O.)*
Brook Trout (Salvelinus fontinalis)	Gravel/Sand Moraines/ Gravel and Sand Tills; Sand Plains (deep overburden)	High Found in active discharge areas	10 - 20°C	1 – 3 Historically used larger rivers for over-wintering	C3-C5; E4-E5	High Water Quality (i.e., D.O.>7 mg./l.)
Brown Trout (Salmo trutta)	Gravel moraines; gravel spillways; sand and gravel tills (moderate to deep overburden)	Moderate – High Require groundwater for thermal refuge and temperature moderation	15 - 23°C	2 – 5 Will occasionally use 1st order streams for reproduction	B3-B4; C3-C4; E4; F4 (limited)	Mod.– High Water Quality (i.e., D.O.>6 mg./l.)
Rainbow Trout (Oncorhynchus mykiss)	Gravel spillways; gravel tills and moraines (shallow to moderate overburden)	Moderate – High Require groundwater for thermal refuge and temperature moderation	15 - 24°C	1 – 7 Most successful spawning in 1 - 4	B3-B4; C3-C4; F3-F4 (possible)	Mod.– High Water Quality (i.e., D.O.>6 mg./l.)
Smallmouth Bass (Micropterus dolomieui)	Gravel spillways; gravel tills; some gravel moraines; some clays tills	Moderate – Low (shallow to deep overburden)	18 - 28°C	3 – 8 Require dampened hydrograph for spawning success)	C1-C4; F1-F4	Mod.– High Water Quality (i.e., D.O.>4 mg./l.)
Walleye (Stizostedion vitreum vitreum)	Gravel outwash; gravel/ cobble tills	Low	16 - 24°C	3 – 8 Require high flows over riffles for 2 weeks)	C2-C3; F2-F3	Mod. Water Quality (i.e., D.O.>4 mg./l. and mod. to high turbidity)
Northern Pike (Esox lucius)	Gravel outwash; or gravel/ clay tills	Low	14 - 22°C	1 – 3 4 - 8	E4-E6 (wetland margins with hydrograph control by wetland and spring flow) C3-C4 (spawning in floodplains with 2-3 week connection to main river)	Mod.– Low Water Quality (i.e., D.O.>4 mg./l.)

5.0 PREFERRED MANAGEMENT OPTIONS

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Preamble

This chapter presents an organizational framework and structure for the plan. The development of a major environmental plan requires a framework that provides scientific and management principles and a context and structure by which all aspects of the plan can be judged and defended. A framework also ensures that the recommendations fit current scientific understanding, are logical and well founded, understandable and reasonable, and defensible. Without a framework and commonly understood context, participants in this type of process would have a difficult time determining what recommendations are reasonable and which are either scientifically impossible or unsustainable. The framework includes:

- the development of geologically-based zones of similar structure and characteristics within the watershed for context setting;
- a suite of management principles agreed to by all parties, used to ensure that all recommendations are scientifically sound and reflect current management principles;
- A layout for all elements of the recommended plan that is readable and easily understood.

The chapter then reviews and discusses the preferred management recommendations and options that have been developed for the sub-basins of the Grand River through the public and committee process. These recommendations and options are deemed to be technically and environmentally viable and focus on the protection, management and restoration of the sub-basins of the Grand River within the three major fisheries zones and seven major sub-basins that comprise the Grand River Watershed. Figure 5.1 illustrates the Grand River Watershed and the combination of the three major geological zones and the seven major sub-basins that are found within it. Fisheries management recommendations in the Grand River watershed contain three components:

- determination of fisheries community objectives;
- determination of aquatic habitat objectives (includes relationships between valley bottom habitat, channel form, and in-channel structure); and
- linkages to the overall Grand River Watershed Management Plan.

5.1 Zoning the River

The Grand River Fisheries Management Plan identifies the fundamental components and strategies that are appropriate for the entire system. The plan begins by identifying general opportunities and constraints to fish community and habitat management. These broad

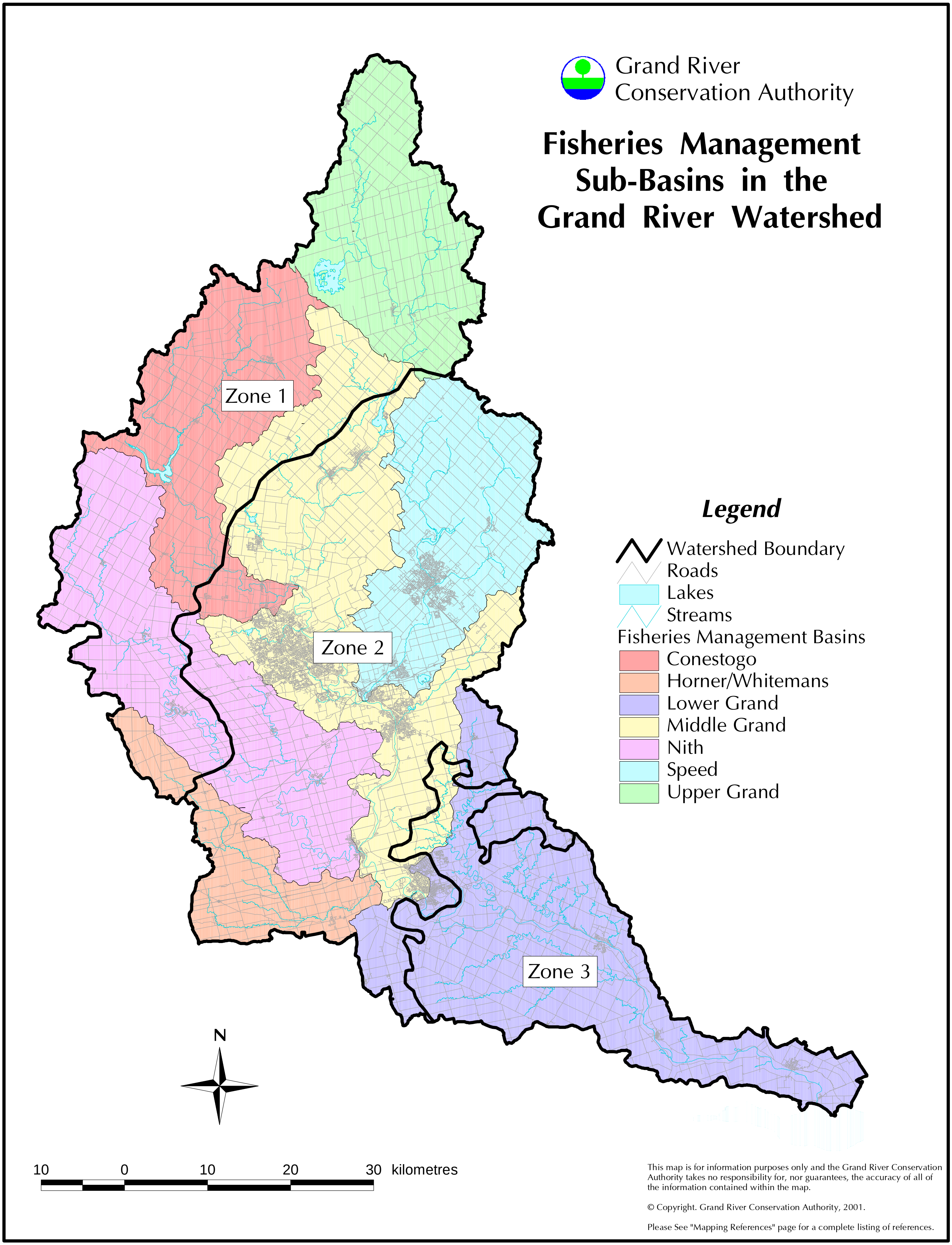

Figure 5.1: Fisheries Management Sub-Basins in the Grand River Watershed.

scale opportunities and constraints are based on the three major geological units found in the basin. From this information, the plan then identifies options that appear to be unique to each sub-basin and to the portions of these sub-basins within one, two or three of the major zones.

The three major zones of the river are (see Figure 4.8 - map of the surficial geology with the described three major zones):

- Zone 1 -Upper (upstream of Belwood and southwest to just north of New Hamburg);
- Zone 2 - Middle (Belwood Lake across to just north of New Hamburg downstream to Brantford at Waterworks Park, locally known as Green Waters);
- Zone 3 - Lower from Brantford to the mouth.

These major zones are delineated based upon the surface geology of the Grand River watershed as outlined in Chapter 4 of the background report.

Zone 1, the Upper River constitutes a large surface area mainly dominated by till/clay plains and silty/clayey till moraines with small localized areas of gravel and sand deposits. These tills are very dense and are not very permeable to infiltration of precipitation. Because of this natural impermeability, this zone is very prone to flashy floods and extreme low flow conditions. Although there are some areas of gravel and sand deposits, these deposits are generally very shallow (i.e. <1.5m) and therefore contribute very little storage or recharge to regional watertables. Consequently, stream flows are extremely variable, small creeks dry up in the summer and water temperatures are generally very warm in the summer. The predominant fish communities found in this zone are warmwater and mixed water fish communities.

The Middle Zone, Zone 2 is a complex region of rolling topography, comprised predominantly of extensive kame moraines, sand moraines and outwash areas of gravels and sands interspersed with sandy to sandy/silty tills such as Catfish and Wentworth Tills. The hydrology of the tributaries is complex because of the large amounts of groundwater that results from the porous geology. These conditions create streams with high baseflows, and cooler temperatures than those streams found in Zone 1 or 3. The large amounts of groundwater discharge provide better opportunities to restore water quality quickly because of the dilution factor. Localized outcroppings of Devonian bedrock, especially the Amabel formation, create regional groundwater discharge points in some of the sub-basins such as the Eramosa. As a result of this complex geology, this zone contains all three fish community types: coldwater, mixed water and warmwater.

The Lower Zone, Zone 3 is a region of geologically recent glacial lake deposits of silts overlaying older clay/cobble and boulder till deposits. Mainstem flows are regulated by inputs from upstream watershed and series of lowflow augmentation reservoirs. Tributaries exhibit highly variable flows with rapid, short and intense highflows and extreme low flows where riparian wetlands do not exist. The northern portion of the sub-basin contains shallow deposits of sands and silty sands and some exposure of dolostone, gypsum and shale with modest discharges of regional groundwater. The northeast portion of the sub-basin, southwest of Brantford contains a small finger of the Norfolk Sandplain with substantial localized groundwater discharges at the edge of Zone 2 and Zone 3. The majority of the tributaries of the mainstem flow through the low gradient surface glaciolacustrine deposit and are therefore often turbid. Fish communities in this zone are dominated by mixed and warmwater species. Salmon and rainbow trout are considered a mixed water fish. However, they use the lower Grand River as a migration route to spawning areas and as a migration route downstream to the lake (as smolts).

5.2 General Principles

After careful discussion, the Grand River Fisheries Management Committee endorsed the following principles. These principles were then equally used to guide the development of the plan and to provide an ecological and scientific context for decision-making.

- **An Ecosystem-based Approach**

Any environmental planning process must consider the “system” or “ecosystem” within which the resource resides. This principle is fundamental to other Provincial strategies such as the Strategic Plan for Ontario Fisheries (SPOF II 1990). The key management questions asked of the plan and the types of resources to be managed dictate which ecosystem or management unit to employ: there is no one “correct” ecological unit. Figure 5.2 provides an example of several hierarchically-based ecological and political units that can be used for resource planning. Historically, we have exclusively used the political hierarchy, whereas more recently, resource agencies are beginning to realize that political units provide the “political” context, but not an ecological context. For riverine resource planning purposes, the watershed is the fundamental ecosystem unit.

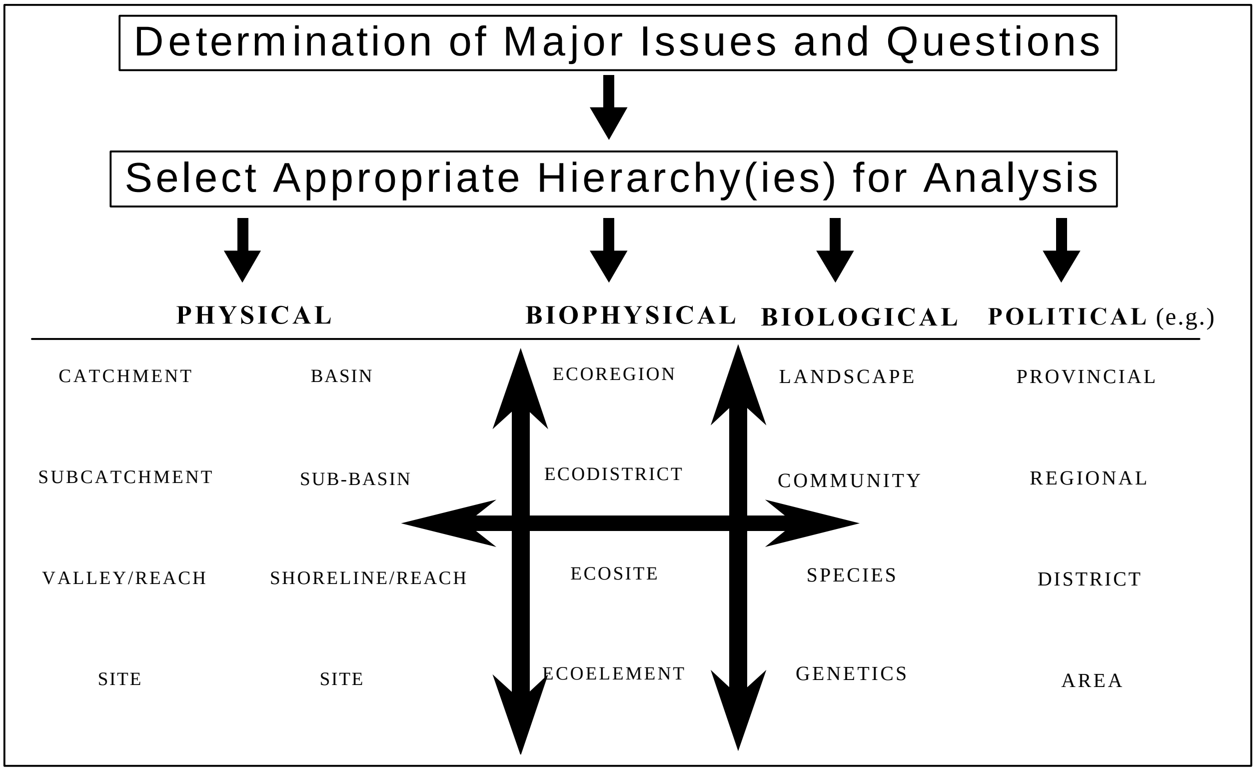

Figure 5.2: Example of typical hierarchies that can be used for ecological planning and management (from Imhof pers. comm.)

The large arrows in the figure indicate that any sound ecological planning process must be able to develop an understanding of the role that spatial and temporal scale play in management. The horizontal arrows suggest that under certain circumstances, questions and issues will develop that require the manager to use a different ecological unit to solve a problem.

One of the major principles of an ecosystem approach is that we consider all appropriate scales in the development of our management plans. These scales include the overall watershed, sub-watersheds, portions or reaches within the watershed, in the context of the management of the whole watershed. In addition to spatial scale in general, the plan should also consider the linkages between scales and the longitudinal relationships between spatial units.

The plan denotes division of the watershed into three major zones, based upon the geology of the basin. The plan then uses these zones as a way to create the context of how fish and other aquatic animals and plants can exploit the various sub-watersheds (sub-basins) within the overall watershed. For this document, the planning works down to the sub-watershed scale and identifies where plans are needed to address finer scale issues at the reach level (i.e., recommendation for the development of a tailwater fisheries management plan).

In addition to the general consideration of scale, the plan must address the importance of linkages upstream and downstream between contiguous sub-watersheds. For example, some of the most important management approaches for the Upper watershed should revolve around the need for, and the results of, improvements in water quality and quantity in the Middle and Lower watershed.

- **Limits to resources**

There are natural limits to the productive potential of any waterbody. These limits are imposed by the geology, topography, climate and chemistry of the particular portion of landscape. These natural limits not only control the relative productivity of the system and its' ecological zones but can also control the distribution and habitat characteristics necessary for different fish communities. For example, coldwater fish species such as brook trout require groundwater active areas for reproduction. Groundwater active areas are usually associated with a surface geology comprised of gravel and/or sand outwash areas or moraines. Till plains and till moraines containing clays and silts do not have active groundwater tables and therefore do not have the critical characteristics to maintain a coldwater brook trout community. These limitations based upon geology can be further altered by landuse activities that impair or damage the natural systems elements and functions.

- **Manage for naturally reproducing fish species and communities based on indigenous or naturalized populations of fish.**

This principle supports the notion that fish communities and species that have either evolved or adjusted to conditions within a stream or watershed are best suited for the system. The management and maintenance of these populations also costs very little other than in protection and management of habitat. This principle does not preclude the consideration of supplementing a population of fish with other species, but this should only be considered if an indigenous or naturalized species can no longer tolerate conditions of the system and the rehabilitation of original environmental features and community structure is no longer a viable option.

- **Manage for community types composed of the appropriate community composition and functional structures appropriate to the system.**

Community objectives should consider not only the composition of species appropriate to a specific stream form and location within a watershed but also the appropriate levels of functional groups associated with the stream form and size or location of the stream. For example, in medium to larger streams, fish communities are made up of a variety of fish species that have different feeding and ecological requirements including fish that primarily eat plant and algae material, fish that primarily eat detritus, fish that eat other fish, etc. Anglers usually focus on the fish that eat other fish, also referred to as top level predators, game fish or piscavores. Fisheries management must focus both on the fish of interest to the angler but also fish that are important to the perpetuation and stability of the overall community. A healthy fish community will include species of various trophic levels, foraging behavior and habitat requirements. The types of species appropriate to a community in any particular location within the watershed will be controlled by a number of factors including: geology, topography, stream type, substrate type, nutrient status and stream size.

- **Habitat protection and rehabilitation should be based upon both fish community and habitat objectives**

Habitat protection, management and rehabilitation is the most effective long-term management principle for healthy productive fish populations in streams or watersheds. The key strategic elements of this principle in order of importance are:

- Protect what is healthy and functional;
- Remediate where only minor occurrences took place;
- Rehabilitate that which is degraded;
- Restore to some level of function that which can no longer be rehabilitated to original condition.

These strategies are only effective if they consider the natural tendencies of the stream for the appropriate habitat forms and fish communities associated with the habitat forms and controlling environmental features of geology, topography, climate and chemistry.

- **Using a Watershed and Natural Channel Systems Approach**

Most habitat and fish community problems are not created at a specific site within a basin, but are more often a result of major changes or disturbances over larger areas of land or stream. Watershed analysis and management provides a context to examine the inter-relationships between landform, geology, landcover and human uses in order to understand how these elements interact to create or inhibit the health of rivers and their fish communities. The Natural Channel System (NCS) initiative is a finer scale planning and management approach (see above Figure 5.2). The NCS links to watershed analysis and planning and provides tools for managing rivers and their corridors in a manner that maintains their functions and integrity and reduces costs associated with property loss, flood damage, water quality degradation and habitat rehabilitation and restoration.

5.3 Major Management Descriptors for the Sub-Basins of the Grand River Watershed

A watershed and its’ streams cannot be all things to all people. As discussed in Chapter 4, geology and human induced changes to the landscape create certain opportunities and constraints on the system and our desires for the systems. Three zones were identified in Chapter 4 to predict the likely fish community types found in each of the zones. In addition to fish community potential, an understanding of the geology, topography and landuses in each sub-basin can help the manager understand and categorize issues and to determine which management strategies might be appropriate for what conditions or circumstances. Constraints occurring within the watershed occur in two forms: natural and human induced.

Chapter 4 discussed the constraints surficial geology places upon the watershed and the fish communities found within the watershed. The UPPER, MIDDLE, and LOWER are delineated in Section 4 and are shown on Figure 4.8. These zones correspond to major geological features created through glacial actions over the last 40,000 years. The dominant geological features of each zone exert certain controls on physical, chemical and biological processes that occur within each zone. These processes can be altered in small ways by localized geological features that act as modifiers to the overall tendency of the zone. However, unless massive land changes occur on a landscape level, the dominant control of these features will not change the overall constraints and tendencies found within those units.

Human induced constraints are more variable than geological constraints, although some human induced constraints such as large reservoirs will not likely be removed for very long periods of time and can therefore be viewed as "permanent" based upon the time scales this plan is using. However, other human induced constraints such as agricultural drains, berms, dykes, stormwater management systems and servicing structures can be modified or removed over time as human activities in those areas change and new information on alternative management options develop.

Tables 5.1 – 5.7 present the descriptor information and an overview for the constraints and opportunities available to the manager for each sub-basin.

Table 5.1: The descriptor information, constraints and opportunities available for fisheries management for the Upper Grand River Watershed.

Descriptor (Zone 1):

- Clayey to silty/clayey till plains and low moraines with poor to very poor infiltration, flashy flood flows and extremely low baseflows
- Many first order tributaries are intermittent
- Localized deposits of gravels and sands occur in large patches but are very shallow and contribute little to low flow volumes in the tributaries or mainstem
- Bedrock near the surface of the mainstem upstream and downstream of Grand Valley
- Much of the upper watershed was once composed of wetlands/swamps
- In and downstream of Grand Valley river enters narrow gravel spillway with some groundwater influences (some local aggregate extraction occurs here)
- Large sandplain with moraine features occurs southeast of Grand Valley, and due east of Belwood Lake providing sufficient depth and surficial area to generate local active groundwater discharge features

Constraints to Fisheries Management

- Given high runoff characteristics, little storage of precipitation occurs resulting in very low baseflows on the mainstem or intermittent channels in small tributaries which limits total productivity of the tributaries
- Historical drainage practices in till plain have resulted in very broad channels unable to maintain a low flow channel form appropriate for fish habitat
- Small tributaries cut through silty tills and have poor habitat structure after drainage
- Absence of groundwater activity upstream of Grand Valley limits potential fish communities to warmwater or coolwater
- Bedrock control of mainstem upstream and downstream of Grand Valley limits maximum pool depths and tends to promote excessive channel widths

Opportunities for Fisheries Management

- Baseflow of mainstem of Upper Grand augmented by Luther Lake providing some opportunities for warmwater and coolwater fish in mainstem
- Sand plain exists south-east of Grand Valley and supports a coldwater tributary (i.e. Butler Cr.); therefore some possibilities for habitat restoration for cold or mixed water fish community downstream of Grand Valley
- Drainage in much of the watershed no longer needed for agricultural purposes and could be modified to create mini-floodplain storage in order to augment low flows, increase duration of higher flows, reduce magnitude of higher flows and thereby provide opportunities for coolwater fish that utilize floodplains for spawning (e.g. northern pike)
- Although gravel and sand deposits are shallow, they do provide material to the creeks for substrate. Therefore some tributaries and mainstem do have coarse gravel/cobble substrate appropriate for habitat for forage fish and aquatic bugs.
- Grand Valley - Belwood: possibility of major restoration work for small mouth bass or trout - channel structure management is needed

Table 5.2: The descriptor information, constraints and opportunities available for fisheries management for the Conestogo River Watershed.

Upper Section- headwaters to Hwy 86 (Zone 1):

Descriptor:

- Clayey to silty/clayey till plains and low moraines with poor to extremely poor infiltration, extremely flashy floodflows and extremely low baseflows
- Most first order tributaries are intermittent
- Extremely small, localized but deep deposits of gravels and sands occur
- Heavily agriculturalized and drained system
- Lack of baseflow and permanent landcover in headwaters as well as lack of functional riparian zones, unstable slopes and sedimentation due to agriculture and physiography
- High nutrient runoff from landscaped areas due to agricultural practices, lack of riparian structures and geology
- Much of area was historically composed of wetlands and swamps

Constraints to Fisheries Management

- Water turbid below Conestogo dam as a result of physiography and resuspension; also alga problems and high nutrient loadings and bacteria
- Silty/clayey till plains and moraines restrict bottom sediments to silts, clay and fine organic material, limiting production of mainstem of river upstream of Conestogo Dam
- Intermittency of flow coupled with poor low flows and drained tributaries limit habitat diversity for many fish species

Opportunities for Fisheries Management

- Some coldwater resources may still be present due to highly localized gravel deposits and small spillways, need to inventory and assess for coldwater habitats present and potential (i.e. Moorefield Cr., Rothsay Cr., Spring Cr.)
- Mainstem flows over deep deposits of till leading to deep pools above and below dam
- Mainstem downstream of dam has augmented low flows and extended moderated high flows providing some opportunities for habitat creation and restoration of floodplains

Lower Section - Hwy 86 to confluence with Grand River (Zone 2)

Descriptor:

- Physiography is complex, small localized kame moraines, glacial spillways and sandy to sandy/silty till moraines, with rolling topography
- Hydrology in tributaries complex because of the large amounts of groundwater due to the physiography. This generates higher baseflows, cooler temperatures and better opportunities to restore water quality quickly because of dilution factor
- Poor riparian systems in tributaries, although the mainstem has some good riparian forests and floodplains because of the valley slopes and shape

Constraints to Fisheries Management

- Unit is heavily agriculturalized and drained with significant amounts of sediment and nutrients coming off farm fields
- Channel stability is very low and therefore habitat quality is very poor due to drainage
- Active cattle pasturage in the floodplain impairs natural floodplain functions
- This portion of Zone 2 has a higher proportion of sandy/silty till than other Zone 2 portions thereby reducing the overall amounts of groundwater from other more permeable materials
- Because of the relatively low amounts of groundwater in this unit (compared to other Zone 2 units), coldwater streams are small and few

Opportunities for Fisheries Management

- Because of groundwater intrusions, opportunities for restoration of tributaries and agricultural drains is possible and would likely be quite successful
- Floodplain of the mainstem is quite large providing an opportunity for restoration

Table 5.3: The descriptor information, constraints and opportunities available to fisheries management for the Nith River Watershed.

Upper Section - Headwaters to Town of Plattsville (Zone 1)

Descriptor

- Clayey to silty/clayey till plains and low moraines with poor to extremely poor infiltration, extremely flashy floodflows and extremely low baseflows
- Most first order tributaries are intermittent
- Extremely small, localized but deep deposits of gravels and sands occur along with small deposits of sandy/silty tills
- Heavily agriculturalized and drained system (high livestock populations) creating very poor water quality conditions
- Lack of baseflow and permanent landcover in headwaters as well as lack of functional riparian zones, unstable slopes and sedimentation due to agriculture and physiography
- High nutrient runoff from landscaped areas due to agricultural practices, lack of riparian structures and geology
- Mainstem, however, flows through a narrow spillway of alluviums, gravels and cobbles

Constraints to Fisheries Management

- Extreme headwaters are intermittent and flashy, generating high flow volumes, which are difficult to manage
- Extremely poor water quality as a result of geology and landuses are affecting productivity of fish
- Floodplains actively used for agriculture and very degraded, some portions of the mainstem channel are entrenched and unstable

Opportunities for Fisheries Management

- Floodplain elevations and characteristics still exist, providing an opportunity for revegetation and restoration
- Some long reaches do have healthy riparian systems providing a restoration foundation
- Localized gravel spillways and gravel deposits create mixed water tributaries having some opportunity for localized coldwater fish communities

Lower Section - Town of Plattsville to confluence with the Grand River (Zone 2)

Descriptor

- Physiography is complex, extensive kame moraines, sandplains and glacial spillways interspersed with sandy to sandy/silty till moraines, with rolling topography
- Hydrology in tributaries complex because of the large amounts of groundwater due to the physiography. This generates higher baseflows, cooler temperatures and better opportunities to restore water quality quickly because of dilution factor
- Poor riparian systems in tributaries, although the mainstem has some good riparian forests and floodplains because of the valley slopes and shape

Constraints to Fisheries Management

- High agricultural activity with extensive loadings of nutrients and sediments
- Extensive damage of historical floodplains
- Channel entrenchment is high in some of the tributaries and mainstem

Opportunities for Fisheries Management

- Tributaries have high volumes of groundwater and can respond quickly to restoration of channel and riparian zone
- Although mainstem is structurally degraded, groundwater inputs from tributaries and main channel inputs provide enormous opportunities for restoration for coolwater and coldwater fish communities
- Groundwater discharge areas in mainstem provide thermal refugia for developing migratory coldwater population and refugia for coolwater populations

Table 5.4: The descriptor information, constraints and opportunities available to fisheries management for the Middle Grand River Watershed.

Descriptor (Zone 2)

- Physiography is complex, extensive kame moraines, sand moraines and glacial spillways interspersed with sandy to sandy/silty till moraines, with rolling topography
- Hydrology in tributaries complex because of the large amounts of groundwater due to the physiography. This generates higher baseflows, cooler temperatures and better opportunities to restore water quality quickly because of dilution factor
- Poor riparian systems in tributaries, although the mainstem has some good riparian forests and floodplains because of the valley slopes and shape
- Localized outcroppings of Devonian bedrock, especially Amabel formation, create regional groundwater discharge points
- Main river channel has numerous areas of active groundwater discharge generating thermal refuges for various fish species, especially in the mid to lower portions of the sub-basin
- Mainstem flows through an extensive outwash spillway of variable depths, greatest extent of these deposits from Kitchener-Waterloo downstream to Brantford
- Mainstem for first 25km downstream of Belwood Lake appears to be bedrock controlled
- Extensive gravels in floodplain provide an opportunity for groundwater movement and floodplain enhancement and restoration
- Landuse varies from intensive to passive agriculture
- Highest density of urban centers and urban growth occur in this portion of the overall watershed

Constraint to Fisheries Management

- Bedrock controlled sections have limited pool depths
- Urban centers create water quality problems due to inputs of sediments and stormwater
- Agriculture generates extensive inputs of sediments and nutrients
- Historical removal of floodplain and riparian forests has severely limited the supply of Large Wood Debris (LWD) which is very important to habitat diversity in rivers
- Major extraction of aggregates and groundwater for water supply may threaten capacity of the tributaries for rehabilitation (e.g. Mill Cr.; Blair Cr.)
- Old onstream dams pose a major problem to migration of fish
- Old onstream dams pose a problem to channel morphology and productivity if they fail
- Rapid and continuing urban growth with related increases in imperviousness, stormwater flows, demands for water supply and waste water treatment

Opportunities for Fisheries Management

- Infiltration capabilities are high in urban areas (e.g. sand moraines in Kitchener)
- Massive groundwater inputs into mainstem and from small tributaries downstream of Cambridge to Brantford may provide opportunities for the establishment of coldwater fishery
- Coldwater tributaries can be restored in many locations by simple improvements in riparian zones and channel restoration
- Creation of LWD jams in the mainstem can be used to offset limited pool depths in bedrock controlled sections
- Excavation of deeper pools in exposed bedrock reaches may provide improvements in over-summer and over-winter habitat for coolwater fish communities

Table 5.5: The descriptor information, constraints and opportunities available to fisheries management for the Speed River Watershed.

Descriptor (Zone 2)

- Physiography is complex, small localized kame moraines, glacial spillways and sandy to sandy/silty till moraines, with rolling topography
- Very specific distribution of geological units in this sub-basin: uppermost localized gravel and kame moraines; mid to lower portions mostly sandy/silty tills with localized confined outwash materials along mainstem; extensive kame and sand moraines with outcroppings of Devonian Amabel formation in Eramosa sub-basin
- Mainstem is bedrock controlled from upstream of Speed River Reservoir downstream to confluence with Grand River in Cambridge
- Hydrology in tributaries is variable depending upon the location in the sub-basin.
- Areas of appropriate geology have large amounts of groundwater due to the physiography. This generates higher baseflows, cooler temperatures and better opportunities to restore water quality quickly because of dilution factor
- Poor riparian systems in tributaries, although the mainstem has some good riparian forests and floodplains because of the valley slopes and shape

Constraints to Fisheries Management

- Tributary streams and mainstem of Speed River basin have localized and variable amounts of groundwater (because of the high proportion of sandy/silty till moraines), but not the extensive supply of other portions of the sub-basin (gravel and sand moraines)
- Urbanization of lower river has limited opportunities for mainstem restoration, especially through Guelph
- Bedrock channel sections are limited in pool depth and complexity

Opportunities for Fisheries Management

- Eramosa sub-basin, because of the Amabel bedrock outcroppings, receives enormous amounts of regional groundwater providing a major opportunity for coldwater fish communities
- Given controlled flows from Speed River reservoir, opportunities exist for re-establishment of limited coldwater and coolwater fish communities
- Bedrock pool excavation is possible to improve survivorship of coolwater species
- Infiltration technology in serviced and soon to be serviced urban areas can restore groundwater tables in the lower sub-basin
- Most urban and urbanizing tributaries in the lower basin have sufficient space to allow for natural channel restoration of old engineered channels

Table 5.6: The descriptor information, constraints and opportunities available to fisheries management for the Whiteman's Creek Watershed.

Upper Zone **-** Headwaters to Princeton (Zone 1)
Descriptor

- Clayey to silty/clayey till plains and low moraines with poor to very poor infiltration, flashy floodflows and extremely low baseflows
- Many first order tributaries are intermittent
- Extensive localized deposits of gravels and sands occur in large patches but are very shallow and contribute little to lowflow volumes in the tributaries or mainstem in the upper reaches although depth of material increases closer to Princeton
- Much of the uppermost watershed was once composed of wetlands/swamps
- Intensive agriculture with heavily drained upper watershed
- Poor water quality and heavy discharges of sediment

Constraints to Fisheries Management

- Heavily drained nature of watershed necessary for agriculture in dense tills
- Extremely low baseflow volumes and extremely low stream gradient
- Heavily damaged riparian zone and highly entrenched tributaries in some locations

Opportunities for Fisheries Management

- Some tributaries flow through sand lenses discharging sufficient groundwater to support coldwater communities
- Some isolated riparian wetlands can be used as the building blocks for additional riparian zone restoration
- Drains in till plains can be designed to be utilized by coolwater species for reproduction
- Natural stream reaches in till plains with stable riparian zones often have very deep pools thereby providing refuge for fish communities

Lower Section **-** Princeton downstream to confluence with Grand River (Zone 2)
Descriptor

- Physiography is complex, extensive kame moraines, sand moraines and glacial spillways with small localized portion of sandy to sandy/silty till moraine in the westernmost portion of the sub-basin with extensive rolling topography
- Very few tributaries because of extremely high infiltration of this portion of the sub-basin
- Tributaries small but have very high baseflow volumes with very cold water temperatures.
- Mainstem and tributaries have high capacity for water quality improvement through dilution
- Relatively good riparian systems in tributaries, and mainstem due to deeply incised valley
- Main river channel has numerous areas of active groundwater discharge generating thermal refuges for various fish species, especially in mid to lower portions of sub-basin
- Mainstem flows through an extensive outwash spillway of substantial depth

Constraints to Fisheries Management

- Valley slopes are highly erodible and unstable where vegetation is lacking and can generate slope failures that can affect stream channel stability
- Tendency of main channel to braid and become unstable (i.e. 15 years ago)
- Active agricultural drain maintenance in tilly tributaries
- Floodflow characteristics caused by upper watershed

Opportunities for Fisheries Management

- Extensive gravels in floodplain provide an opportunity for groundwater movement and stream channel enhancement and restoration
- Removal of obstructions to migration on spring tributaries
- LWD is present in channel, needs to be managed to optimize positive contribution to channel structure
- Enhanced management of developing riparian forest

Table 5.7: The descriptor information, contrainsts and opportunities available to fisheries management for the Lower Grand River Watershed.

Descriptor (Zone 3)

- Dominated by glaciolacustrine deposits of silts and clay displaying very poor infiltration
- Deep deposit under glaciolacustrine deposits of silty/clayey till with cobble and boulder
- Topography moderate to rolling to relatively flat
- Tributaries exhibit highly variable flows with rapid, short and intense highflows and extreme low flows where riparian wetlands do not exist
- Mainstem flows are regulated by inputs from upstream watershed and series of lowflow augmentation reservoirs
- Northern portion of sub-basin contains shallow deposits of sands and silty sands and some exposure of dolostone, gypsum and shale with modest discharges of regional groundwater
- Northern portion of sub-basin, southwest of Brantford is a small finger of the Norfolk Sandplain with substantial localized groundwater discharges at the edge of Zone 2 and Zone 3
- Majority of the tributaries of the mainstem flow through the low gradient surface glaciolacustrine deposit
- Streams flowing through this area are predominantly “E5” and “E6” type channels
- Mainstem of the Lower Grand River flows through a relatively broad and deep valley that cuts through the glaciolacustrine deposits into the older formation silty/clayey cobble, boulder till underneath. As a consequence the stream bottom contains a coarse substrate of cobbles and boulders despite the dominant particle size of the surface geology
- Area is used for intensive agriculture with concurrent problems of water quality and high sedimentation
- Clayey and silty geological deposits generate relatively high volumes of suspended material in the river
- Mainstem has very low concentrations of LWD due to clearing of large portions of the historical floodplain forests therefore channel complexity is low

Constraints to Fisheries Management

- Extensive removal of riparian vegetation has degraded many small tributaries
- Intensity of agriculture in some portions of the sub-basin
- Large, old dams on the river at Dunnville and Caledonia
- Berms and dykes in some reaches of the river bar access to historic floodplain
- Bank and slope instability is high where vegetation has been removed

Opportunities for Fisheries Management

- Small headwater zones touching bedrock sections or Norfolk Sandplain may provide stable lowflows that can help support localized cool or perhaps coldwater fish communities therefore high local rehabilitation potential
- Small “E” type tributaries with stable flows and relatively healthy riparian zones may provide opportunities for northern pike reproduction
- Some portions of tributaries and mainstem may be physically appropriate for muskellunge re-introduction
- Addition of LWD jams against outside meanders of the larger tributaries and mainstem may enhance channel complexity

5.4 The Structure of the Plan and Major Plan Categories

5.4.1 Structure of the Plan

The information and recommended options for the Grand River Fisheries Management Plan are presented as a series of stand alone matrices organized at the sub-basin level for ease of reading and quick referencing. The three geological zones are used as a means to understand the different conditions that occur within each sub-basin and the types of control the geology places upon the physical and chemical habitat characteristics of that portion of the sub-basin. The descriptor information presented in Section 5.3 provided the committee with a summary of the implications of geology to each sub-basin and provided guidance for selection of realistic fish community objectives and appropriate management strategies and tactics.

The major sub-basins of the Grand River Fisheries Management Plan (Figure 5.1) are:

- Upper Grand River Reach;
- Middle Grand River Reach;
- Lower Grand River Reach.
- Conestogo River Sub-basin;
- Speed River Sub-basin;
- Nith River Sub-basin;
- Horners/Whiteman's Creek Sub-basin;

Each sub-basin is further divided into a set of specific aquatic units that occur within the sub-basin. These units can include:

- Mainstem
- Coldwater tributaries
- Mixed water tributaries
- Warmwater tributaries
- Ponds, reservoirs and lakes

Each unit is organized in the same way and includes a summary of objectives, issues, options and tactics for each sub-basin within the watershed. The recommendations are structured in this manner in order to ensure that all sub-basin plans for the watershed comply with naturally occurring watershed units while still identifying the geological controls within each sub-basin that act to control and modify habitat potential for various communities of fish.

The Plan uses a reporting structure with standardized components for each aquatic unit within the sub-basin plan. Each unit is broken down into the following general format.

General Structure for each Matrix:

- **Heading:** (for the Sub-basin) the watershed has been divided into its three major mainstem reaches and into its 4 major sub-basins;

- **Map:** of the specific sub-basin or reach identifying the surficial geology and the boundaries of the sub-basin or reach;

- **Side Bar (Portion of the sub-basin):** Delineates whether the information is about the main stem of the sub-basin, a reservoir or lake or a tributary of the specific sub-basin. Tributaries are classified as either: coldwater, mixed water or warmwater tributaries found within each sub-basin, within each of the three geologic zones (these categories identify whether the stream is dominated by groundwater discharge; has dispersed groundwater intrusions that occasionally favour coldwater species although warmwater fish often dominate the population; or has little groundwater to modify thermal regimes and is therefore dominated by surface runoff and the variability in flow that that entails).

- **Descriptor:** identifies the geological characteristics of the zone(s) within the Sub-basin (See chapter 4 for the three major zones and their boundaries) and the relative proportion of the geological units making up the zone. As well, a brief description is presented of the implications of the geology of the unit on constraints and opportunities for fisheries management.

In addition to this general structure, the overview and recommendations for each sub-basin are divided into a number of specific categories:

- **Fish community objectives:** these fall into two major categories: coldwater fish communities such as the various trout species and sculpin; and warmwater communities comprised of northern pike, smallmouth bass and walleye, largemouth bass, black crappie, channel catfish, etc. (some warmwater communities are exclusively forage-based comprised of fish species used as a forage-base by predator species and often favoured by the baitfish industry);

- **Issues:** these are issues associated with achievement of the fish community objectives for the specific geological zone, tributary type found within the particular sub-basin (see Table 5.8 Summary of the issues related to the implementation of the Grand River Fisheries Management Plan);

- **Management Strategies**: these are proposed options to address the issues in order to achieve the fish community objectives;

- **Management Tactics:** these are specific tactics designed to achieve the management options identified through this process.

In a watershed as large as the Grand River, there are a number of major problems and solutions that are common to each category for many of the sub-basins. These repeating components for each category have been summarized in Appendix I.

5.4.2 Major Categories of the Plan

There was an extensive listing of ideas under each of the categories mentioned in the previous section. For example, Table 5.8 provides a summary of all the major issues identified by the public through the planning process for each of the major divisions of the watershed. These issues are presented in their original form as the public at the meetings expressed them. There were a total of 288 issues of various complexities (including duplicate issues) outlined in the table. The number of issues per major division are outlined below:

- Mainstem (includes mainstem of all major sub-basins) (issues - n=124);
- Coldwater Tributaries (issues - n=39);
- Mixed Water Tributaries (issues - n=41);
- Warmwater Tributaries (issues - n=35);
- Reservoirs/Lakes and Ponds (issues - n=49)

The issues appear to fall into several broad categories that span the spectrum of physical, chemical, biological, social and economic concerns:

- Water Quality/Quantity Impacts;
- Inadequate Information;
- Ineffective Communication;
- Fish Habitat Impacts;
- Fish Population/Community Concerns;
- Competing Uses;
- Fiscal Constraints.

All these issues were summarized, reviewed and then condensed into a set of standard wording that captured the full range of issues identified for the all types of system within the watershed. A similar approach was done for all major divisions of the management plan report. The final standard wording list is attached as Appendix I.

- Fish community objectives
- Issues
- Management Strategies
- Management Tactics

Analysis of the issues in the various sub-basins suggests that there is a strong role for both fish population and habitat assessment work (i.e. inadequate information; fish population/community concerns) and a strong need to improve communications and interactions between the managers and anglers and between angling groups as well.

In almost every sub-basin, water quality and/or water quality/quantity are major issues. Of all the various sub-basins, water quality and quantity issues are the most pressing, it appears in the Conestogo and Nith sub-basins. From a management perspective, perhaps the “biggest bang for your buck” as it relates to restoration could occur with programs targeting non-point source inputs in these sub-basins. Fish habitat is also identified as a “best bet” for these two sub-basins.

Table 5.8: Summary of issues related to the implementation of the Grand River Fisheries Management Plan.

MAIN STEM

- water quality and quantity impacted by rural land use practices
- conflict between land drainage and sufficient summer base flows
- lack of information regarding impact of baitfish fishery on forage supply and on threatened and endangered fish species
- impact of Grand Valley Dam as a barrier to fish migrations, downstream movements of stream bedload and possibly increased water temperatures
- inadequate information on influence of flows from Luther Lake and their effect on local fish community and water quality
- lack of fish community objectives in those areas not capable of supporting a cold water fishery
- inadequate information on the improvements that could occur to the river following modification of operating procedures for Belwood reservoir
- insufficient information to indicate if natural reproduction of brown trout in area is presently occurring, where it is occurring, what factors might be limiting reproduction and uncertainty on how these fish can be protected
- inadequate information on the impact that a large predator population (e.g., brown trout) would have on other species
- inadequate information on the impact of pike and other predators on brown trout management efforts
- inadequate information on the genetic makeup of brown trout being stocked and the impact on resident fish (concern expressed that the genetic diversity in the brown trout population is being impacted)
- inadequate information on the impact of baitfish harvest activities on forage supply, sport fish populations and/or threatened and endangered species
- conflict between the flood control/low flow augmentation function of the reservoir and the habitat requirements of fish populations both in the reservoir and in the river downstream of the reservoir.
- potential for introduction of zebra mussels into Belwood Reservoir via boats and/or bait buckets
- concerns regarding public access (likelihood increasing as angler pressure in this zone increases)
- effect of old dams and impoundments on fish populations and fish habitat (barrier to fish migrations, downstream movement of stream bedload, possibly increased water temperatures)
- water quality impacted by urban landuse activities (e.g. sewage treatment plant effluents, stormwater effluents)
- water quality and quantity impacted by rural land use practices (e.g. excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows highly variable flows)
- public are not aware of impacts on water quality and sources of problems
- potential impact of stocking brown trout on brook trout in Swan and Carroll Creeks
- inadequate enforcement of existing regulations
- conflict between competing users of the water resource (e.g., recreational users other than anglers)
- fish resource is under-valued
- winter ice fishing in Belwood Reservoir constrained by public safety concerns
- impacts of current landuse with respect to sediments and nutrients, pollution, removal of riparian habitat
- impacts of specific tributary problems (e.g., Canagagigue Cr.)
- potential impact of municipal drain maintenance activities on the reproductive activities of pike and other species
- conflict between habitat requirements of fish and water level manipulations which are required to carry out the flood control/low flow augmentation functions of the Belwood Reservoir and the Conestogo Reservoir.
- inadequate information on the value and effect of flood plain enhancement to fish habitat diversity (e.g., Snyder Flats)
- impact of onstream ponds/dams in small tributary systems (affecting water quality and fish migration)
- inadequate information on fish communities (e.g., bass, vulnerable-threatened-endangered fish species
- inadequate information on the impact that various nutrient levels have on fish populations

- lack of data on the health of the smallmouth bass population (declining?)
- inadequate information on the impact of baitfish harvest activities on forage supply, sport fish populations and/or threatened and endangered fish species
- impacts of urbanization (e.g., water taking, sewage treatment plants, stormwater outfalls, etc. limiting water quality and fish habitat (I2)
- (perceived) concern regarding impacts to fish community by pre-season angling for smallmouth bass, impacts of local bass derby and impact of angling activities downstream of barriers and lack of information on the impact on fish community as a result of these activities
- inadequate information on the health of the smallmouth bass population and on the factors which may be limiting the productivity of this population
- inadequate information on the distribution and population size of vulnerable-threatened-endangered fish species
- inadequate information on the impact of baitfish harvest activities on forage supply, sport fish populations and/or populations of rare species of fish
- insufficient access to this section of river
- impact of onstream ponds/dams on main stem and small tributary systems on water quality and fish migrations
- public attachment to dams for historical or aesthetic reasons
- (perceived) steady decline in quality of smallmouth bass fishery
- impact of desired outcomes on vulnerable-threatened- endangered fish species
- (perceived) impact of water taking at the Mannheim Weir on downstream fish habitat
- water quality impacted by urban landuse activities (e.g. sewage treatment plant effluents, stormwater effluents)
- potential conflict exists between migratory rainbow trout (possibly pacific salmon) and resident brook and/or brown trout in the many accessible tributaries
- potential impact of exotic species if barriers removed
- achievement of the various fish community objectives is dependent on Penman's Dam (Paris) continuing or not continuing to be a barrier to migratory species. To a large extent, the integrity of this dam is out of our control.
- Wilkes Dam (Brant Park Conservation Area) likely acts as a barrier to non-trout fish species
- inadequate enforcement
- lack of information on the predicted impact of migratory rainbow trout on resident brook and brown trout population
- inadequate information on the impact of baitfish harvest activities on forage supply, sport fish populations and threatened fish species
- inadequate communication with municipalities regarding importance of resource and how impacts can be alleviated
- inadequate information regarding the need to provide access by alternate species around Wilkes Dam at Brant Park Conservation Area

Inadequate information:
- inadequate information on fish community and habitat conditions (particularly for walleye, migratory species and especially that section of the river from Brantford to Caledonia)
- distribution of vulnerable, threatened and endangered fish species
- genetic makeup ("uniqueness") of fish stocks (e.g., walleye)
- colonization and production of rainbow trout and impacts on other fish
- suitability of habitat to enable re-introduction of former species (e.g., muskellunge, sturgeon, forage fish)
- harvest of walleye between Brantford and Dunnville
- impact of bait fish industry on forage species

Conflicts:
- between commercial and recreational fishermen (e.g., setting of commercial fishing nets at the mouth of the Grand River, fish species sought by both users - channel catfish)
- between recreational users (i.e., anglers and boaters),
- among users of the water resources (e.g., water taking, effluent discharges, recreation)

- ethics related to dipnetting and spearing pike (target species) by recreational fishers
- use of regulations (e.g., sanctuaries) as a means of controlling illegal harvest of various species can impact on the legitimate fishing by some fishers during the specified time period

Access:
- inadequate access for recreational purposes (i.e. boat launches) especially between Cayuga and Calendonia

Communication:
- limited public knowledge regarding location of access points
- inadequate communication with municipalities &/or cottagers &/or communities regarding importance of resource and how impacts can be alleviated

Impacts:
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- water quality impacted by urban landuse activities (e.g., sewage treatment plant effluents, stormwater effluents)
- impact of dams as barriers to fish migrations; specifically Caledonia (all species except rainbow trout), Wilkes (only during low flows) [Dunnville - impact mitigated by fishway]
- ineffective fishway at Calendonia Dam [rainbow trout ascend over face of dam]
- health and survival of genetically-diversified and genetically-distinct fish stocks, such as walleye populations
- introduction and invasion of unwanted exotic species (e.g., ruffe, gobi, sea lamprey) and impacts on native species through deliberate/accidental introduction or migrations
- incidental catch of vulnerable or out-of-season fish species during the open season for pike
- inadequate compliance by anglers of angling regulations (especially related to fishing below barriers)
- inadequate enforcement in general to ensure compliance
- impact of harvest from fishing derbies on fish populations (e.g., walleye)
- incidental harvest of non-target species such as walleye and rainbow trout by recreational fishers using dipnets and spears
- restrictive regulations (i.e., closed season for trout in fall resulting in "wasted fishing opportunities"
- managing for one species may actually impact on others species (e.g., increasing muskellunge at possible expense of walleye)
- introduction and invasion of unwanted exotic species (e.g., ruffe, gobi) and the impacts such species have on native species (by deliberate/accidental introductions)
- water quality and quantity impacted by rural land use practices
- conflict between land drainage with its effect on sufficient summer base flows and fish habitat values
- inadequate communication with municipalities and communities regarding importance of resource and how impacts can be alleviated
- lack of information on fish community and habitat in tributaries and main river (e.g., harvest) and on impacts of introduced fish on indigenous and Threatened and Endangered species (e.g., silver shiner, redhorse sucker)
- lack of information regarding the ability of the tailwater reach below the Conestogo Dam to support a coldwater fishery
- impacts of current landuse (i.e., nutrients, temperature, sediment and loss of riparian zone)
- habitat is impacted by landuse activities (e.g., agricultural, sewage treatment plant effluents, etc.)
- inadequate knowledge transfer to public, partners, etc. regarding management initiatives to enable dialogue to occur (e.g., success of adult walleye transfers)
- insufficient information to enable evaluation of impacts of interactions among resident top predators
- conflict between landuse activities and use of flood plains as productive fish habitat
- insufficient information to develop fish community objectives
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- conflict between landuse activities and use of flood plains as productive fish habitat
- conflict between land drainage with its effect on sufficient summer base flows and fish habitat values

- potential impact of municipal drain maintenance activities on reproduction of northern pike and other species.
- inadequate information on the effectivenesss of the fishway at the New Hamburg Dam
- very little knowledge on the fish resources in the headwater areas
- few largemouth bass upstream of the New Hamburg Dam
- impacts of landuse with respect to nutrients, sediments, stormwater, etc.
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- water quality impacted by urban landuse activities (e.g., sewage treatment plant effluents, stormwater effluents)
- conflict between land drainage with its effect on sufficient summer base flows and fish habitat values
- potential impact of municipal drain maintenance activities on reproductive activities of pike and other fish species.
- conflict between landuse activities and use of flood plains as productive fish habitat
- lack of information regarding the fish community
- poor water quality at times results in river conditions, which are unaesthetic and may discourage anglers and canoeists.
- inadequate information on fish habitat conditions
- inadequate communication with municipalities &/or cottagers &/or communities regarding importance of resource and how impacts can be alleviated
- inadequate knowledge transfer to public and partners on various management initiatives (required to enable meaningful dialogue to occur - e.g., success of adult walleye transfers)
- lack of natural cover in the area to support desired fish community
- large number of mill dams and private ponds impact on water quality and migration
- impacts of current landuse (urban and rural) on habitat and water quality and quantity
- potential impact on resident fish community if exotic top predator (e.g., brown trout) is introduced
- vulnerability and dependency of a brown trout program to the operation of the Guelph Lake Dam
- inadequate information on existing fish community
- inadequate communication with municipalities and communities regarding importance of resource and how impacts can be alleviated
- inadequate information on potential impact that existing pike populations might have on efforts to introduce trout into these waters
- impact of Guelph Dam as a barrier to fish migrations, downstream movements of stream bedload and possibly increased water temperatures
- inadequate information on the impact of baitfish harvest on forage supply and/or on threatened and endangered fish species
- water supply needs for the City of Guelph and impact on water quality/quantity from a fisheries perspective

COLDWATER TRIBUTARIES

- current information on fish habitat conditions is inadequate
- former brook trout population has disappeared
- water quality is impaired
- potential impact between resident brook and brown trout and migratory salmonids (if they are allowed access to these streams)
- lack of information required to determine "state" of water course and major land use activities (habitat, water quality)
- water quality and quantity impacted by rural landuse activities (excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows)
- potential impact between land drainage activities and fish habitat (effect on sufficient summer base flows, sediment discharge etc)
- impact of onstream dams and impoundments on fish and fish habitat (barrier to fish migration, impact on downstream movement of sediment, water quality impacts, temperature impacts)
- inadequate information on fish communities and related habitat

- inadequate communication and knowledge transfer to public and partners on various management initiatives, importance of resource and how impacts can be alleviated
- potential impact on resident brook and brown trout community as rainbow trout colonizes streams
- introduction and invasion of unwanted exotic species (e.g., ruffe, gobi) and the impacts such species have on native species (by deliberate/accidental introductions)
- dependence of pumped water from Domtar Quarry to maintain cold water temperatures and whether abandonment of quarry would threaten this water supply
- invasion of beaver and potential impact on water quality and fish migrations
- impaired water quality and degraded habitat attributed to current land uses
- impact of urban development on ground water infiltration
- landuse impacts (increased nutrients, sediment, onstream ponds and barrier dams)
- beaver activity resulting in impacted habitat (barriers, pond creation) in some areas
- impact of onstream impoundments (Cedar Creek) on potential of coldwater fish population and fish habitat
- impact (competition) between migratory rainbow trout and resident brook trout
- lack of information regarding existing fish community and habitat conditions
- many of the above habitat type issues apply to these streams as well
- 'pristine' condition of Blue Springs Cr. could be impacted by landuse activities which could affect or impair existing conditions
- beaver activity could have a potential impact on water quality and could affect migrations, particularly on coldwater species
- inadequate public access to fishery
- potential impact of water taking for domestic purposes on the quality and quantity of Blue Springs Cr.
- water quantity impacted by rural land use practices (e.g. water abstraction for irrigation requirements vs. fish habitat requirements)
- divergent opinions among anglers regarding the management of rainbow trout vis-à-vis brown trout (should the fittest be allowed to survive or should these species be partitioned)
- inadequate information on the fish community and related habitat to evaluate the impacts of interactions among resident top predators
- perceived (actual?) conflict between rainbow and brown trout
- perceived (actual?) disappearance of mature trout
- inconsistent recruitment in the main channel due to instability of redd sites
- insufficient access to private property for anglers
- failure by some anglers to comply with special angling regulations
- water taking for irrigation purposes intercepting base flow
- excess sand and sediment instream from adjacent landuse
- potential conflict with Landon's Creek being designated a municipal drain
- degraded habitat in some reaches
- beaver activity on Landon's Creek creates problems with agricultural land drainage, downstream movements of stream bedload and possibly increased water temperatures.

MIXED WATER TRIBUTARIES

- water quality and quantity impacted by rural land use practices
- conflict between land drainage and sufficient summer base flows
- lack of information regarding impact of baitfish fishery on forage supply and on threatened and endangered fish species
- conflict between commercial bait fishing and recreational fishing objectives
- knowledge gap regarding base flows
- potential impact between land drainage activities and fish habitat
- impact of onstream dams and impoundments on fish and fish habitat (barrier to fish migration, impact on sediment movement, water quality impacts, temperature impacts)
- potential negative impact on resident brook and brown trout if migratory rainbow trout are allowed into these tributaries

- lack of information required to determine "state" of water course and major land use activities (habitat, water quality)
- other rural land uses (e.g., aggregate extraction) may affect function of system (e.g., groundwater flows, excess nutrients, riparian zone destruction, temperature impacts and sediment loadings)
- water quality in Laurel, Mill and Colonial Creeks is impacted by urban landuse activities (i.e. sewage treatment plant effluents, stormwater effluents)
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- large number of mill dams and private ponds impact on water quality and migration
- impact of various mill dams and private ponds on fish migrations, downstream movements of stream bedload and water quality (e.g., increased water temperatures)
- inadequate information on fish communities and related habitat
- inadequate information on use of habitat by vulnerable, threatened, endangered species
- introduction and invasion of unwanted exotic species (e.g., ruffe, gobi) and the impacts such species have on native species (by deliberate/accidental introductions)
- inadequate promotion of underutilized areas and species
- inadequate communication with municipalities and communities regarding importance of resource and how impacts can be alleviated
- impacts of current landuse on habitat and water quality
- current landuse results in highly variable flows
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- conflict between landuse activities and use of flood plains as productive fish habitat
- potential impact of municipal drain maintenance on reproductive activities of northern pike and other species
- inadequate communication with municipalities &/or cottagers &/or communities regarding importance of resource and how impacts can be alleviated
- impacts of dams and impoundments on fish migration, downstream movements of stream bedload, water quality and possibly increased water temperatures (particularly Hunsberger Creek and Firella Creek)
- landuse impacts (e.g., nutrients, sediments, etc.)
- conflicts between local residents and anglers (i.e., desire for a diverse warmwater fish community along with the need to protect downstream coldwater resources
- downstream impacts from Alder Lake on Alder Creek
- impacts of numerous on-stream dams and impoundments have negative impacts on Alder Creek
- many of the habitat type issues listed above also apply to these streams
- 'pristine' condition of Blue Springs Cr. could be impacted by landuse activities which could affect or impair existing conditions
- beaver activity could have a potential impact on water quality and could affect migrations, particularly on coldwater species
- inadequate public access to fishery
- potential impact of water taking for domestic purposes on the quality and quantity of Blue Springs Cr.
- impacts of landuse and land drainage on base flows, peak flows and water quality
- lack of communication with municipalities and land owners
- water taking for irrigation intercepting base flows
- inadequate information on fish habitat conditions, and fish community composition and distribution
- inadequate information on impacts of baitfish harvest on forage supply and/or on threatened and endangered fish species
- limited substrate diversity in areas of sand plain

WARMWATER TRIBUTARIES

- water quality and quantity impacted by rural land use practices
- conflict between land drainage and sufficient summer base flows

- lack of information regarding impact of baitfish fishery on forage supply and on threatened and endangered fish species
- perceived conflict between commercial bait fishing and recreational fishing objectives
- potential conflict between management options
- impacts of landuse and land drainage on water quality, peak and baseflows
- lack of communication with municipalities, landowners, other stakeholders regarding values of healthy aquatic systems
- online ponds act as barriers to fish movements and degrade water quality
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- impaired water quality acting as a constraint to recreational angling opportunities
- inadequate information on fish communities and related habitat
- inadequate information on use of habitat by vulnerable, threatened, endangered species
- introduction and invasion of unwanted exotic species (e.g., ruffe, gobi) and the impacts such species have on native species (by deliberate/accidental introductions)
- inadequate communication with municipalities and communities regarding importance of resource and how impacts can be alleviated
- water quality is impacted by landuse (e.g., excess nutrients, sediments, riparian zone destruction, temperature impacts)
- lack of communication with municipalities and communities in general regarding the importance of the resource and on means of alleviating the impacts
- lack of information regarding tributaries (i.e., provision of habitat, fish community, etc)
- conflict between land drainage with its effect on sufficient summer base flows and fish habitat values
- impacts of current landuse on habitat and water quality
- current landuse results in highly variable flows
- urban stormwater affecting habitat quality
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- lack of communication with municipalities and communities in general regarding importance of resource and how impacts can be alleviated
- conflict between land drainage with its effect on sufficient summer base flows and fish habitat values
- conflict between landuse activities and use of flood plains as productive fish habitat
- potential impact of municipal drain maintenance activities on reproduction of northern pike and other species.
- very little knowledge on the fish resources in the headwater areas
- impacts of landuse and land drainage on base flows and water quality
- lack of information regarding existing fish community and habitat conditions
- lack of communication with municipalities and landowners
- add other generic habitat type issues
- low public interest in catchment (inability of public to recognize potential or contribution that catchment makes to watershed as a whole)
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- inadequate communication with municipalities, landowners and the community at large regarding importance of the aquatic resource and how impacts can be alleviated
- high peak flows and large volume of woody debris (i.e., log jams) cause obstructions to flow

RESERVOIRS/LAKES

- conflict between recreational fishing activities and wildlife/waterfowl management goals
- conflict between commercial bait fishing and recreational fishing objectives
- population currently dominated by young perch which is impacting on forage fish community
- inadequate information on fish community
- management options are constrained by the requirements for operating water levels for wildlife values

- conflict between the habitat requirements of fish and the need to fluctuate water levels to perform flood control and low flow augmentation functions
- the quality and quantity of water entering the reservoirs is impacted by rural land uses (excess nutrients, sediment, riparian zone destruction)
- conflict between the desires of different types of smallmouth bass anglers ('trophy' vs non-trophy anglers)
- (perceived) lack of enforcement
- winter ice fishery constrained by concerns regarding public safety
- impacts of drawdowns on littoral zones
- specific issues:

Belwood:
- illegal harvest of concentrated fish in late fall (after drawdown occurs)
- inadequate structure in the littoral zone (related water level fluctuations)
- rooted aquatic vegetation minimal in littoral zone (unable to tie up nutrients)
- concern regarding possible introductions of exotic (undesired) species (e.g., crappie)

Mohawk:
- inadequate information regarding the ability of Mohawk Lake in Brantford to be improved in terms of habitat conditions to support diverse urban fishery
- insufficient information exists regarding the possible introduction of channel catfish
- water quality is impacted by landuse (e.g., excess nutrients, sediment, riparian zone destruction)
- lack of communication with municipalities, cottagers and communities in general regarding importance of resource and how impacts can be alleviated
- water quantity (i.e., lack of baseflow and conflict with land drainage
- lack of funding to maintain facility (Damascus)
- imbalance in fish community (e.g., stunted largemouth bass)
- management options are constrained by the management for flood control and flow augmentation
- constraint imposed on winter ice fishing in Conestogo Reservoir by public safety concerns
- increasing angling pressure both in summer and winter
- conflict with different user group interests (e.g. mill ponds fish habitat vs. aesthetics)
- inadequate information on fish habitat conditions required to determine if muskellunge or other suitable species could be introduced

Ponds:
- impact of various ponds on downstream fish communities (e.g., barrier to fish migrations, downstream movements of stream bedload and possibly increased water temperatures)
- increasing summer and winter angling pressure
- conflict among different user group interests
- imbalanced fish community in some ponds (e.g., stunted population of bass)
- water quality and quantity impacted by rural land use practices (e.g., excess nutrients, sediment, riparian zone destruction, temperature impacts, base flows, highly variable flows)
- water quality impacted by urban landuse activities (e.g., sewage treatment plant effluents, stormwater effluents)
- impact of on-stream ponds which act as heat sinks and barriers to fish migrations
- increasing angling pressure both in summer and winter
- conflict with different user group interests (e.g. mill ponds fish habitat vs. aesthetics)
- inadequate information on fish habitat conditions required to determine if muskellunge or other suitable species could be introduced
- limited public access to the many ponds (private access) which could constrain efforts to expand the fishery
- inadequate information on fish communities and related habitat
- impact of various dams as a barrier to fish migrations, downstream movements of stream bedload and possibly increased water temperatures
- introduction and invasion of unwanted exotic species (e.g., ruffe, gobi) and the impacts such species have on native species (by deliberate/accidental introductions)

- lack of clear objectives regarding operation/use of Taquanyah Reservoir
- degraded habitat
- act as heat and nutrient sinks
- operations of water control structures may impact on opportunities to manage fisheries
- dams impounding water act as barriers to fish migration
- ponds themselves have negative impacts on downstream fish populations and fish habitats
- some activities associated with the ponds (boating, water skiing, waterfowl populations, septic inputs from adjacent facilities) may cause negative impacts on fisheries within the ponds and downstream of the ponds.

5.5 Definition of Terms and Description of the Layout of the Plan

5.5.1 Definition of Terms

Base flow - flow primarily derived from groundwater discharge (not augmented by surface runoff)

BMP - Best Management Practices

Coldwater - summer water temperatures usually less than 22° C (prolonged water temperatures not exceeding 20° C) thereby capable of supporting a coldwater fish community provided other environmental factors are favourable

Coldwater fish species - fish species requiring coldwater usually not exceeding 20° C for prolonged periods of time during the summer months (i.e., trout, salmon, sculpins)

COSEWIC - Committee on the Status of Endangered Wildlife in Ontario

COSSARO - Committee on the Status of Species at Risk in Ontario

Geology - science which examines the earth, rocks of which it is composed and the changes which it has undergone or is undergoing

Geomorphological - pertaining to landforms, landscapes, their evolution and weathering (includes description, classification, origin, development and history of land surfaces)

Glaciolacustrine - pertaining to the deposits left by glacial lakes

Hydrology -science dealing with the properties, distribution and circulation of water on the surface of the land, in the soil and underlying rocks and in the atmosphere

Infiltration - movement of water from the surface into the ground (usually associated with groundwater inputs)

Mixed water - sections of streams having characteristics of both cold- and warmwater.

Moraines - accumulation of earth and stones (gravel and/or tills and clays) carried and finally deposited by a glacier

Physiographic - related to the origin and evolution of land forms

Threatened - indigenous species that are likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed [COSEWIC definition]

Vulnerable - species of special concern because of characteristics making them particularly sensitive to human activities or natural events (indigenous species at risk because of low or declining numbers, occurrence at fringe of its range or in restricted areas or for some other reason - but is not a threatened species) [COSEWIC definition]

Warmwater - characterized with summer water temperatures exceeding 22° C for prolonged periods thereby capable of supporting a warmwater fish community provided other environmental factors are favourable

Warmwater fish species - fish species more tolerant of prolonged warmwater temperatures exceeding 20° C during the summer months

5.5.2 Layout of the Plan

The following is an overview of the layout used in the Fisheries Management Plan:

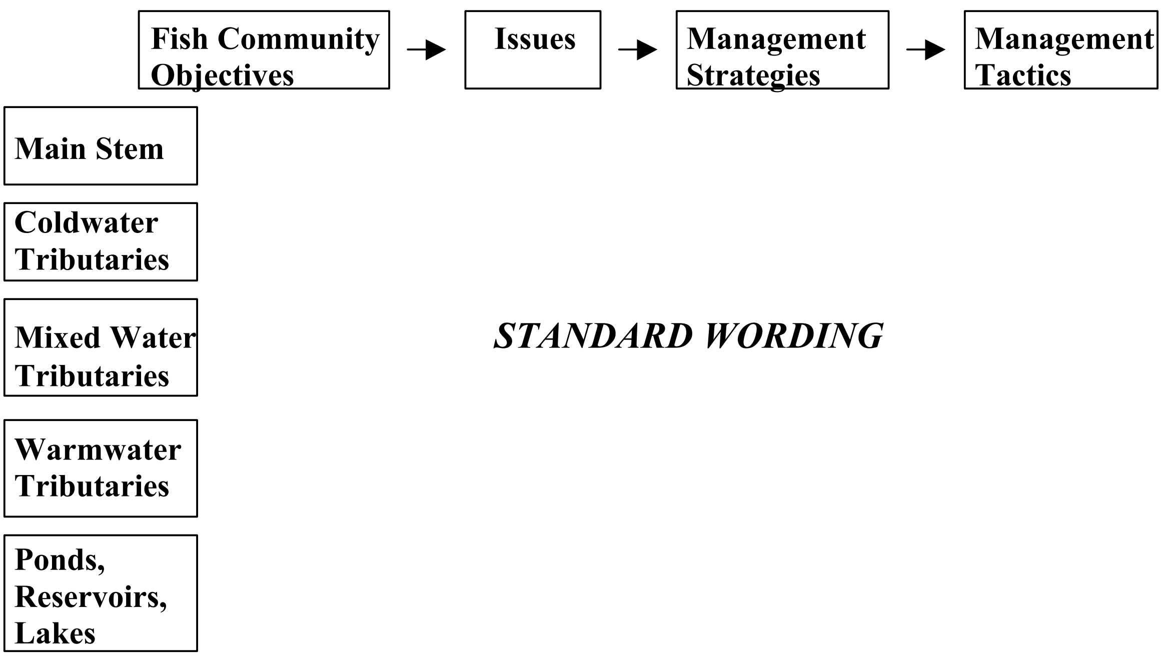

Figure 5.3: Layout and Major Themes used in the Grand River Fisheries Management Plan.

5.6 The Fisheries Management Plan

Refer to Appendix 4. The Grand River Fisheries Management Plan.

Appendix I: The final standard wording used for the GRFMP.

Fish Community Objectives

1. diverse warmwater fish community dominated by top predators (e.g., ____)
2. warmwater fish community composed of forage (minnow) species
3. stable forage base
4. coldwater fish community downstream of Grand Valley (if feasible),with emphasis on native brook trout
5. coldwater fish community with emphasis on native brook trout
6. coldwater fishery in tailwater of Conestogo Reservoir
7. diverse warmwater fish community
8. a stable warmwater fish community dominated by pike, smallmouth bass and walleye (?) in Conestogo and largemouth bass in Damascus
9. a seasonal coldwater fish community (i.e., migratory rainbow trout)
10. coldwater fish community in areas where geological and biophysical characteristics are present and habitat exists or has been rehabilitated
11. warmwater fish community
12. warmwater fish community in reaches that cannot support coldwater fish
13. self-sustaining coldwater fish community composed of resident brown trout
14. coldwater fish community composed of resident brook and brown trout
15. self-sustaining, high quality warmwater fishery (Mohawk Lake)
16. recognition that main stem is a migratory route for trout and salmon

Issues

1. **Water Quality/Quantity Impacts**

1.1 through rural landuse practices (e.g., excess nutrients, sediment inputs, riparian zone destruction, increased water temperatures, land drainage with related effects on summer base flows, water taking (for irrigation purposes) and effect on summer base flows)

1.2 Grand Valley Dam impoundment possibly increases water temperatures and interrupts downstream movements of stream bedload

1.3 through rural and urban landuse activities (e.g., excess nutrients, sediment inputs, riparian zone destruction, increased water temperatures, land drainage with related effects on summer baseflows, water treatment plant effluents, stormwater discharge, water supply and baseflow interactions, irrigation and effect on summer base flows)

1.4 act as heat and nutrient sinks (impacts on downstream sections)

1.5 from onstream ponds and barriers (e.g., Cedar Creek) on water quality (increased temperatures)

1.6 from aggregate extraction and resulting impact on groundwater movement and temperature

1.7 through urban landuse practices (e.g., excess nutrients, sediment inputs, water treatment plant effluents, stormwater discharge)

1.8 from adjacent landuse practices resulting in increased enrichment of receiving waters (e.g., increased aquatic plant growth, poor water quality)

1.9 potential impact of existing and future municipal water taking on baseflows

1.10 potential impact of existing and future ground water abstraction on baseflows

1.11 potential impact on water quality from aquaculture practices (e.g., effluent discharge, increased water temperatures

2. **Fish Habitat Impacts**

2.1 Grand Valley Dam acts as barrier to fish migrations

2.2 potential impact of municipal drain maintenance activities on reproductive success of pike and other species (e.g., isolating flood plain meadows or reducing the period that these areas are available as productive fish habitat)

2.3 impaired water quality, sediment release, unstable shoreline and loss of shoreline vegetation
2.4 conflict between landuse activities and use of flood plains as productive fish habitat
2.5 St. Jacob's weir as a barrier to fish movements
2.6 from dams and impoundments on fish migration, downstream movements of stream bedload, water quality and possibly increased water temperatures
2.7 former Greenfield Dam (specifically remnant concrete apron) acts as a seasonal barrier to migratory fish species and as an interceptor of sediment bedload
2.8 incremental losses of fish habitat due to various landuse activities
2.9 potential impact of onstream impoundments (e.g., Cedar Creek) on fish movements
2.10 loss of natural habitat due to channelization and stream bank hardening (urban encroachment)
2.11 despite having excellent water quality capable of supporting a coldwater fish community, instream habitat favourable to sustaining such a community is seriously degraded
2.12 from perched culverts on fish movements
2.13 effect of beavers through dam construction resulting in barriers to movement and thermal impacts
2.14 limited deep water overwintering habitat
2.15 inconsistent recruitment of brown trout due to instability of redd sites (limited to 'flashy' flows during incubation period)
2.16 reduction of shoreline roughness (e.g. plant removal; shoreline hardening)
2.17 geological constraints on fish habitat and community (e.g. bedrock controlled stream; groundwater discharge patterns)
2.18 potential for introduction of invasive exotics (e.g., zebra mussel) and/or undesirable fish species via boats and/or bait buckets and/or unauthorized stocking

3. **Inadequate Information**

3.1 on impact of baitfish fishery on forage supply and on vulnerable and threatened fish species
3.2 on influence of flows from Luther Lake and their effect on local fish community and water quality
3.3 on feasibility of establishing coldwater fish community downstream of Grand Valley
3.4 on fish habitat conditions
3.5 on water quality and base flows
3.6 on fish community
3.7 on location of public access points (main stem only)
3.8 on importance of resource and how impacts can be alleviated (with municipalities and within communities)
3.9 on fish community and related habitat
3.10 on impacts of introduced fish on indigenous and Vulnerable and Threatened fish species (e.g., silver shiner, redhorse sucker)
3.11 on the ability of the tailwater reach below the Conestogo Dam to support a sustainable coldwater fishery
3.12 on suitability of habitat to enable re-introduction of former species
3.13 on potential impacts and benefits of introducing top predators (e.g., walleye, channel catfish) on existing fish community (Conestogo Reservoir)
3.14 insufficient information to enable evaluation of impacts of interactions among resident top predators
3.15 on the success of the adult walleye transfer project
3.16 on the status of fish resources in the headwater areas
3.17 on the status of the fish community and condition of related fish habitat ***(see 3.9)***
3.18 on habitat conditions required to determine if __________ *(or other suitable species)* could be introduced
3.19 on angler harvest and use of fishery
3.20 on factors limiting natural reproduction of ________ (e.g., genetic, habitat, winter conditions, water quality)
3.21 on the value and effect of flood plain enhancement to fish habitat diversity (e.g., Snyder Flats)
3.22 on impact of baitfish fishery on game fish populations, forage supply, vulnerable-threatened fish species and related habitat
3.23 on the distribution/colonization of exotic species such as sea lamprey, zebra mussel, gobi, ruffe
3.24 on the genetic uniqueness of fish stocks

3.25 on impact of aquaculture operations on receiving waters and resident fish populations

4. **Fish Population/Community Concerns**
4.1 former brook trout population has disappeared
4.2 forage fish (minnow) community is currently dominated by young yellow perch
4.3 former warmwater top predator populations have disappeared
4.4 imbalance in fish community (e.g., stunted largemouth bass) in Damascus
4.5 potential competition between migratory rainbow trout and resident brook trout
4.6 fish community constrained by water quality impacts
4.7 brook trout population has been significantly reduced
4.8 lack of consensus regarding fish community objective
4.9 lack of mature brown trout due to angler harvest
4.10 potential impact of hatchery stocks on genetic integrity of native wild stocks (i.e., intentional stocking, escapees from aquaculture facilities)
4.11 potentially incompatible fish species and/or communities
4.12 real or perceived over-exploitation of gamefish
4.13 reduced spawning success of __________ due to a variety of factors (e.g., genetic makeup of stocked fish, impacted habitat conditions, winter effects such as ice)
4.14 (perceived) concern regarding impacts to fish community by preseason angling for smallmouth bass and impacts of local bass derby
4.15 potential competition between migratory rainbow trout and resident brown and brook trout
4.16 subject to periodic summer- and winterkill
4.17 (perceived) overharvest of smallmouth bass
4.18 potential impact of exotic species (e.g., sea lamprey, zebra mussel, gobi, ruffe) on fish communities
4.19 incidental catch of vulnerable or out-of-season fish species during the open season for pike
4.20 potential overharvest of fish species where/when they are vulnerable (e.g., fall congregation of smallmouth bass, fish stacking up below barriers)
4.21 (perceived) impacts of derbies/tournaments on local fish community
4.22 health and survival of genetically-diversified and genetically-distinct fish stocks
4.23 (potential) impact of baitfish fishery on coldwater fish communities through incidental catch and/or through illegal practice of “hardening” bait fish in confined sections of coldwater tributaries

5. **Competing Uses**
5.1 conflict between commercial bait fishing and recreational fishing objectives (perceived or actual)
5.2 conflict between recreational fishing activities and wildlife/waterfowl management goals
5.3 fisheries management options are constrained by managing reservoirs for flood control and flow augmentation
5.4 constraint imposed on winter ice fishing in Conestogo Reservoir by public safety concerns
5.5 operations of water control structures may impact on opportunities to manage fisheries
5.6 water supply vs base flows
5.7 unreasonable expectations (i.e., maintaining fishery in midst of residential development)
5.8 conflict between implementation of desired management options and tactics and other uses of the river
5.9 conflict between recreational fishing activities and private ownership (i.e., restricted access)
5.10 insufficient ice fishing locations to satisfy angler demand
5.11 conflict between competing users of the water resource (e.g., recreational users other than anglers)
5.12 competition for limited angling opportunities (e.g., guiding services and recreational anglers)
5.13 conflict between angler expectations (e.g., trophy vs harvest)
5.14 constraint imposed on angling opportunities by restrictive fishing regulations

6. **Ineffective Communication**
6.1 with municipalities and public in general regarding the importance of the resource and on means of alleviating the impacts

6.2 with municipalities, cottage users and public in general regarding importance of resource and how impacts can be alleviated
6.3 inadequate knowledge transfer to public and partners regarding management initiatives to enable dialogue to occur (e.g., success of adult walleye transfers)
6.4 low public interest in these waters (low public recognition of potential or contribution that catchment makes to watershed as a whole)
6.5 inadequate knowledge transfer to public regarding fisheries and angling opportunities (e.g., under-utilized resources)
6.6 inadequate knowledge transfer to public regarding Ontario Fisheries Regulations and management approaches (e.g., seasons, harvest limits, sanctuaries, possible Special Angling Regulation areas)

7. **Fiscal Constraints**
7.1 lack of funding to maintain and operate facility effectively (Damascus Dam)
7.2 inability to address impacts of impaired water quality and highly variable stream flows
7.3 lack of support to complete data analysis/documentation pertaining to Special Angling Regulations Study

Management Options

1. **Communication/Education/Partnerships**
1.1 improve communication with municipalities & landowners regarding landuse practices
1.2 develop land stewardship initiatives as a means of improving water quality
1.3 improve communications with municipalities, public, cottagers and landowners regarding landuse practices
1.4 consider other funding sources (e.g., private interests) (Damascus)
1.5 work with owners of dams and impoundments to eliminate or reduce the impacts of these features on downstream fish populations and fish habitat
1.6 consider developing a watershed plan for *(the Speed River and its)* these tributaries *[Habitat Mgmt/Rehab 3.13]*
1.7 encourage tributary restoration program (seen as extremely important in “big” picture)
1.8 promote and provide input into watershed plans
1.9 ensure that the water supply plan for the City of Guelph incorporates and addresses fisheries values
1.10 through partnerships, address water quality concerns associated with water treatment plants
1.11 through partnerships, develop and/or implement fisheries management strategies
1.12 improve communication with the public regarding regulations used to protect fish and their habitat
1.13 promote fishing opportunities directed towards underutilized fish species (e.g.,)
1.14 promote non-consumptive use of the fish resource
1.15 provide public education and awareness opportunities on the value of healthy aquatic ecosystems
1.16 formally recognize contributions that agencies, industry, partners, individuals have made in improving water quality and fish communities
1.17 improve communication with the baitfish industry regarding baitfish fishery practices as a means of resolving those which negatively impact resident fish populations
1.18 consult with the aquaculture industry (Ontario Aquaculture Association) as a means of developing techniques to address environmental concerns
1.19 review water quality concerns associated with aquaculture facilities with the Ministry of the Environment and Energy and explore possibilities of addressing these

2. **Data Collection /Assessment**
2.1 assess baitfish harvest and impacts on fish community, particularly on vulnerable and threatened fish species
2.2 assess habitat quality/quantity (actual/potential) ___________________________
2.3 assess condition of riparian zone

2.4 assess fish communities (including vulnerable and threatened fish species) and recommend actions to improve these ***(see 2.18)***
2.5 assess fish community (including vulnerable and threatened fish species such as silver shiner) ***(see 2.18)***
2.6 assess condition and limitations of habitat in the tailwater reaches below the Conestogo Dam with regards to the sustainability of a coldwater fishery
2.7 assess importance of municipal drains as fish habitat
2.8 assess habitat conditions and recommend candidates for rehabilitation
2.9 assess interactions among top predators
2.10 evaluate use of flood plains as productive fish habitat
2.11 assess value of ponds/dams to local communities & municipalities (consider removal of barriers if ponds are of little value)
2.12 review/evaluate existing operating regime of ponds and permitted uses in or adjacent to ponds to determine which are or are not appropriate
2.13 investigate actual competition between rainbow and brook trout and identify means of reducing this conflict
2.14 monitor impacts of aggregate extraction on groundwater
2.15 assess ability of watershed or portions thereof to support brook trout as the primary species with brown trout considered as a secondary species
2.16 assess feasibility of utilizing bottom draw at Guelph Reservoir as a means of supporting coldwater fishery (introduction - risk assessment necessary)
2.17 review status of existing fish community information, consolidate and implement program to address data gaps
2.18 assess impacts of online ponds (e.g., increased temperatures, water quality issues) and develop strategies to mitigate such impacts
2.19 evaluate success of walleye introductions (i.e., Puslinch Lake)
2.20 monitor angler success and impacts on fish populations
2.21 assess impacts of irrigation on base flows (i.e., in conjunction with MOEE)
2.22 assess colonization of watershed by migratory species from Lake Erie
2.23 assess effect of geological and hydrogeological characteristics on channel form, groundwater discharge and fish habitat potential
2.24 assess social and economic benefits associated with the fish resource
2.25 identify major spring discharge areas and tributaries
2.26 assess effectiveness of the New Hamburg fishway
2.27 monitor impact of municipal water abstraction on groundwater
2.28 assess effectiveness of Parkhill Dam (Cambridge) as a barrier to fish migrations (i.e., partition)
2.29 assess impact of Wilkes Dam on the fish community (i.e., effect on production, migration) *[recognizes that barrier provides water supply intake point for the entire City of Brantford - cannot be removed!)*
2.30 assess potential impacts of exotic organisms on resident fish communities
2.31 assess response of fish populations/communities to various fisheries management initiatives (e.g., habitat rehabilitation, fishways, fish population manipulation, regulation changes, etc.)
2.32 monitor commercial fishery and assess impacts on fish populations as they affect the recreational fishery (e.g., crappie, channel catfish)
2.33 monitor impacts of aquaculture facilities on water quality and on resident fish populations

3. **Habitat Management/Rehabilitation**
3.1 rehabilitate fish habitat with the objective of extending the coldwater attributes downstream of each system
3.2 work with GRCA regarding the operation of the Luther Lake Dam to ensure base flows are maintained throughout year
3.3 determine rehabilitation needs and prepare rehabilitation plans (instream and riparian zones)
3.4 restore riparian zone
3.5 improve water quality, riparian zones and fish habitat
3.6 improve water quality, establish stable flows and restore riparian vegetation

3.7 increase baseflow and reduce landuse impacts to benefit water quality
3.8 review operations of dams to determine opportunities for optimizing water levels with GRCA (recognize the engineering limitations)
3.9 improve water quality and baseflows downstream of reservoirs (to give managers the opportunity to optimize operations; i.e., a stable warmwater fish community benefits from these changes)
3.10 restore and maintain shoreline vegetation (Conestogo)
3.11 recognize and optimize use of floodplains as fish habitat (e.g., spawning habitat for pike)
3.12 consider modifications to/removal of existing barriers to fish passage
3.13 rehabilitate degraded habitat to restore functional system using the natural channel system approach
3.14 work with Alder Lake Committee to develop means of improving fish habitat in Alder Lake and of reducing or eliminating the negative impact of Alder Lake on downstream fish communities and fish habitats
3.15 improve quality of effluents from water treatment plants
3.16 protect groundwater and riparian zones to maintain water quality/quantity
3.17 improve overwintering habitat conditions
3.18 provide and maintain access to spawning and nursery habitat for trout
3.19 identification of limitations and options based upon geological constraints
3.20 habitat creation through development opportunities (e.g. aggregate extraction in reservoirs)

4. **Fish Population Management**
4.1 reintroduce brook trout *(and consider other candidate coldwater fish species such as brown trout)* once habitat is capable of supporting this species
4.2 review Luther Marsh Management Plan (1991) as it relates to baitfish
4.3 consider means of controlling yellow perch population
4.4 initiate risk assessment to evaluate species introductions (Conestogo)
4.5 consider amending Ontario Fishery Regulations to provide additional fishing opportunities as well as affording protection to vulnerable fish populations
4.6 reduce impacts of baitfish harvesting on non-target fish species
4.7 continue to manage for native brook trout
4.8 increase compliance with angling regulations
4.9 protect wild genetic stocks of fish
4.10 use of structures (e.g. dams) for partitioning incompatible fish species/communities
4.11 assess fish production in response to harvest and sustainability
4.12 extend brown trout populations and fishery downstream to West Montrose
4.13 review stocking plan (i.e., brown trout) vis-a-vis fish community objectives
4.14 preserve genetic stocks of self-sustaining fish populations
4.15 consider establishing an “exceptional waters” strategy for smallmouth bass and rainbow trout (between Highway 403 and upstream boundary of Brant Conservation Area)
4.16 design fishways and/or boat locks to minimize/prevent upstream passage of invasive organisms (e.g., sea lamprey, ruffe, gobi, etc.)
4.17 consider modifying the Ontario Fishery Regulations if assessment data on harvests indicates that a reduction in creel limits (e.g., rainbow trout 5→2, walleye 6→2) and/or size limits (e.g., maximum size limit for walleye) and/or other tactics are required to effectively manage the fish resource
4.18 reduce impacts of escapees from aquaculture facilities on resident fish populations

5. **Conflict Resolution**
5.1 resolve potential conflict among user groups (i.e., bait fishermen and recreational users)
5.2 between public desire for coldwater fishery and existing warmwater fish community
5.3 resolve conflict between land drainage and the importance of municipal drains as fish habitat
5.4 review operations of water control structures as part of a community action program *(specifically a re-examination of the operating curve with respect to the fish community)*
5.5 address conflicts regarding access to resource
5.6 resolve concerns regarding potential negative interactions between resident brown and migratory (seasonal) rainbow trout

5.7 resolve concerns regarding potential negative interactions between resident brook and brown trout
5.8 resolve conflicts amongst recreational users (e.g., anglers, boaters)
5.9 resolve conflicts regarding angler ethics (i.e., related to means of fishing **-** dip netting, spearing, etc.)

6. **Fiscal Opportunities**
6.1 implement programs to generate revenue that can be dedicated to fisheries programs/projects in the Grand River watershed

Management Tactics

1. **Communication/Education/Partnerships**
1.1 disseminate information on proper land management practices through workshops, meetings with landowners, demonstration sites, BMP Booklets & Fact Sheets, etc.
1.2 encourage land management incentive program (e.g., similar to Region of Waterloo project) to reduce nutrient and sediment inputs, thermal impacts and reestablish riparian zone
1.3 review management options required for a balanced fish community and initiate discussions with public to resolve outstanding issues
1.4 develop partnerships with municipalities to initiate and promote innovative land drainage and management as a means of protecting fish habitat
1.5 partners working with GRCA to take advantage of opportunities that may exist both in reservoir (habitat enhancement) and in operations
1.6 consider promotional opportunities and/or private funding (Damascus)
1.7 create an informed public (e.g., problems, awareness, education) to enable future communication regarding management decisions (e.g., Community Action Team, organized angler groups)
1.8 develop a watershed management plan (i.e., municipalities & GRCA)
1.9 identify opportunities to restore riparian vegetation and/or rehabilitate fish habitat (e.g., through development projects)
1.10 acquire equipment necessary to implement various tactics identified in the Fisheries Plan through partnership arrangements
1.11 use the water quality problems associated with __________ (*(e.g., on-stream ponds)* as a catalyst to get local communities to improve water quality and land management practices upstream of _____________ *(affected areas such as impoundments)*
1.12 initiate development of sub-watershed plans (partner municipalities and GRCA)
1.13 integrate municipal initiatives to improve habitat in urban areas (in River System Management and Strategy, City of Guelph)
1.14 encourage partners to become involved in monitoring and stream restoration projects
1.15 provide improved access to the resource through partnership arrangements (e.g., easements)
1.16 identify and promote public access points throughout watershed
1.17 encourage partners and public to report fishing violations and fish habitat destruction (e.g., Report a Poacher, Crime Stoppers)
1.18 disseminate information to anglers on angling ethics, fisheries management approaches and importance of fish habitat (e.g., River Watch Program, Fact Sheets, Public Service Announcements, Videos, etc.)
1.19 create working group to examine fish species interactions and make recommendations on best management approaches (e.g., whether partitioning/barrier is desired and if so, best means of doing so)
1.20 complete Special Angling Regulations Study and disseminate findings to partners and public
1.21 determine if there is a balance between reservoir operation and winter ice fishing
1.22 establish partnerships with universities as a means of undertaking studies to learn more about fisheries resources in the Grand River
1.23 work with the Regional Municipality of Waterloo to develop and implement an intensive program to monitor impacts of municipal water taking on stream baseflows
1.24 implement the recommendations of existing (e.g.,) and future watershed plans

1.25 work within existing Water Management Liaison Committee to review reservoir operations and develop methods of optimizing fish production in both the reservoirs and downstream reaches while still allowing for the intended functions of flood control and low flow augmentation
1.26 encourage interest groups, in conjunction with MNR/GRCA to initiate a “conservation limit” campaign for pike and bass
1.27 promote underutilized fishing opportunities, primarily for non-game species through brochures, derbies, etc.
1.28 promote and enhance opportunities for fish viewing at the Dunnville Dam fishway and at the Caledonia Dam (fishway)
1.29 continue to update the GRCA shoreline management plan which includes 25 km of nearshore habitat and tributaries flowing directly into Lake Erie within this area
1.30 formally recognize achievements that agencies, industry, partners and individuals have made in improving water quality and fish communities (criteria for awarding recognition and type of acknowledgment must be addressed prior to implementation
1.31 work with baitfish license holders to develop comprehensive baitfish management program
1.32 work with the Ontario Aquaculture Association to develop means to reduce impacts on water quality and on resident fish populations from the operation of aquaculture facilities

2. **Data Collection/Assessment**
2.1 establish mechanism to monitor harvest of baitfish and impacts on game fish, forage base and Threatened & Endangered species
2.2 assess water quality and habitat downstream of Grand Valley to determine capability of this section of the river to support brook trout
2.3 assess water quality and habitat to determine capability of creek to support brook trout
2.4 assess fish community ***(see 2.16)***
2.5 assess condition of riparian zone ***(see 2.16)***
2.6 assess habitat and monitor water quality (especially dissolved oxygen and temperatures throughout summer) with regards to the establishment of a coldwater fishery
2.7 assess fish community with emphasis on those waters upstream of Conestogo Reservoir
2.8 assess fish communities (including vulnerable and threatened fish species such as silver shiner)
2.9 assess potential interactions between existing warmwater fish community and coldwater fish species which could be introduced (e.g., food supply, habitat) = *risk assessment*
2.10 assess fish community and habitat conditions in tributaries and drains where little documentation has occurred
2.11 complete reservoir assessment, implement recommendations
2.12 evaluate integrity of local St. Jacobs weir
2.13 assess interactions of top predators
2.14 assess effectiveness of current walleye stocking initiatives
2.15 assess use of floodplain systems by fish
2.16 assess fish community (including vulnerable and threatened fish species), related habitat and adjacent riparian zone
2.17 undertake study to assess extent of colonization of watershed by rainbow trout
2.18 monitor status of coldwater fish communities (long term)
2.19 assess angler success (e.g., creel surveys, angler diaries)
2.20 evaluate potential as spawning/nursery habitat for migratory rainbow trout
2.21 assess the socio-economic benefits attributed to the fish resource
2.22 identify coldwater locations offering refuge from warmer temperatures (i.e., thermal refuges)
2.23 continue tagging and monitoring tag returns of walleye captured at the New Hamburg Dam
2.24 monitor impacts of aquaculture facilities on receiving waters and resident fish populations

3. **Habitat Management/Rehabilitation**
3.1 prepare habitat rehabilitation plan, which incorporates a natural channel design approach to identify priority areas for restoration *(in-stream habitat and riparian zone)*
3.2 rehabilitate degraded habitat *(as outlined in rehabilitation plans)*

3.3 support and implement Upper Grand River Watershed Plan & integrate fisheries management plan requirements into other resource management planning initiatives
3.4 operate valve at Luther Lake to ensure summer flows are augmented to meet fish community needs if possible
3.5 rehabilitate degraded habitat downstream of Grand Valley (dependent upon water quality and habitat assessment findings)
3.6 develop and apply municipal drain classification system as a proactive means of linking fish habitat protection to drainage activities
3.7 introduce policy, which can be applied to protect shoreline vegetation (Conestogo Reservoir)
3.8 consider removal of St. Jacob's weir dependent upon the evaluation of the integrity of this structure
3.9 restore riparian vegetation *(as outlined in rehabilitation plans)*
3.10 site restoration of former Greenfield Dam (i.e., barrier removal)
3.11 retrofit/remove reservoirs and mill dams/private ponds and restore site (if appropriate to fish community objectives)
3.12 improve overwintering habitat (i.e., through aggregate extraction and bedrock pool creation) (i.e., make deeper)
3.13 integrate fisheries management plan recommendations with the overall Grand River Watershed Plan
3.14 consider protection of thermal refuges
3.15 investigate the feasibility of enhancing the productive capacity of reservoirs to counteract the effects of drawdowns (i.e., retaining water in Nursery Bay, Belwood Reservoir)
3.16 implement nutrient control program (i.e., tie up nutrients in the food chain, establish marsh at upper end of reservoir)

4. **Fish Population Management**

4.1 reintroduce brook trout (if feasible) through adult transfers and/or upwelling incubation boxes once habitat is capable of supporting this species
4.2 review baitfish data currently available to ensure stable fish community (i.e., avoid over-harvesting resource and impacts on vulnerable and threatened fish species)
4.3 amend Luther Marsh Management Plan to incorporate fish community objectives in Luther reservoir and downstream
4.4 control yellow perch population (if feasible)
4.5 based on the findings from the study assessing interactions of introduced coldwater fish species, decisions will have to be made on whether this type of fishery can be established and if so, what species would be introduced and would it be self sustaining or artificially maintained
4.6 review literature to assess risk of introducing top predators (e.g., walleye, channel catfish) in Conestogo Reservoir
4.7 introduce top predator if the risk assessment study indicates this is feasible
4.8 evaluate and take actions on the recommendations from MNR's walleye assessment report
4.9 determine potential capability of creeks to support coldwater fish community and reconsider Fish Community Objective if this is not possible (i.e., change from cold to warmwater fish community) *[Data Collection/Assessment 2.4]*
4.10 continue to operate fishway at New Hamburg
4.11 consider extending open season for rainbow trout in main stem <u>only</u> (i.e., from October 1 to December 31)
4.12 consider reducing catch limit for rainbow trout to one fish/day
4.13 consider establishing seasonal sanctuaries (i.e., from October 1 to opening of trout season)
4.14 defer until water quality/quantity improves to the extent that fish communities can be maintained
4.15 consider banning the harvest of baitfish from coldwater systems
4.16 review recommendations of Special Angling Regulations Study with respect to protection of existing fish populations and implement appropriate regulation changes (e.g., extending Special Angling Regulations such as catch-and-release to other locations)
4.17 manage for wild genetic stocks (identify, assess, protect and manage)
4.18 use natural or manmade barriers as partitions for incompatible fish species and/or communities
4.19 consider increasing angling opportunities by extending the open season for brown trout (possibly to year-round fishing) in selected areas in conjunction with a catch-and-release regulation (i.e.,

extending existing angling regulation zone) *[related to the Grand River Tailwater Plan - in preparation]*

4.20 introduce regulations, if biologically defensible to protect and enhance the quality of smallmouth bass angling

4.21 implement “exceptional waters” strategy for rainbow trout and smallmouth bass by applying Special Angling Regulations approach (i.e., no-kill, single-barbless hook, no organic bait)

4.22 consider increasing angling opportunities for rainbow trout (e.g., extended open season) based on results of fish community, colonization and spawning/nursery habitat studies

4.23 modify fishway at the Caledonia Dam to improve fish passage of non-jumping fish species such as walleye

4.24 consider establishing open season for pike to be the same as that for walleye (i.e., January 1 → March 31, 2nd Saturday in May → December 31

5. **Fiscal Opportunities**

5.1 issue annual angling stamps on a voluntary basis as a means of generating revenue which can be dedicated towards the implementation of fisheries projects on the Grand River

6.0 PUBLIC INFORMATION MEETING RESULTS

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Through the sharing of information between representatives from angling business and conservation organizations and a series of open houses, or “town-hall” meetings, input was received on the state of the fishery and future enhancements were sought.

Two series of town-hall meetings were held January through March of 1996 and 1997. At the first set of public meetings (Phase I) the public was asked to provide input on the future of angling in the Grand River and its’ tributaries. A year later, at the second set of public meetings (Phase II) management options were presented for this fishery following technical review by the Ontario Ministry of Natural Resources (MNR) and the Grand River Conservation Authority (GRCA).

Phase I – Dates and Locations: all meetings ran from 7:00 to 10:00 p.m.

January 16, 1996	Brantford	Brant Artillery Club 2nd floor, 115 Henry Street
January 30, 1996	Kitchener	Bingeman Park 1380 Victoria Street North
February 6, 1996	Dunnville (District)	Hunters and Anglers Cons. Clubhouse, McLaughlin Sd.
February 13, 1996	Elora	Wellington Terrace Centre Wellington Drive
February 26, 1996	Arthur	Royal Canadian Legion 281 George Street

Phase I meetings consisted of: a presentation on the current fisheries situation on the entire length of the Grand River system and it’s relevance to Lake Erie (at the Dunnville meeting many comments and questions related to the Lake Erie fishery); group discussion of five questions on the past, present and future of the Grand River system (breakout sessions); and a question and answer session facilitated by GRCA and MNR staff.

The results from these meetings were collected in two forms: results from the -breakout sessions; and results from the open question and answer session. The question and answer session findings were compiled with results collected from public comment sheets. The submissions were virtually all positive in nature, with some expressing appreciation at having the opportunity to participate in the planning process.

A Communications Consultant was hired to review and compile all the public comments and also to prepare meeting notices and handle media relations for these meetings. A verbal summary was given by Charles Ross at each meeting, which allowed participants to hear and if necessary correct their input. In March of 1996 a *Summary of Comments* report (Appendix 5) was drafted that abridged all of the comments made based on the questions posed at the Open Houses.

The following is a brief overview of this report:

1. What kind of fishery exists now?

Anglers felt that the fishery represented a healthy, diversified fishery with both warm-water and cold-water species. There were concerns about excessive angling in well-known “hot spots”, urban refuse and restricted access.

2. What changes have you observed in the watershed?

There was a general consensus that water quality, levels and flows had improved and become more consistent but there was still room for improvement.

They had also observed an increase in recreational use, angling pressure (including poaching), and development in the watershed, which they felt was putting stress on the river system and the fishery.

Anglers also noted an increase in the geese, amphibian and invertebrate populations. They also felt that dam removal had resulted in an increase in migratory species and undesirable exotic species.

3. What issues are important in your area?

The public expressed many issues that were important to them. These issues were related to: increasing funding; access to the fishery; the fishery and the need for better control and regulation; fisheries enhancement; water quality and quantity; enforcement; and the ecosystem.

4. What can you or your organization do to help?

There were three areas in which the anglers and/or their organizations felt they could contribute to better management of the watershed. They believed they could help through: their involvement in activities (i.e., volunteer for rehabilitation projects); public education and awareness; and fund-raising.

5. What kind of fishery do you want?

The anglers voiced several points which needed to be addressed within the fisheries plan in order to give them the kind of fishery they were looking for. These points included: protective measures (i.e., more catch-and-release areas); improved management of steelhead access; water management (i.e., reservoir levels); increase fishing opportunities; better control and monitoring of the commercial fishery; increased enforcement (i.e., on dipnetting and spearing); community responsibility; and public education.

Overall the anglers wanted a healthy, diversified, self-sustaining fishery and ecosystem, which would produce edible fish.

The format of Phase I public meetings helped the credibility of the planning process. The breakout groups allowed the participants to be heard and to see their comments actually recorded. The summary at the end of each evening confirmed that their comments and /or concerns had been noted. The concerns and comments of all the participating interests were shared so no singular thrust i.e., give us only steelhead, could be pushed through.

This process was an exercise in finding a balance between sentiment and science. The questions raised and the technical evaluation of the needed information pointed to gaps, and therefore more information was required. Rather than pursue any one restrictive path, the working group decided to prepare options that would provide flexibility in meeting public demands. Taken into account in preparing those options are the ecological and physical characteristics of the river system and sound scientific information on fish species, their habitat preferences and the health of the entire aquatic ecosystem.

Some background information that ministry/agency representatives committed to preparing (i.e., migratory fish report, forage fish report, a history of fish stocking and genetic details) was not available as intended. Some elements and anecdotal information on these subjects was available and included in the drafting of the plan, other parts were deferred to further information required, but not lost. This flexibility made for a more realistic and cohesive working relationship rather than a feeling that one or two “experts” had all the answers. It pointed to what background information was required to be sought after or organized.

This planning process was combined with the observations and comments collected from the first set of town hall meetings as well as other information on the current users of the fishery and potential uses and demands on the river system, as a whole.

For instance, the needs of other recreational users had to be taken into account, as well as the continued residential and commercial growth in the Grand River system that will make increased demands on its water and water quality.

During the second set of public meetings (Phase II) the public was presented with management options for the future, which were drafted from the first set of public meetings. This was the publics' chance to decide which options they preferred before the preparation of the final draft of the fisheries management plan.

Phase II – Dates and Locations: all meetings ran from 6:30 to 10:00 p.m.

February 19, 1997	Kitchener	same location as Phase I
February 26, 1997	Brantford	same location as Phase I
March 5, 1997	Dunnville	same location as Phase I
March 19, 1997	Elora	same location as Phase I
March 27, 1997	Caledonia	Royal Canadian Legion 29 Caithness Street East

The agenda for the Phase II public meetings began with an introduction given by the host for that particular meeting location and then an overview was given by agency representatives. The overview consisted of topics such as physical limitations, desired outcomes, and watershed principles.

A flow chart of the Draft Plan was presented and reviewed with the attendants. Then, certain members of the steering committee representing either the MNR or the GRCA spoke about the highlights of the three zones of the watershed (Upper, Middle and Lower). The public was then asked to break into groups, which represented the geographic area of their interest.

Examples of specific issues that were discussed at the Phase II meetings were: the trout fishery below the Belwood Dam; the future of the Paris Dam; the need for a fishway at the Caledonia Dam; walleye management; and the impact of migratory species such as rainbow trout (steelhead) throughout the system.

Some of the publics general concerns and comments on the topics mentioned above are as follows:

- Need for better buffer strips along the river and major tributaries
- Muskie predation was a concern
- Interested in more information on VTE species, baitfish management, and walleye harvest (from Brantford to Dunnville) and also suggested getting this information into schools for youth education
- Wanted to promote fishing tournaments for awareness and economical benefits for particularly coarse fish (i.e., catfish and carp)
- Questioned whether baitfish should be harvested only in the spring and the fall, and felt that better regulations were needed

- Need for a committee to study the present fishery regulations and a questionnaire or survey was suggested
- Would like recreation opportunities maximized but not at the expense of the fishery
- Creel surveys are expensive and suggested Angler diary alternative
- Stewardship Councils incentive program to encourage conservation practices
- Proposed extension of rainbow trout season, catch and release season, size limits, lower limits, or slot limit possibilities
- Concern for impact of urbanization on future fish habitat
- Felt that walleye catch limit should be decreased for better management
- Concerned that as temperatures increase the walleye will move to deeper holes or move to cooler areas i.e. the Lake Erie
- Felt walleye protection was need at Caledonia Dam, possibility of enforcing a 25 yard restriction and extend ¼ mile
- Questioned the number of walleye tournaments in the lower river and also asked about the possibility of licensing
- Smallmouth bass, decline in numbers of larger fish - from Brantford to Glen Morris

The role of the MNR and GRCA in these group sessions was to present the management options and to facilitate opportunities for the public to give their input and documentation of comments. The public was asked: what they agreed with in the management options; whether they felt the agencies were on the right track; closure on acceptable recommendations; and what areas needed more work.

These options were then combined into a five-year plan. To a large extent, the plan is divided into “need to dos” and “nice to dos”, which were then presented to the public for further comment.

The fisheries management plan’s direction has been shaped by a steering committee of scientists and concerned users (anglers) and moulded by members of the public. It is a plan that is both deliverable based on a watershed and holistic approach, and one which meets the needs of the users of the river system.

7.0 FIVE YEAR ACTION PLAN (BEST BETS)

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Preamble

The Grand River Fisheries Management Plan was completed in 1998 to direct fisheries management activities in the Grand River watershed. The plan was prepared jointly by a committee composed of staff from the Grand River Conservation Authority and Ontario Ministry of Natural Resources, the Department of Fisheries and Oceans (DFO), from representative stakeholders from outdoor clubs, local universities, and the Six Nations of the Grand River.

As the plan was being developed, certain themes such as protecting and improving water quality through stewardship initiatives and improving stream habitat through community action became obviously the most important components to address and focus on. Some management activities identified in the plan required additional information collection, public consultation or refinement before they could be implemented. Other activities received strong public support and had obvious benefits with few or no negative repercussions associated with them. These are the "best bets" for immediate implementation, which are summarized below.

These include projects that have a high priority and a high likelihood of successfully sustaining and/or enhancing the fishery and the entire aquatic ecosystem. It was anticipated that funding would have to be sought out from both government and private sources because the plan could not be completed if it depended entirely on public funds. Overall, the "best bets" are those most likely to be achieved within the current operational plans of MNR and the GRCA, with the support of its partners and the private sector. This led to the development of the lead and support partners identified for each project given under the "Best Bets" (see Section 7.1).

The Best Bets are grouped under various headings based on type of action proposed. No attempt was made to prioritize management actions listed under each heading or one type of management activity over another. Many of the activities will be implemented as opportunities arise. An example would be structural habitat creation timed to take advantage of heavy equipment availability and lower costs when adjacent but otherwise unrelated land use activities take place.

Management actions associated with the Fisheries Plan are being conducted under the direction of the Grand River Fisheries Management Plan Implementation Committee (GRFMPIC). As new information becomes available, the GRFMPIC may endorse modifications to the scope, design, or implementation of individual projects. If changes are significant, the GRFMPIC may decide to submit the project to further public consultation. It should also be noted that some projects may be subject to further public consultation under Provincial or Federal Environmental Assessment requirements.

7.1 The Fisheries Management Plan "Best Bets"

Land Management

These are land stewardship activities that will benefit fish populations indirectly through improved water quality or quantity, reduced sedimentation, etc. (i.e. crop and manure management, buffers and cattle fencing).

Land Stewardship Incentive Program
Provide technical support and financial incentives for land stewardship activities, which would address water quality and habitat degradation problems throughout the watershed. The objective will be to reverse water quality and habitat degradation due to non- point sources of sediment and nutrients. Focus throughout the watershed, but priority will be for the Conestogo and Nith River watersheds, where impacts are the greatest and potential for improvement is the highest (best bang for the buck).
Lead: GRCA
Support: Environment Canada, MNR, municipalities (i.e., RMOW, Wellington, Brant, Guelph and others as they come on board)

Habitat Management

Activities that directly influence habitat structure in the waterbody or watercourse (i.e., dam removal, floodplain pool creation, channel rehabilitation, etc.).

Aquatic Renewal Program
Develop and facilitate a community based stream rehabilitation initiative. Projects will be largely implemented through voluntary action with funding support and technical support from dedicated staff. Highest participation is expected at urban and near urban coldwater streams in the Middle Grand watershed, but emphasis will not be restricted there.
Lead: MNR and GRCA
Support: DFO, community groups, Stewardship Councils, Environment Canada, GRFMP Action Committee and Sub Committees, MOE, NGO's, landowners, and Wildlife Habitat Canada

Dunnville/Port Maitland Habitat Initiative
Implement habitat initiatives recommended in the Dunnville Marsh Management Plan. Provide input to the federal harbour devolution process with the intent of implementing habitat enhancements where feasible.
Lead: MNR (Guelph), GRCA and MNR (LEMU)

Support: DFO, universities, ROM and community groups (i.e. Dunnville District Hunters and Anglers)

Small Dam Removal/Conversion Initiative
Utilize dam inventory data (see below) to develop a strategy to remove or modify small dams with the goal of reducing water temperatures and barriers to migration.
Lead: GRCA, municipalities, GRCA and MNR for private ponds
Support: MNR, DFO, municipalities, NGO's, GRFMP Action Committee, landowners, and community groups

Large Cover Placement - Grand River
Experimental project to secure boulder clusters, large trees, stumps, root wads to selected channel and bank sections of the Grand River between Elora and West Montrose to enhance channel structure and provide cover for brown trout.
Lead: MNR and GRCA
Support: DFO, community groups, Stewardship councils, Environment Canada, GRFMP Action Committee, MOE, NGO's, landowners, and Wildlife Habitat Canada

Coldwater Refuge Enhancement - Middle Grand
Identify groundwater discharge zones in the middle reaches of the Grand River (e.g. Grand River - Cambridge to Brantford, Nith River - Ayr to Paris) and determine utilization by salmonids. If feasible, modify flow characteristics and channel structure to enhance suitability as salmonid habitat.
Lead: dependent on the project
Support: any interested party among licensees, GRFMP Action Committee, MNR, GRCA, Universities, DFO, NGO's, MOE, developers, landowners and municipalities

Reservoir Habitat Enhancement
Dike selected embayments on large reservoirs to enhance fish and wildlife production without compromising water management objectives. Use Nursery Bay (Belwood Lake) as a pilot project and demonstration site.
Lead: GRCA
Support: MNR, DFO, and NGO (i.e. Ducks Unlimited)

Municipal Drain Initiatives
The goal is to devise a classification scheme to into, which, all agricultural drains can be categorized according to their fish habitat sensitivity. The application of drain classifications requires knowledge of flow (permanent/intermittent), temperature regimes (cold/cool/warm water), habitat characteristics, and existing fish populations.
Lead: GRCA and DFO
Support: MNR, NGO's (i.e., DSAO) and municipalities

Fish Community Management

The following are activities that involve direct or indirect manipulation of the fish community (i.e., fish stocking or introductions, wild stock transfers, fishways, barriers).

Caledonia Fishway Improvements
Modify existing fishways or create additional fish passage facilities at the Caledonia Dam that would allow passage of native non-jumping fish species (e.g. walleye, suckers, mooneye) and facilitate passage of rainbow trout, yet prevent or minimize passage of harmful exotic species.
Lead: MNR (Guelph)
Support: GRCA, DFO, Six Nations, and NGO's

Barrier Maintenance
Recognize the Penman's Dam (Paris) as a logical partition point between resident fish species and Lake Erie migrants until structural deterioration results in its failure as a fish barrier. Where feasible and practical (i.e. if funding is not prohibitive), actively maintain the Parkhill Dam (Cambridge) as a barrier to migratory fish species from Lake Erie.
Lead: MNR (Guelph)
Support: GRCA and DFO

Native Species Reintroduction Initiatives
Implement reintroduction of desirable native species (e.g. VTE species, sturgeon, and muskellunge). This strategy will only be implemented after completion of Feasibility studies and introduction strategies (see Section 6).
Lead: MNR (Guelph)
Support: MNR (Lake Erie), GRCA, and NGO's

Regulatory Actions

The following initiatives include creation, modification, or enforcement of fishery regulations.

Extended Fall Fishery: Rainbow Trout
Implement an extended fall angling season for rainbow and brown trout (to December 31) in the Grand River upstream to Highway 2. [from 25m (82ft.) downstream of Wilkes Dam in the city Brantford, downstream to the edge of Lake Erie – see 2001 Recreational Fishing Regulations Summary for more information]
Lead: MNR (Guelph)
Support: MNR (Lake Erie), GRCA and NGO's

Trout Stream Sanctuaries
Implement a fall/winter fish sanctuary (October 1 to opening day of trout season) on coldwater streams to protect vulnerable spawning trout.
Lead: MNR (Guelph)
Support: NGO's and GRCA

Lower Grand River Pike Season
Modify the existing open season for pike in the lower Grand River (Caledonia to Port Maitland) to provide increased protection to pre-spawning and spawning fish. This also

includes prohibiting the practice of spearing and dipnetting. The season would be closed from March 31 to the second Saturday in May.
Lead: MNR (Guelph)
Support: GRCA, MNR (Lake Erie) and NGO's

Smallmouth Bass Special Regulation Zones
Create special angling regulation zones (catch and release) in the Grand River to increase catch success and average size of fish caught. The most suitable candidate sites are located in the middle Grand River watershed.
Lead: MNR (Guelph)
Support: MNR (Aquatic Ecosystem Science Section), NGO's, municipalities, GRCA, public, landowners and universities

Extension of Existing Trout Special Regulation Areas
Expand the boundaries of the existing special regulations areas for trout on Whitemans Creek and the Grand River at locations that do not conflict with family fishing opportunities (e.g. Inverhaugh Flats downstream to West Montrose).
Lead: MNR, GRCA and MNR Lake Erie Management Unit (LEMU)
Support: DFO, community groups, Royal Ontario Museum (ROM), MNR (LEMU), universities and consultants

Voluntary Conservation Limits
Implement a program to establish voluntary "conservation limits" (minimum size or slot limits, reduced possession limits) at popular reservoirs to develop trophy-fishing opportunities.
Lead: MNR (Guelph) and GRCA
Support: NGO's and municipalities

Special Regulations at Rehabilitation Sites
Implement catch and release at specific coldwater streams in conjunction with habitat restoration activities in order to facilitate recovery and response of the trout population to improved habitat.
Lead: MNR (Guelph)
Support: GRCA, NGO's and municipalities

Exceptional Waters
An Exceptional Water is a river or lake of exceptional quality that is managed as a community resource providing unique outdoor experiences for anglers and other outdoor recreation interests while promoting environmental sustainability and health. The approach to this initiative is to provide technical criteria, environmental management options and marketing options to support the community and its' Exceptional Water.
Lead: GRCA and MNR
Support: DFO, universities, municipalities, landowners, Watershed Science Centre, NGO's and Six Nations

Extension and Promotion

Activities that serve or educate the public or promote underutilized recreational opportunities.

Ecosystem Awareness Program
Utilize a variety of forums and media (schools, outdoor shows, demonstration sites, Internet, brochures, etc.) to increase public support for fisheries management goals through awareness of the value of a healthy aquatic ecosystem and presence of indicators of a health environment (e.g. presence of trout in urban streams).
Lead: GRCA and MNR
Support: NGO's, Six Nations and DFO

Aquatic Resources Centre(s)
Establish a multi-purpose educational, recreational, and tourism facility that facilitates and promotes fisheries related tourism opportunities. The facility should also serve as an environment/ecological education facility for local schools and community groups. Incorporate additional features where feasible to create interest or educational opportunities (e.g. artificial stream channel, fish hatchery, fly fishing museum, and tourism kiosk).
Lead: NGO's
Support: GRCA, MNR, DFO and municipalities

Public Access Development and Signage
Establish a network of public access sites (parking lots, boat or canoe launch ramps, etc.) along the river complete with signs to guide anglers.
Lead: GRCA
Support: MNR (Guelph), NGO's and municipalities

Expanded Distribution of Data, Reports, and Guides
Utilize a variety of media (internet, displays at outdoor shows, newsletters, signage, kiosks) to provide the public access to fisheries technical information (e.g. fishway counts, results of population studies, species range distributions, access guides, etc.).
Lead: GRFMP Implementation Committee
Support: MNR, GRCA, DFO, NGO's and Six Nations

Promotion of Underutilized and Urban Fisheries
Utilize a variety of media (as above) to promote utilization of underutilized fish species (e.g. channel catfish, mooneye, and redhorse) and underutilized fisheries. Emphasis will be placed on urban and youth fishing opportunities.
Lead: MNR (Guelph) and GRCA
Support: NGO's and municipalities

"Grand Slam" Angler Awards Program
Establish an angler recognition/awards system (similar to the Master Angler Program) that will generate interest in the fishery, promote underutilized species and foster

conservation ethics. Anglers will be required to catch and release fish of a minimum size on a bronze/silver/gold gradation based on the number of species caught.
Lead: MNR (Guelph) and GRCA
Support: NGO's and municipalities

Planning and Information Management

Studies, plans, or data collection required before further management action can be taken.

Integration of Fisheries Plan and Watershed Plan
Use fish community goals as targets within an overall plan that integrates the two above documents.
Lead: GRCA
Support: MNR (Guelph)

Establish Long Term Data Monitoring Programs
Monitor fish community health through the use of strategic index measures to be collected annually (i.e. Dunnville and/or Caledonia fishway data, strategic biomass stations, redd counts, etc.).
Lead: MNR and GRCA
Support: universities, DFO, Watershed Science Centre, NGO's, baitfish industry, consultants, ROM, municipalities and MNR (LEMU)

Grand R. Tailwater Management Plan
Finalize the development of a detailed (5 or 10 year) plan to manage the trout fishery of the tailwater section of the Grand River below Shand Dam. The Plan will include strategies for genetics research, regulations, population measures, marketing and promotion, barrier maintenance or removal, etc.
Lead: MNR (Guelph)
Support: GRCA, NGO's (especially Friends of the Grand) and municipalities

Conestogo R. Tailwater Fishery Feasibility Study
Establish a working group to determine the feasibility, benefits and consequences of establishing a high profile put-and-take trout fishery below the Conestoga Reservoir. The plan will be prepared with the principle that any fishery created must not be at the expense of the native fish community.
Lead: MNR (Guelph)
Support: GRCA, NGO's and municipalities

Migratory Salmonids Management Strategy
Establish a working group to develop a detailed plan (5 or 10 year plan) to manage migratory salmonids in the lower and middle reaches of the Grand River and in its major tributary, the Nith River. The Plan will include strategies for facilitating or preventing migration where appropriate to maximize production in a way that does not impact native

species. The plan will include strategies for information collection (genetics, index biomass stations), fish passage, prevention of access to vulnerable native fisheries, etc..
Lead: MNR (LEMU), GRFMP Implementation Committee
Support: NGO's, Six Nations, MNR (Guelph), community groups and DFO

Lake Sturgeon Recovery Plan
Investigate the feasibility of enhancing a self-sustaining lake sturgeon population in the Grand River watershed. Include strategies for information collection (e.g. genetics, habitat evaluation, etc.), fish passage, monitoring etc.
Lead: MNR (LEMU) and GRFMP Implementation Committee
Support: NGO's, Six Nations, MNR (Guelph), community groups and DFO

Muskellunge Recovery Plan
Investigate the feasibility of establishing a self-sustaining muskellunge population in the Grand River watershed as above.
Lead: GRCA and MNR (Guelph and/or LEMU)
Support: MNR (STU), GRCA, universities and NGO's (i.e. Muskies Canada)

Fish Habitat Protection and Management Plan
Develop a detailed fish habitat protection and management plan for the watershed plan.
Lead: MNR and/or GRCA (variable partners could assume lead depending on project)
Support: GRFMP Action Committee, MNR, GRCA, universities, DFO, NGO's, MOE, developers, landowners, municipalities and licensees

Information Needs Strategy
Develop a plan that prioritizes and coordinates information required to manage the Grand River fishery (e.g. creel surveys, fishway assessment, temperature data collection, population estimates, etc.). Include roles and responsibilities, identify partners, and establish a schedule.
Lead: MNR and GRCA
Support: universities, DFO, Watershed Science Centre, NGO's, baitfish industry, consultants, ROM, municipalities and MNR (LEMU)

Dam/Pond Inventory Initiative: Coldwater Streams
Initiate a detailed inventory of ponds and dams that may have a negative impact on trout populations. Include recommendations for management action.
Lead: MNR (Guelph)
Support: GRCA and DFO

Baitfish Management Review
Conduct a review of the baitfish management program in the Grand River watershed with the input and participation of bait industry representatives. Include recommendations for management action that addresses problems and issues.
Lead: MNR (Guelph)
Support: Ontario Baitfish Association, MNR (Fisheries Section) and universities

Restoration Plans for VTE Fishes at Risk
Develop a plan for protection and restoration of VTE fish species. Include recommendations for management action.
Lead: MNR (Guelph)
Support: MNR (Lake Erie), GRCA, NGO's and BAO (Baitfish Association of Ontario)

Ice Fishing Management and Promotional Strategy
Develop a plan for management of ice fisheries in the Grand River watershed. Priorities should be public safety and resource sustainability.
Lead: GRCA (GRCA property) and MNR (Guelph)
Support: Cottage associations and NGO's

Implementation

Planning, coordination, and facilitation of fisheries management activities (includes fund raising).

Implementation Steering Committee
Establish a steering committee composed primarily of action-oriented members of the public (business and community leaders) to guide coordination of implementation projects. The group will establish a terms of reference, track progress, demand accountability of resource managers and generally crack the whip.
Lead: GRCA and MNR
Support: DFO and any agency or group

Marketing Strategy to Fund Implementation
Develop a marketing strategy to assist in promotion of watershed fisheries and solicit funding from the private sector.
Lead: GRFMP Implementation Committee (Marketing Sub-Committee)
Support: any interested group or agency and variable on the project

Fisheries Plan Promotional Package
Develop a multi-media package to promote the fisheries plan, implementation projects, and marketing strategy.
Lead: GRCA Implementation Committee
Support: MNR, GRCA, DFO, NGO's and Six Nations

Voluntary "Fisheries Stamp" Program
Implement a voluntary stamp program that would be issued with angling licenses to raise funds for the fisheries initiatives outlined above. Ensure transparency and accountability.
Lead: GRCA
Support: GRFMP Implementation Committee, Wildlife Habitat Canada, DFO (Ottawa) and Ground River Foundation

Table 7.1:Summary of the estimated funds required for the Grand River Fisheries Management Plan "Best Bets" from the year 2000 to 2004.

Titles	2000	Actual	2001	Anticipated	2002	2003	2004	Total
Land Management								
** LandStewardship Incentive Program*	75,000.00	0	75,000.00	0	125,000.00	175,000.00	75,000.00	375,000.00
Habitat Management								
** Aquatic Renewal Program*	100,000.00	40,000.00	100,000.00	11,000.00	100,000.00	150,000.00	150,000.00	451,000.00
** Dunnville /Port Maitland Habitat Incentive*	50,000.00	0	50,000.00	0	50,000.00	50,000.00		100,000.00
Small Dam Removal/Conversion Initiative	25,000.00	0	25,000.00	0	25,000.00	50,000.00	50,000.00	125,000.00
** Large Cover Placement - Grand River*	125,000.00	0	50,000.00	100,000.00	100,000.00	100,000.00		300,000.00
Coldwater Refuge Enhancement - Middle Grand	35,000.00	0	35,000.00	0	35,000.00	35,000.00		70,000.00
Reservoir Habitat Enhancement	100,000.00	0	100,000.00	0		100,000.00	100,000.00	200,000.00
** Municipal Drain Initiatives*	70,000.00	70,000.00	65,000.00	65,000.00	65,000.00			200,000.00
Fish Community Management								
** Caledonia Fishway Improvements*	50,000.00	50,000.00				450,000.00		500,000.00
Barrier Maintenance	100,000.00	0				100,000.00		100,000.00
Native Species Reintroduction Initiatives	15,000.00	0				15,000.00	15,000.00	30,000.00
Regulatory Actions	50,000.00	0	50,000.00	0	25,000.00			25,000.00
Extended Fall Fishery: Rainbow Trout	completed							
Trout Stream Sanctuaries	completed							
Lower Grand River Pike Season	completed							
Smallmouth Bass Special Regulation Zones	2,500.00	2,500.00	completed		2,500.00	2,500.00		7,500.00
Extension of Existing Trout Special Regulation Areas	2,500.00	2,500.00	completed					2,500.00
Voluntary Conservation Limits			5,000.00	5,000.00				5,000.00
Special Regulations at Rehabilitation Sites								
** Exceptional Waters*	125,000.00	105,000.00	75,000.00	19,000.00	50,000.00	50,000.00		224,000.00
Extension and Promotion								
** Ecosystem Awareness Program*	10,000.00	0				10,000.00	10,000.00	20,000.00
Aquatic Resources Centre (s)							250,000.00	250,000.00
** Public Access Development and Signage*	100,000.00	0	100,000.00	50,000.00	100,000.00	100,000.00	150,000.00	400,000.00
Expanded Distribution of Data. Reports and Guides	10,000.00	0	10,000.00	0	10,000.00	25,000.00	15,000.00	50,000.00
Promotion of Underutilized and Urban Fisheries					2,500.00	2,500.00	2,500.00	7,500.00
"Grand Slam" Angler Awards Program	25,000.00	0	5,000.00	0	25,000.00	5,000.00	5,000.00	35,000.00
Planning and Information Management								
Integration of Fisheries Plan and Watershed Plan								
Establish Long Term Data Monitoring Programs	50,000.00	50,000.00		50,000.00	100,000.00	100,000.00		300,000.00
Grand River Tailwater Management Plan	2,500.00	2,500.00						2,500.00
Conestogo River Tailwater Fishery Feasibility Study					10,000.00			10,000.00
Migratory Salmonids Management Strategy	20,000.00	20,000.00	50,000.00	50,000.00	100,000.00			170,000.00
Lake Sturgeon Recovery Plan						10,000.00		10,000.00
Muskellunge Recovery Plan						10,000.00		10,000.00
Fish Habitat Protection and Management Plan	5,000.00	5,000.00	40,000.00	40,000.00	40,000.00	40,000.00	40,000.00	165,000.00
** Information Needs Strategy*	50,000.00	0	75,000.00	0	50,000.00	75,000.00		125,000.00
Dam/Pond Inventory Initiative: Coldwater Streams	15,000.00	15,000.00	10,000.00	10,000.00				25,000.00
Baitfish Management Review					5,000.00			5,000.00
Restoration Plans for VTE Fishes at Risk	40,000.00	40,000.00	15,000.00	15,000.00	65,000.00	30,000.00		150,000.00
Ice Fishing Management and Promotional Strategy					5,000.00	5,000.00		10,000.00
Implemetation								
Implementation Steering Committee	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	10,000.00
Marketing Strategy to Fund Implementation					1,000.00	1,000.00	1,000.00	3,000.00
Fisheries Plan Poromotional Package	35,000.00	0	35,000.00	35,000.00	25,000.00			60,000.00
** Voluntary "Fisheries Stamp" Program*	42,500.00	17,000	7,500.00	0	7,500.00	7,500.00	7,500.00	39,500.00
Total	1,332,000.00	421,500	979,500.00	452,000	1,125,500.00	1,700,500.00	873,000.00	
							Grand Total:	**4,572,500.00**

* = High Priority

GRCA April 18, 2001

8.0 IMPLEMENTATION PLAN

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8.1 Process Used to Develop the Plan

The Grand River Fisheries Management Plan (GRFMP) released in November 1998 represents the combined efforts of various resource management agencies and several organizations. The GRFMP Steering Committee became the GRFMP Implementation Committee (GRFMPIC) in February of 1999 and continued to worked together in a partnership arrangement to develop the Grand River Fisheries Implementation Plan, which was a follow-up to the FMP (i.e., indicated what the priorities for implementation of the tactics should be).

The GRFMP sets out fish community objectives, identifies issues related to the achievement of these objectives and finally outlines management strategies and tactics that can be implemented to address the issues. The plan is somewhat unique, as it has been created on a reach and sub-basin level for the entire watershed (i.e., Upper, Middle and Lower Reaches + Conestogo, Speed, Nith and Horner/Whitemans Creek Sub-Basins). Also, waters have been characterized by type within each of these geographic areas thereby making it possible for anyone to learn more about the fishery and what needs to be done for virtually any watercourse or body within the entire watershed. The types of water were broken down into the following: main stem; coldwater tributaries; mixed water tributaries; warmwater tributaries and reservoirs/lakes/ponds.

The overall direction for managing the fish resource and fisheries of the seven components of the watershed are contained within the GRFMP. However, the Fisheries Plan does not provide an implementation schedule to indicate what could be done by priority and which agency or organization would be best suited to undertake such work.

The Grand River Fisheries Implementation Plan was created to provide a specific focus on the tactics identified in the overall (original) plan. Specifically, it indicates where the tactics should apply, which organizations are likely to take the lead followed by a listing of who the partners likely should be to help implement the tactic. Other information presented in the Implementation Plan includes an estimate of the cost to implement each tactic, the time frame for doing so, general comments to help clarify the tactic and finally, an indication of the priority assigned to the tactic.

Priorities are arranged as being high, medium/high, medium, low/medium and low. The priority ranking provides an indication of the importance of the tactic on a broad scale. These priorities provide an indication of where an emphasis should be applied when contemplating actions. Having stated this, the priorities should be used as a guide and no tactic should be turned down if an interested party is interested in implementing a tactic that has been identified as having a low priority.

The GRFMP Implementation Plan has been prepared through the Grand River FMP Implementation Committee composed of the following partners:

- Ontario Ministry of Natural Resources (Guelph District, Southcentral Science & Technology Unit, Lake Erie Management Unit),
- Grand River Conservation Authority,
- Department of Fisheries and Oceans (Canada),
- Six Nations (Wildlife Management),
- Brantford Steelheaders,
- Caledonia Bait and Tackle,
- Dunnville District Anglers and Hunters,
- Friends of the Grand River,
- Ontario Federation of Anglers and Hunters,
- Ontario Streams,
- Ontario Steelheaders
- Trout Unlimited/Izaak Walton Fly Fishing Club.

These partners for the most part were all present during the preparation of the fisheries management plan itself and are committed to seeing the plan implemented.

The Grand River Fisheries Management Plan and the Implementation Plan have been created to be dynamic documents. They are meant to provide direction not only to those who are responsible for managing the resource but also to those who can influence land-based activities that can affect the water resources of the watershed that the fish depend upon. The Fisheries Management Plan and the Implementation Plan provides the means whereby anyone who is interested in the well being of the fish resource of the Grand River watershed can become involved. Through the Implementation Plan, it is now possible to provide a coordinated approach and a means of documenting achievements related to the implementation of the plan.

8.2 Major Tactics

The tactics outlined in the Implementation Plan are indicated below. These are the tactics appearing in this plan. Priorities for implementation are not indicated below but are available in the Implementation Plan itself (Appendix 6).

8.2.1 General Strategies

General Strategies refer to those strategies that are applicable both across the watershed and all reaches and sub-basins as well as applicable to all agencies and partners.

- Formally recognize achievement agencies, industries, partners and individuals have made in improving water quality and fish communities.
- Assess the socioeconomic benefits attributed to the fish resource.
- Create and then promote special interest stamps (fish theme) directed towards the Grand River as a means of generating revenue, which can be dedicated towards the implementation of fisheries projects on the Grand River.
- Use water quality problems as a catalyst to get local communities to improve water quality and land management practices in upstream reaches.
- Promote the values of cold water systems to the public as a means of obtaining support for efforts being undertaken to protect and rehabilitate them.
- Create an informed public (i.e., problems, awareness, and education) to enable future communication regarding management decisions (i.e., Community Action Team, organized angler groups).
- Consider promotional opportunities and/or private funding.

8.2.2 Partnerships

Partnership can be a loaded word. Here, partnerships refer to the individuals, groups, other agencies, businesses, municipalities and others who work co-operatively together as equals in the implementation of the Grand River Fisheries Management Plan. Partnership as used here also refers to a sharing of responsibility, successes and occasionally failure in the management of the Grand River fisheries. Partnership in this context does not mean devolving of responsibility to others but a sharing of work. It is a dynamic process that is in constant flux.

Partnerships (Municipalities, Local Communities, General Public)

- Develop partnerships with municipalities to initiate and promote innovative land drainage and management as a means of protecting fish habitat.
- Integrate municipal initiatives to improve habitat in urban areas (i.e., outlined in River System Management and Strategy, City of Guelph or Kitchener).
- Identify opportunities to restore riparian vegetation and/or rehabilitate fish habitat (i.e., through development projects).
- Encourage partners to become involved in monitoring and restoration projects.
- Establish partnerships with universities as a means of undertaking studies to learn more about fish resources in the Grand River.
- Establish partnerships with the baitfish industry to review and/or modify harvest strategies and develop communications package regarding such practices.
- Develop partnerships with the aquaculture industry to develop means of reducing impacts on water quality and on resident fish populations from the operation of

aquaculture facilities.

8.2.3 Planning

Although many do not realize it, we live in a society where planning is a major tool in the decision-making process for all elements of our society. Municipal and watershed planning are critical processes for ensuring that the fisheries management plan is implemented in an integrated manner with other interests of society. As well, many of the reach and sub-basin specific plans for fish management were not completed through the overall GRFMP process, but were deferred to a later date. These reach level plans need to move forward as the next level of fisheries planning through the overall implementation process for the FMP.

Plan Implementation/Linkages

- Integrate fisheries management plan recommendations with the overall Grand River Watershed Plan.
- Support and implement Watershed and Sub-Watershed Plans and integrate fisheries management plan requirements into other resource management planning initiatives.
- Complete and implement the Grand River Tailwater Fisheries Management Strategy (includes extending the Special Angling zone downstream, consider extending open season for brown trout in conjunction with catch-and-release provisions, etc.).
- Create Migratory Salmonid Management Working Group to examine fish species interactions and make recommendations on best management approaches (i.e., whether partitioning/barrier is desired and if so, best means of doing so). *[committee focus being expanded to include all migratory fish that move from Lake Erie to the Grand]*

8.2.4 Fish Habitat

Without a home, animals cannot survive. Habitat management, protection and restoration is perhaps one of the most important strategies for fisheries management in the watershed. A healthy river and lake environment where the population of fish is maintained through natural reproduction is one of the most important principles upon which the GRFMP is founded. Fish habitat management strategies are sub-divided into the key themes of: knowledge acquisition and management/protection and rehabilitation.

Fish Habitat (Knowledge Acquisition)

- Assess water quality (especially dissolved oxygen and temperatures throughout the summer) and habitat to determine capability of area to support specified fish species.
- Determine potential capability of creeks to support coldwater fish community and reconsider Fish Community Objective if this is not possible (i.e., change from cold to warmwater fish community).

- Identify coldwater locations offering refuge from warmer temperatures (i.e., thermal refuges).
- Assess fish community and related habitat and adjacent riparian zone.
- Assess fish community and habitat conditions in tributaries and drains where little documentation has occurred.
- Assess use of natural and rehabilitated floodplain systems by fish.

Fish Habitat (Management/Protection/Rehabilitation)

- Investigate various options to protect and maintain coldwater inputs and thermal refuges.
- Develop and apply municipal drain classification system as a proactive means of linking fish habitat protection to drainage activities.
- Develop and implement an intensive program to monitor impacts of municipal water taking on stream baseflows.
- Prepare habitat rehabilitation plan, which incorporates a natural channel design approach to identify priority areas for restoration (instream habitat and riparian zone).
- Rehabilitate degraded habitat (as outlined in rehabilitation plans or should adhere to an accepted prescription as a minimum in the absence of rehabilitation plans).
- Improve over-wintering habitat.
- Integrate fish habitat restoration/rehabilitation/creation into wildlife habitat management projects (i.e., shoreline works to improve habitat for waterfowl, construction of satellite open water marshes).
- Enhance fish populations and habitat through flood plain rehabilitation projects.
- Restore riparian vegetation (as outlined in rehabilitation plans or should adhere to an accepted prescription as a minimum in the absence of rehabilitation plans).
- Evaluate integrity of weirs.
- Retrofit/remove reservoirs and mill dams/private ponds and restore site (if appropriate to fish community objectives).

8.2.5 Fish Populations/Communities

Although habitat is the critical element that we hope to protect and restore within the Grand River watershed, individuals, communities and anglers focus on the results of healthy aquatic environments, the fish. Sound management of fish populations requires good information, measures to protect communities of fish from various activities that may impair their survival and the management of specific species of interest to anglers. Strategies for the management of fish populations and communities are sub-divided into the following components: knowledge acquisition; general; migratory species (general); rainbow trout; brown trout; brook trout; walleye; northern pike; smallmouth bass; muskellunge; and yellow perch.

Fish Populations/Communities (Knowledge Acquisition)

- Assess status of the fish community (includes coldwater species).

- Assess interactions of existing top predators.
- Assess risk of (re) introducing top predators (i.e., potential interactions, food supply, habitat requirements, etc. between existing fish community and top predators such as muskellunge and northern pike, which could be introduced).
- Assess potential/actual interactions between migratory coldwater fish species and the existing warmwater fish community (i.e., food supply and habitat).
- Continue to monitor fishways *(*also see tactic regarding tagging and monitoring tag returns).

Fish Population Management – General

- Manage for wild strains of fish (identify, assess, protect and manage).
- Review management options required for a balanced fish community and initiate discussions with public to resolve outstanding issues.
- Use natural or manmade barriers as partitions for incompatible fish species and/or communities.
- Based on the findings from studies assessing possible interactions of introduced coldwater fish species, decisions will have to be made on whether this type of fishery can be established and if so, what species would be introduced and would it be self-sustaining or artificially maintained.
- Introduce top predator if risk assessment indicates this is feasible.
- Continue to operate existing fishways.
- Defer action until water quality/quantity improves to the extent that fish communities can be maintained.
- Determine potential capability of creeks to support coldwater fish community and reconsider Fish Community Objective if this is not possible (i.e. change from cold to warmwater fish community).

Fish Population Management – Migratory Fish Species (General)

- Create Migratory Salmonid Management Working Group to examine fish species interactions and make recommendations on best management approaches (i.e., whether partitioning/barrier is desired and if so, best means of doing so). *[committee focus being expanded to include all migratory fish that move from Lake Erie to the Grand]*
- Modify fishway to improve fish passage of non-jumping fish species (e.g., walleye).

Fish Population Management – Rainbow Trout

- Evaluate potential as spawning/nursery habitat for migratory rainbow trout.
- Undertake study to assess extent of colonization of watershed by rainbow trout.
- Consider increasing angling opportunities for rainbow trout (i.e., extended open season) based on results of fish community, colonization and spawning/nursery habitat studies.
- Consider extending open season for rainbow trout (i.e., from October 1 to December 31).

- Consider reducing catch limit for rainbow trout to one fish/day.
- Implement "exceptional waters" strategy for rainbow trout and smallmouth bass by applying Special Angling Regulations approach (i.e., no-kill, single-barbless hook, and no organic bait).

Fish Population Management – Brook Trout

- Reintroduce brook trout (if feasible) through adult transfers and/or upwelling incubation boxes (once habitat is capable of supporting this species).

Fish Population Management – Brown Trout

- Assess effectiveness of current brown trout program.
- Complete and implement the Grand River Tailwater Fisheries Management Strategy (includes extending the Special Angling zone downstream, consider extending open season for brown trout in conjunction with catch-and-release provisions, etc.).

Fish Population Management – Walleye

- Evaluate and take actions on the recommendations from MNR's walleye assessment report.
- Assess effectiveness of walleye stocking initiative.
- Modify walleye stocking procedure if the assessment indicates that current practices are ineffective.
- Continue tagging and monitoring tag returns of walleye captured at the Dunnville Dam.

Fish Population Management – Yellow Perch

- Control yellow perch population (if feasible).

Fish Population Management – Smallmouth Bass

- Investigate and implement means to improve the quality of the smallmouth bass fishery and the fish community as a whole (i.e., through voluntary or regulatory changes if biologically defensible)
- Review recommendations of Special Angling Regulations Study with respect to protection of smallmouth bass populations and implement appropriate regulation changes (i.e., extending Special Angling Regulations such as catch-and-release to other locations).
- Implement "exceptional waters" strategy for rainbow trout and smallmouth bass by applying Special Angling Regulations approach (i.e., no-kill, single-barbless hook, no organic bait).

Fish Population Management – Muskellunge

- Assess risk of (re) introducing muskellunge (i.e., potential interactions, food supply, habitat requirements, etc.).

Fish Population Management – Northern Pike

- Consider establishing open season for pike, which protects spawning adults during the closed season (i.e., open season being from Jan. 1 to March 1 and from the 2nd Saturday in May to Dec. 31).
- Assess risk of (re) introducing northern pike (i.e., potential interactions, food supply, habitat requirements, etc.).

8.2.6 Managing Potential Impacts

A variety of additional impacts that may affect our ability to manage the fisheries of the Grand River were identified.

Baitfish

- Establish and implement mechanism to monitor harvest of baitfish and assess impacts on the fish community.

Aquaculture

- Monitor impacts of aquaculture facilities on receiving waters and resident fish populations.
- Develop means to reduce impacts on water quality and on resident fish populations from the operation of aquaculture facilities.

Reservoir Management

- Complete reservoir assessment and implement recommendations.
- Work within existing Water Management Liaison Committee to review reservoir operations and develop methods of optimizing fish production in both the reservoirs and downstream reaches while still allowing for the intended functions of flood control and low flow augmentation.
- Investigate feasibility of enhancing productive capacity of reservoir to counteract the effects of drawdowns.
- Implement nutrient controls (i.e., tie up nutrients in the food chain, establish marsh at upper end of reservoirs).
- Introduce policy, which can be applied to protect shoreline vegetation.
- Determine if there is a balance between reservoir operation and winter ice fishing.
- Amend/append Luther Marsh Management Plan (1991) to incorporate fish community and habitat considerations.

- Operate valve at Luther Lake to ensure summer flows are augmented to meet fish community needs if possible.

Land Management

- Disseminate information on proper land management practices (workshops, meetings, demonstration sites, BMP Booklets/Fact Sheets).
- Encourage land management incentive program (i.e., similar to Region of Waterloo project) to reduce nutrient and sediment inputs, thermal impacts and reestablish riparian zone.

8.2.7 Angler Use

The GRFMP process enabled all participants to realize that there is only one Grand River watershed and that its' ability to provide specific opportunities is limited. The participants realized that there were a variety of fish of interest to anglers in the Grand River watershed. In some cases, the preferred species for some anglers was at odds with the species of interest to other anglers. Participants recognized that individual angler interests, ethics and practices must be understood and managed in a way that ensures the best possible river for angling and at the same time recognizes the diversity of interests for fishing opportunities and the finite nature of the fishery and the watershed. These ideas are reflected in the following strategies.

Angling (Knowledge Acquisition)

- Promote angler diary program to obtain information on the fisheries
- Assess angler success (i.e., creel surveys, angler diaries).

Angler Ethics/Practices

- Encourage interest groups, in conjunction with MNR/GRCA to initiate a "conservation limit" campaign.
- Encourage partners and public to report fishing violations and fish habitat destruction (i.e., Report a Poacher, Crime Stoppers).
- Disseminate information to anglers on angling ethics, fisheries management approaches and importance of fish habitat (i.e., River Watch Program, Fish and Wildlife Guardian Program, Fact Sheets, Public Service Announcements, Videos, etc.).

Angler Harvest Management

- Promote underutilized fishing opportunities, primarily for non-game species through brochures, derbies, etc.
- Consider implementing a conservation limit for ice fishing.
- Complete Special Angling Regulations Study and disseminate findings to partners

and public.
- Review recommendations of Special Angling Regulations Study with respect to protection of existing fish populations and implement appropriate regulation changes (i.e., extending Special Angling Regulations such as catch-and-release to other locations).
- Expand the Special Angling Regulation zone (includes catch-and-release fishing and restricting gear to artificial lures with barbless hooks).
- Consider establishing seasonal sanctuaries (i.e., from October 1 to opening of trout season).
- Introduce regulations, if biologically defensible to protect and enhance the quality of recreational angling (i.e., reduced limits, size limits, catch-and-release, close walleye season from March 15 to second Saturday in May).

Angler Access

- Provide improved access to the resource through partnership arrangements.
- Identify and promote public access points throughout the watershed.
- Provide signage at all access points informing anglers of regulations concerning bass angling and other species (i.e. brown trout).

8.3 Formation of the Matrix and Flow Chart

Once the Grand River Fisheries Management Plan was completed, the need was identified to have various questions addressed prior to full implementation of the tactics identified in the plan itself. Specifically, the following needs existed:

- Who would assume the responsibility for specific components of the plan and commit to implementation?
- Who would assume a leadership role - several agencies or groups for implementing various tactics?
- Which members or partners would agree on the lead and who would provide a support function?
- Which organization, group or members would be actively involved in project implementation?
- What amount of funds could be directed to various projects and where would these funds originate from?

The shear number of projects identified in the Grand River Fisheries Management Plan as well as in the Implementation Plan necessitated the need to set priorities for projects, which could be implemented in the short term. The Implementation Committee developed a short list of projects (Best Bets). From the list of Best Bets, priorities were then established (See Chapter 7). This was done with the cooperation of the Grand River Foundation committee.

The Grand River Foundation was established in 1965 (known as the Grand Valley

Conservation Foundation until 1996). A board of volunteers from the private sector directs the Foundation, who ultimately offers the Foundation many forms of active involvement. The main objective of the Foundation is to assist the enduring efforts of the GRCA by means of providing both support and a funding resource. As a registered charity they have facilitated projects such as: the reconstruction of 12 active GRCA Conservation Areas; acquisition and construction of 3 Rail-Trails for hiking and biking; and fisheries rehabilitation projects.

Once the priorities were set, working groups were asked to commit to certain actions, to identify potential projects listed in the "Best Bets" and to assign projects to willing sponsors.

The implementation plan was developed to give anyone reviewing the document, a sense of where help was required, who would take the lead and support roles, the target location for the project and the cost associated with the implementation. It was a way of spreading out the accountability as well as providing a place for the public to show leadership and become involved. It doesn't matter whether you're a politician; biologist or interested angler, the overall GRFM Plan along with the Implementation Plan was developed to include everyone and to provide a system where each could identify their specific interest.

Preliminary funding requirements were identified in the implementation plan in order to establish a guide for estimating the costs of each strategy and as a guide for future budgeting and work planning.
In addition, the layout for the Implementation Plan documented a time frame for completion and a gauge of each priority, which is now used to develop annual agency work plans from. Just as important, it provides an overview for others outside the GRFMP process to review, integrate and align their future priorities with (i.e. Water Managing Group). This leads to a much more coordinated and integrated approach to the overall Grand River Watershed Plan.

The overall planning of the matrix and flow chart was patterned on the Grand Strategy's Work Plan layout for the Water Managers Working Group. The layout used for the Implementation Plan is provided in Figure 8.1.

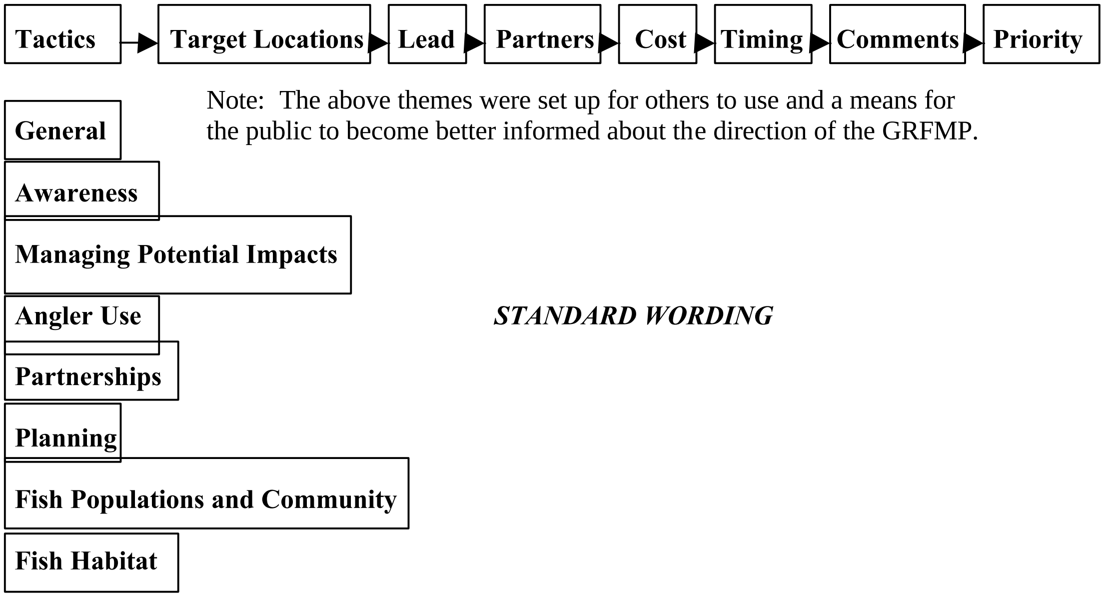

Figure 8.1: Layout and Major Themes used in the Grand River Fisheries Implementation Plan.

8.4 The Draft Implementation Plan

See Appendix 6. Grand River Fisheries Implementation Plan.

8.5 Issues Related to Implementation

The true success of any plan is its implementation. There are many instances of good plans being developed but never being implemented. All partners in the GRFMP process saw the planning process only as a means to a specific end. The end being the implementation of the agreed-to plan. With that in mind, a great deal of thought was given as to how the plan was to be implemented. A number of issues were identified that could impede implementation of the plan. Some of the issues identified include:

- sources of funding;
- adequate funding;
- need for broader awareness of the plan within the watershed;
- need for strong linkage between the fisheries plan and other planning and management initiatives within the watershed;
- strong linkage of the plan to other Great Lakes basin plans (i.e. Lake Erie Management Plan);
- a more strategic approach to the collection and acquisition of information on the fisheries;
- a more strategic approach to the acquisition of science and new knowledge.

It was felt that in order to have an effective implementation plan, a committee would have to be established to guide the implementation process. Some of the criteria or major components necessary in an effective implementation plan and committee are outlined below:

- the implementation plan had to be ultimately "owned" by the anglers and communities;
- the Implementation Committee would be comprised of non-agency people (i.e. users of the resource) with MNR and GRCA participating as resource people;
- overall facilitation may be with agency staff to ensure consistency and support, but actual implementation of local projects must be directed by the anglers themselves;
- overall committee would set priorities for projects;
- promote tasks that could be done;
- prepare (or oversee the preparation of) status reports;
- solicit funds from public, private and corporate sectors to be directed towards implementation of tactics recommended in the plan.

8.6 Role of the Implementation Committee

The Grand River Fisheries Management Implementation Committee was formed in February of 1998. The primary role of the Implementation Committee was to oversee the implementation of the "Best Bets" (See Chapter 7), and to give direction and support for management actions associated with the Fisheries Management Plan. It is also the responsibility of the Implementation Plan Committee to oversee how the tactics outlined in the Implementation Plan are being implemented and to report back to the committee on progress made in implementing those various tactics.

At the time the Fisheries Management Plan was at the stage where implementation approaches needed to be considered, two separate task teams were created from interested members of the Implementation Committee. One task team was required to address marketing, and the other to put in place an action plan.

This initiated the forming of the Marketing Sub-Committee and the Action Sub-Committee chaired by Gary Allen (Trout Unlimited/Izaak Walton Fly Fishing Club) and Larry Mellors (Ontario Steelheaders) respectively. Many more partners became involved in undertaking of various initiatives involved within these Sub-Committees.
The active Implementation Committee members and their affiliations are as follows:

Co-Chairs	**Representation**
Warren Yerex	Grand River Conservation Authority (GRCA)
Mitch Wilson (acting Area Supervisor)	Ministry of Natural Resources (MNR) – Guelph
Mr. Larry Mellors (Chair of the Action Sub-Committee)	Ontario Steelheaders/Brantford Steelheaders
Mr. Gary Allen	Trout Unlimited/Izaak Walton Fly Fishing Club

(Chair of the Marketing Sub-Committee)

Ms. Lorraine Normington	Ontario Streams
Mr. Mike Pettigrew	Caledonia Bait and Tackle
Mr. Mike Warrian	Trout Unlimited Canada
Mr. Russ Piper	Ontario Federation of Anglers and Hunters
Mr. Ken Collins	Friends of the Grand River
Mr. Walt Crawford	former representative of Ontario Streams
Mr. Paul General	Six Nations (Wildlife Management)
Mr. Otto Lemke	Ontario Federation of Anglers and Hunters
Mr. Felix Barbetti	Dunnville District Anglers and Hunters
Mr. Norm Smith	DFO (Sarnia)
Ms. Shelly Dunn	DFO (Burlington)
Ms. Trish Nash	GRCA
Mr. Sean Geddes	GRCA
Mr. Art Timmerman	MNR – Guelph District
Mr. Al Murray	MNR – Guelph District
Mr. Craig Selby	MNR – Guelph District
Mr. Brad Gerrie	MNR – Guelph District
Mr. Larry Halyk	MNR – Guelph District
Mr. Jack Imhof	MNR – Guelph, Fish and Wildlife Branch
Mr. Joad Durst	MNR – Niagara District
Mr. Trevor Friessen	MNR – London District
Mr. Drew Cherry	member at large

The roles and responsibilities of the Implementation Committee and its two Sub-Committees are as follows:

Implementation Committee

- For representatives from the MNR and GRCA to act as resource people providing technical expertise and financial coordination.
- To manage and set priorities for the projects.
- Promote tasks that could be done and be involved in the work planning initiatives.
- Prepare or oversee the preparation of status reports.
- Solicit funds from corporate sector to be directed towards implementation of tactics recommended in the plan.

Marketing Committee

- To work closely with the Grand River Foundation.
- To solicit funds needed to implement the recommendations.
- To approach large corporations to fund “Best Bets” and pass dollars down to Action Committee.
- To approach the new Provincial Foundation to raise funds for efforts in the Grand River watershed.

- Promotion and education of the Grand River Fisheries Management Plan.
- Link with local initiatives i.e., Product Club, and the Rural Job Strategy.
- To develop common logo/ brochures/ fact sheets/ video for promotion within the community.

Action Committee

- To lead in the identification of specific projects and determination of how best to implement these.
- To pass additional projects in their area to the Marketing Committee to investigate opportunities for funding.
- To explore local smaller sources of funding and pass significant contacts to the Marketing Committee.
- To develop watershed representation for implementation and elect chairs.
- To hold workshops - bring interest groups together and identify potential projects.
- To detail an action plan.

Tactics outlined in the Grand River Fisheries Management Plan and subsequently prioritized in the Grand River Fisheries Implementation Plan will be initiated over time. The Implementation Committee has been charged with the responsibility of promoting various tactics, securing funds for undertaking work and for reporting back on how the tactics are being implemented. The success of these various projects will breed future success.

9.0 PROGRESS TO DATE

Contributing Authors
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This is a summary of all the initiatives that are completed or underway under the auspices of the GRFMP "Best Bets". Each project summary includes: the tactic (outlined in the Grand River Fisheries Implementation Plan); a description of the project; the target locations; the lead and support partners; the timing and/or project agenda; and any additional comments.

Access Improvement

➢ ***Upper Grand River - Belwood Lake to West Montrose***

Tactic:
- To provide improved access to the resource through partnership arrangements.
- To identify and promote public access points throughout the watershed.

Description of the Project:
Access points along the Grand River tailwater fishery were first identified and improved in 1998-1999 with funding from OMNR. A $20,000 grant was used to survey the river and identify usable public accesses for fishing and other recreational activities. Access points on the river above Fergus (the Hydro Lines and Vette Shop accesses) were improved by road widening, to allow parking farther from the traffic flow. Without this widening, the county roads department had proposed to post the entire section as Parking, eliminating two of the most popular access points on the river.

Further off-road parking accesses were constructed at Inverhaugh (Blondie's Lunch) and at the north side of the rail trestle access between Fergus and Elora. This latter access also serves the popular Elora-Cataract walking/cycling trail, with large timber steps from the parking lot up to the trail. Trees were planted, and access trails were surfaced with wood chips. Kiosks were installed to allow disposal of litter, with the help of funding from user groups such as area fishing clubs and businesses.

Further off-road parking accesses were constructed at Inverhaugh (Blondie's Lunch) and at the north side of the rail trestle access between Fergus and Elora. This latter access also serves the popular Elora-Cataract walking/cycling trail, with large timber steps from the parking lot up to the trail. Trees were planted, and access trails were surfaced with wood chips. Kiosks were installed to allow disposal of litter, with the help of funding from user groups such as area fishing clubs and businesses.

Signage for the access program was developed in consultation with OMNR, GRCA, and the Township of Centre Wellington. Smaller road signs with a Heritage River symbol will be used to direct traffic to approved public accesses, and large signs with a map of the Grand River will identify suggested recreational uses at each access. Production costs of nearly $30,000 for the signage were donated by Simpson Screen Print of Bloomingdale, Ont.

Target Locations:
Middle Grand River – Belwood Reservoir to West Montrose Bridge

Lead Partners:
Friends of the Grand River
Ministry of Natural Resources

Support Partners:
Grand River Conservation Authority
Township of Centre Wellington
County of Wellington
Portage Program

Timing and/or Project Agenda:
Completed

➢ ***Middle Grand River - Cockshutt Bridge in Brantford***

Tactic:
- To provide improved access to the resource through partnership arrangements.
- To identify and promote public access points throughout the watershed.

Description of the Project:
The project was partly completed in 1999. GRFMPIC will direct the Grand River Foundation funds towards completing the project.

Target Location:
Cockshutt Bridge

Lead Partners:
Ministry of Natural Resources
Grand River Fisheries Management Plan Implementation Committee
Ontario Steelheaders

Support Partners:
City of Brantford
Brantford Steelheaders

Timing and/or Project Agenda:
The access at Cockshutt Bridge should be improved and completed by the end of August of 2001.

Caledonia Fishway Retrofit

Tactic:
To modify the fishway at the Caledonia dam to improve fish passage of non-jumping fish species such as walleye

Description of the Project:
Following a detailed study, it was determined that the existing fishways located at the Caledonia dam could not be retrofitted. Construction of a new fishway was proposed. A biological survey conducted in 1998 found that the majority of walleye congregated on the south side of the river during spring migration. Detailed designs for a new fishway were finalized following technical review by DFO, Six Nations of the Grand River, MNR and GRCA. Efforts are underway to secure funding for the project.

Target Locations:
Grand River at Caledonia – south side

Lead Partners:
Ministry of Natural Resources
Grand River Conservation Authority
Department of Fisheries and Oceans
Six Nations of the Grand River

Support Partners:
Local angling groups
Town of Haldimand

Timing and/or Project Agenda:
Dependent on funding

Additional Comments:
Sea lamprey control will be required in the final design of the fishway. DFO and the U.S. Fish and Wildlife Service will be conducting surveys in the spring and summer of 2001 to locate sea lamprey habitat in the lower Grand River.

Coldwater Tributary Rehabilitation

Tactic:
- To use water quality problems as a catalyst to get local communities to improve water quality and land management practices in upstream reaches.

- To promote the values of cold water systems to the public as a means of obtaining support for efforts being undertaken to protect and rehabilitate them.

Description of the Project:
In 1999, MNR and GRCA signed a Memorandum of Understanding (MOU) demonstrating their commitment to forthcoming developments of a Coldwater Tributary Rehabilitation Initiative. This initiative was then broken down into four projects. These projects include:

1. Milkhouse waste storage
2. Erosion control and stream rehabilitation
3. 2 Livestock fencing projects

Target Locations:
Township of Wilmot

Lead Partners:
Grand River Conservation Authority
Ministry of Natural Resources

Support Partners:
Waterloo Region Rural Water Quality Program
Local landowners
Municipalities

Timing and/or Project Agenda:
The funding amount of $10,000.00 was allocated in 2000, and was assigned to the 4 projects listed above for completion in 2001.

Development of the Fish Community Goals and Objectives within the City of Guelph for the Speed and Eramosa Rivers

Tactic:

- To integrate municipal initiatives to improve habitat in urban areas (i.e., outlined in River System Management and Strategy, City of Guelph or Kitchener).
- To support and implement Watershed and Sub-watershed Plans and integrate fisheries plan requirements into other resource management planning initiatives.

Description of the Project:
To complete Speed River fish community goals and objectives as part of the GRFMP, in the municipality of Guelph. (At the time of printing, November 1998, the committee did not feel that there was sufficient public input from the community in Guelph to recommend fish community goals and objectives.)

Target Locations:
Speed River and Eramosa River within the boundaries of the City of Guelph

Lead Partners:
Ministry of Natural Resources, Guelph District
Grand River Conservation Authority

Support Partners:
City of Guelph
River Systems Advisory Committee
Various Non-Governmental Organizations

Timing and/or Project Agenda:
The project was initiated in 1999, and public meetings were held in 2000 and 2001. The final Plan requires public input by September 2001, and completion for inclusion in GRFMP by December 2001.

Additional Comments:
It has taken considerable time and persistence to work through the expectations, knowledge and understanding. It will provide great insight into the GRFMP and help the River Systems Advisory Committee set up future work plans with respect to tributary restoration and river projects.

Dunnville Fishway

Tactic:
To assess effectiveness of the Dunnville dam fishway.

Description of the Project:
A denil fishway was constructed in 1994 as a condition of authorization under the Fisheries Act to complete emergency works on the Dunnville dam. GRCA was also required to monitor the effectiveness of the fishway for three years. Funding for the fishway structure was provided by OMNR. Monitoring equipment was provided by the Dunnville District Hunters and Anglers.

Monitoring was initiated in the spring of 1995 and has been conducted for eleven seasons through the efforts of both agencies and volunteer groups. Twenty-seven fish species have been captured to date. Walleye comprise only one percent of the overall catch.

Target Locations:
Weir #3 located on Sulphur Creek

Lead Partners:
Ministry of Natural Resources
Grand River Conservation Authority
Department of Fisheries and Oceans
Six Nations of the Grand River
Dunnville District Hunters and Anglers

Support Partners:
Fort Erie Conservation Club
Port Colborne Conservation Club
DOFASCO Anglers
Habitat Haldimand
University of Guelph
Niagara College
Interested individuals

Timing and/or Project Agenda:
Following research conducted by the University of Guelph, the fishway will be retrofitted in 2001 to enhance use by walleye.

Additional Comments:
OMNR Lake Erie is presently conducting surveys to quantify walleye populations and genetics in the lower Grand River.

EcoAction: Environment Canada's EcoAction Community Funding Program– Gilbert Creek, Kenny Creek and Thompson Creek Rehabilitation Projects

Tactic:
- To encourage land management incentive program to reduce nutrient and sediment inputs, thermal impacts and re-establish riparian zone.
- To create informed public to enable future communication on management decisions (e.g. Community Action Team).
- To encourage partners to become involved in monitoring and stream restoration projects.
- To prepare habitat rehabilitation plans, which incorporate a natural channel design approach to identify priority area for restoration.

Description of the Project:
In 1998, funding was secured under Environment Canada's community-based EcoAction program to conduct rehabilitation projects in three subwatersheds. A total of thirty-four partners were involved and included government agencies, farmers, special interest groups, schools, business and individuals. Projects ranged from wetland creation, livestock fencing, community stream rehabilitation, barrier removal, riparian planting, buffer establishment, natural channel design and public awareness (signage and newsletters).
Monitoring was built in to the projects and will continue on a long term basis to determine effects of work completed and overall health of the watershed.
Partnership development was a huge success.

Target Locations:
- Gilbert Creek, a coldwater stream in the former Town of Paris (now Brant County)
- Kenny Creek, warmwater stream which flows through Oxford and Brant counties

- Thompson Creek, a warmwater stream in the former Town of Dunnville (now Town of Haldimand)

Lead Partners:
Brant Rod and Gun Club
Dunnville District Hunters and Anglers
Paris District High School
Grand River Conservation Authority
Paris Grand Golf Course and Inns
Brantford Steelheaders
Ducks Unlimited
Federal Student Employment Programs
Environment Canada.

Support Partners:
Ministry of Natural Resources
Grand River Foundation
Ontario Stewardship
Numerous special interest groups
Landowners and citizens

Timing and/or Project Agenda:
The EcoAction Program funding was in effect from 1998 – 2000. Additional funds have been donated and will be used to support continuing rehabilitation efforts.

Additional Comments:
Community involvement and participation far exceeded what was initially projected. Discussions are underway with the City of Brantford and County of Brant to develop a rural water quality program to provide incentives to implement similar projects in the middle Grand River watershed.

Exceptional Waters Initiative

Tactic:
Communication/Education/Partnerships/Resource Use – Fish Population Management

Description of the Project:
The Exceptional Waters approach is a community-based resource management process in which landowners, interest groups, communities and agencies are engaged and encouraged to work together. The process helps the various local groups and landowners identify issues of concern to them and develop a process to work together in a way that satisfies personal interests, provides recreational and possibly economic opportunities while protecting and enhancing these Exceptional Waters.

Exceptional Waters are defined as portions of rivers and lakes that through a unique combination of geology, topography, climate, flora and fauna, are exceptional in a regional context. These Exceptional Waters contain exceptional natural resource values, scenery and recreational opportunities.

The Grand River valley and river between Paris and Brantford is noted for several exceptional features:

- The Fish;
- Migratory and stream-resident rainbow trout
- Smallmouth Bass, Pike, Walleye; Species at Risk
- The Natural Heritage Features;
- Perched Fen, complex floodplain & valley forests
- The Groundwater Flow - high discharges;
- Healthy channel structure and complexity;
- Aesthetics of the valley;
- Community interests, hiking, fishing, water supply, parks

Target Locations:
Middle Grand River – Paris to Brantford

Lead Partners:
Ministry of Natural Resources, Guelph District
Grand River Conservation Authority

Support Partners:
Ministry of Natural Resources, Fisheries Section
University of Guelph, Department of Rural Planning and Development
Brant Stewardship
County of Brant
City of Brantford
Six Nations of the Grand River

Timing and/or Project Agenda:
Project development began in 1998 with contacts of all landowners and interest groups. The project is intended to become relatively self-maintaining within 5 years.

Additional Comments:
Community group has formed and is beginning to develop their own agenda. A set of plans are expected with the assistance of the agencies: access plan; resource management plan; business plan.

Also implemented as part of the overall plan in 2001 are new fishing regulations (see new regulation section).

Fish Habitat Stamp

Tactic:
To promote the purchase of annual angling stamps on a voluntary basis as a means of generating revenue, which can be dedicated towards the implementation of fisheries projects on the Grand River.

Description of the Project:
The objective of the fish habitat stamp is to provide a mechanism in which funds can be raised for the implementation of the GRFMP.

Target Locations:
To the public and private sponsors across the entire watershed.

Lead Partners:
Grand River Conservation Authority
Ministry of Natural Resources

Support Partners:
Grand River Fisheries Management Plan Implementation Committee
Department of Fisheries and Oceans
Wildlife Habitat Canada (WHC)
Grand River Foundation

Timing and/or Project Agenda:
The market research was completed in 2000 and the project is anticipated to be completed shortly.

Additional Comments:
This project is a highly regarded "Best Bet" and is strongly supported by the public.

Large River Hydraulic Habitat Assessment

Tactic:
To assess habitat characteristics and to develop a plan that prioritizes and coordinates information required to manage the Grand River fishery.

Description of the Project:
Presently in Ontario, there are no standard, cost-effective methods for the collection of habitat information in large rivers. This project is designed to explore new approaches to assess habitat characteristics of large, non-wadeable rivers. The project will collect depth, width, velocity and roughness data in order to relate the distribution and use of hydraulic habitat by fish.

Target Locations:
Project will be conducted on the Grand River between Paris and Brantford. It is hopeful that this project will be expanded upstream to include the river reach between Cambridge and Paris.

Lead Partners:
Ministry of Natural Resources, Fisheries Section/Research;

Support Partners:
Grand River Conservation Authority
Department of Fisheries and Oceans, Fish Habitat Management
University of Guelph

Timing and/or Project Agenda:
Project was initiated in 2000. Work in 2001 will complete preliminary data collections and linkages between habitat attributes and fish population distribution will likely continue for 2-3 years.

Intent is to have preliminary sampling protocol completed for further Province wide testing by 2004.

Additional Comments:

Goal:
- Development of a baseline bathymetric database that will provide a foundation for developing information on the physical, chemical and biological characteristics of a reach of the Grand River.
- To test the approach to determine future use on other portions of the Grand River and possibly other large rivers of Ontario.

Objectives:
- Collection of detailed information on elevations/depths of the active and bankfull channel of the Grand River from Cambridge to Brantford (using “Total Station” equipment);
- Relating all elevation/depth measurements to GPS co-ordinates for future reference;
- Collect data on relative roughness of each depth point;
- Establishment of key points for differential stage measurements;
- Subsequent collection of three sets of water velocities (20%; 60%; 80%) and temperature profile data at each water point at the sampled river stage;
- Relate all fish community data collection locations to depth and velocity measurements using GPS.

Potential Linkages/Products:
- Use of total station data to develop a bathymetric Map of the sampled reaches of the Grand River;
- Provide the base tool for a mixing model for the GRSM;

- Provide hydraulic habitat information for the reach of river;
- Provide base map for relating fish community data collection to hydraulic habitat;
- Provide a baseline for developing a repeatable and less rigorous hydraulic habitat assessment protocol for large rivers;
- Provide a template for determining minimum flow requirements and thresholds for drought management strategies.

Large River Enhancement Project

Tactic:

- To investigate various options to protect and maintain coldwater inputs and thermal refuges.
- To improve overwintering habitat.

Description of the Project:
This project is composed of three phases that will examine and implement structural enhancements of the Grand River within the lower portion of the Tailwater Fisheries of the Upper Grand River Brown Trout Fishery (Elora CA downstream to Westmontrose). The plan is to improve the quality of the lower reaches of the brown trout fishery by enhancing three major types of habitat that appear limited in this portion of the river:

- Winter Refugia Habitat;
- Summer Refugia Habitat;
- Reproductive Habitat (i.e. spawning).

Target Locations:
There are three reaches of river that will benefit from this initiative: Low level bridge in Elora CA to Wilson's Flats; Wilson's Flats to Townline Bridge; Townline Bridge to Highway 86.

Lead Partners:
Ministry of Natural Resources, Fisheries Section/Aquatic Ecosystem Science Section

Support Partners:
Grand River Conservation Authority
Friends of the Grand River
Parish Geomorphic

Timing and/or Project Agenda:
Background information and plans for Phase I and Phase II have been reviewed and detailed designs have been completed (2000). Plans are waiting for approvals and funding.

Additional Comments:
The project has developed 7 project sites that will create habitat suitable for over-winter, over-summer and spawning habitat for trout and other species. The designs were developed by biologists, geomorphologists and engineers. Background geomorphic and hydraulic data were collected for each site and additional background information on the use of the river by over-wintering fish was collected by Rick Brown as part of his Ph.D. thesis from the University of Waterloo (1997-1999).

Lower Grand River Assessment

- **Lake Erie Eastern Basin Rehabilitation Plan: Lower Grand River Assessment Component**

Tactic:
- To assess the status of fish community (includes coldwater species).
- To continue to monitor fishways.
- To manage for wild genetic stocks (identify, assess, protect and manage).
- To continue tagging and monitoring tag returns of walleye captured at the Dunnville Dam.

Description of the Project:
Assessment of the lower reaches of the Grand River for habitat use/potential use by fish. Includes mark/recapture tagging and genetic stock characterization of Grand River - walleye and spring - fall electrofish surveys of fish communities with a focus on young-of-the-year and juvenile nursery habitat use. Habitat components to include both physical (substrate limitations and barriers to access) and water quality (in particular suspended solids, oxygen demand) measures.

Target Locations:
Lower Reaches of the Grand River from the mouth (and lake-nearshore) to the dam at Dunnville, including Sulphur Creek and the Dunnville Marshes. *See also "Additional Comments" below.*

Lead Partners:
Lake Erie Program Committee
-Ontario Ministry of Natural Resources, Lake Erie Management Unit
-Ontario Federation of Anglers and Hunters
-Ontario Commercial Fisheries Association

Support Partners:
Environment Canada
Grand River Conservation Authority
Ministry of the Environment
University of Toronto
New York State Department of Environment and Conservation (NYSDEC)

Ministry of Natural Resources, Niagara Area Office

Timing and/or Project Agenda:
Field assessment to take place over a five year period (2000-2004, incl.).

Additional Comments:
This assessment is one component of the Lake Erie Eastern Basin Rehabilitation Plan, which is meant to protect and restore eastern basin fish stocks to support a sustainable sport and commercial fishery. This is to be accomplished by managing exploitation of eastern stocks separately from the rest of the lake and by identifying habitat limitations (and the potential for habitat restoration). Study areas includes sites throughout the eastern basin of Lake Erie, both lake nearshore and major tributaries (including Big Creek, Sandusk Creek, Nanticoke Creek).

Migratory Fish Working Group

Tactic:
- To create Migratory Salmonid Management Working Group to examine fish species interactions and make recommendations on best management approaches (i.e., whether partition/barrier is desired and if so, best means of doing so).
- To assess potential/actual interactions between migratory coldwater fish species and the existing warmwater fish community (i.e., food supply, habitat).
- To evaluate potential as spawning/nursery habitat for migratory rainbow trout.

Description of the Project:
The primary purpose of the MFWG is to guide the acquisition and synthesis of technical and scientific information, analyze management option, obtain stakeholder and public endorsement, and ultimately make recommendation to the GRFMPIC regarding management of migratory species in the Grand River watershed.

Specifically, the MFWG will provide management recommendations to the GRFMPIC in the following areas as they relate to migratory fish species:
- Data collection and assessment (includes synthesis of existing data)
- Fish population management (includes designation of fish community zones (partitioning) and recommended use of fishways, barriers, etc.)
- Fishing regulations
- Habitat management and rehabilitation
- Communication, education and partnership

Target Location:
Lower Grand River Reach
Nith River Sub-Basin
Whitemans' Horner Creek Sub-Basin
Middle Grand River Reach (partial)
Conestoga and Speed River Sub-basins

Lead Partners:
Ministry of Natural Resources, Guelph District
Ministry of Natural Resources, Lake Erie Management Unit
Grand River Fisheries Management Plan Implementation Committee

Support Partners:
Ministry of Natural Resources, Guelph District
Department of Fisheries and Oceans
Six Nations of the Grand River
Ontarion Steelheaders
Ontarion Federation of Anglers and Hunters (OFAH)
Tourism interest
Friends of the Grand River (FOGR)
Brantford Steelheaders
Isaak Walton Fly Fishing Club
Federation of Ontario Naturalists (FON)
Dunnville Hunters and Anglers Conservation Club.
Community Groups

Timing and/or Project Agenda:
Development of management recommendation for migratory species is an iterative process that will optimistically take at least three years. Much of the effort during the first year of the project (2001) will be spent gathering and evaluating baseline habitat and population status data, with constant feedback to determine if the data will contribute to meaningful management alternatives leading to recommendations.

The committee will attempt to submit a “Best Bets” list of management options to the GRFMPIC early in their first year, and will update this list as often as possible. However, some complex management issues (e.g. aggressive management suck as creation /maintenance of major migration barriers or removal of others) will require a lot of information evaluation and public consultation to resolve. Public consultation will be required for regulation changes, and to implement management actions in cases where decisions are value based rather then biologically based (e.g. fish introductions, transfers or stocking; barrier creation or removal,.etc.).

Municipal Drain Classification Project

Tactic:
- To assess fish community and habitat conditions in tributaries and drains where little documentation has occurred.
- To develop and apply municipal drain classification system as a proactive means of linking fish habitat protection to drainage activities.

Description of the Project:
The *Class Authorization System for Agricultural Municipal Drains* is a partnership project between Department of Fisheries and Oceans (DFO), conservation authorities and local municipalities. The aim is to devise a classification scheme to into which all agricultural drains can be categorized according to their fish habitat sensitivity. Drains containing less sensitive fish habitat will be classified into groups in which authorizations will be granted once the monitoring organization have been notified of the work. Other more sensitive drain habitats will continue to be reviewed on a project by project basis.

The application of drain classifications requires knowledge of flow (permanent /intermittent) temperature regimes (cold/cool/warm water), habitat characteristics, and existing fish populations.

The following information has been derived:
- Study area includes 1910km^2 which is approximately 1/3 of the watershed;
- Habitat, fishery community, flow regimes and maximum temperatures were completed in the following townships: Amaranth, Blandford-Blenheim, Guelph Eramosa Township, Mapleton and Melancthon;
- 225 drains identified with 274 road crossing assessment sites.

Target Locations:
The townships of Amaranth, Blandford-Bleneim, Mapleton and Melancthon were identified as areas that annually request a high number of petitions for drain maintenance, and therefore were priority for classification completion in the year 2000. Classification will ultimately involve the entire Grand River Watershed.

Lead Partners:
Department of Fisheries and Oceans (DFO)
Grand River Conservation Authority

Support Partners:
Local Municipalities
Ministry of Natural Resources
Non-Government Organizations (i.e. Drainage Superintendents Association of Ontario - DSAO)

Timing and/or Project Agenda:
The target townships for the 2001 season include East Luther, West Luther, Arthur and West Garafraxa. In order to complete the townships of Proton, and East Garafraxa, temperature assessment is also planned for this upcoming season.

New Inventory Work

➢ ***Electrofishing and Spawning Surveys***

Tactic:
Planning and Information Management

Description of the Project:
The purpose of new inventory work is to provide data prior to making further management decisions. This project is monitoring the aquatic community and "health" of the Grand River watershed on a strategic, long-term basis.

Target Locations:
- Lower Grand River/Lake Erie interface
- Confirmation of the Grand River groundwater study through the integration of data collection
- Information is required for the development of a: 'Tailwater Plan'; 'Migratory Fish Plan'; 'Sturgeon and Muskellunge Recovery Plan'; and Species at Risk Project.

Lead Partners:
Ministry of Natural Resources
Grand River Conservation Authority

Support Partners:
Department of Fisheries and Oceans
Environment Canada,
Bass Master's
Muskies Canada
Friends of the Grand River

Timing and/or Project Agenda:
This project has been ongoing since 1998.

Additional Comments:
New inventory work is critical for future decision making. There has been a great deal of interest and financial commitment.

➢ ***Riffle Studies***

Tactic:
Planning and Information Management
To assess effectiveness of current brown trout program.

Description of the Project:
Brown trout spawning on the Grand River appears to be unsuccessful. We are aware they spawn but do not know why they select certain riffles vs others nor if the redd environments are inappropriate (physically and/or chemically) for successful reproduction. This issue becomes problematic given that the goals of the Brown Trout Program on the Grand River is to establish a population of self-sustaining fish in at least a portion of the brown trout zone on the river.

A template of potential constraints to successful spawning was developed several years ago by a panel of biologists. This study was limited by lack of funding and technical support. Nevertheless, work was undertaken in three separate years to monitor the chemistry of river water and the chemistry of water in the redd environment of two sets of riffle types: Riffles demonstrating active spawning most years; riffles that have never demonstrated spawning.

Information collected included:
- Summary of spawning locations up the river (4 years of information);
- Delineation of two sets of three riffle types (Not Used Riffles; Used by trout);
- For both sets of riffles the following data were collected – hydraulic cross-sections, long profile, pebble counts, pavement/subpavement grab samples (replicates); frozen core sample (one per riffle);
- Mini-piezometers (special, shallow design) were installed in two riffles of each set and monitored several times over the winter for three years;
- Basic chemistry of surface water and water from riffles included – dissolved oxygen, conductivity, pH, turbidity, temperature and where possible, nitrate concentrations.

Target Locations:
The study locations were bounded between the riffle below the low level bridge in the Elora Conservation Area, downstream to the riffle just below twin bridges at Wilson's Flats.

Lead Partners:
Ministry of Natural Resources, Fisheries Section/Aquatic Research Section

Support Partners:
Andrew Pentney – hydrogeologist
Grand River Conservation Authority
Ministry of Natural Resources, Science and Technology Transfer Unit

Timing and/or Project Agenda:
The project began in the fall of 1997 and was completed in the spring of 1999. Data was summarized and a preliminary analysis of the data was done under contract to Parish Geomorphic.

Lacking from the study due to costs and lack of manpower was the biological work with egg incubation monitoring.

Additional Comments:
It is essential that managers have information on whether brown trout that are spawning on the Grand River are spawning successfully and where. Just as valuable is information of where they are spawning unsuccessfully and why. This information will be essential in determining:

- management and protection of naturally reproducing stocks of trout
- delineation of the wild trout zone
- determination of what portions of river must be managed as a supplemental or put-and-take fishery
- determination of rehabilitation efforts or environmental efforts necessary to promote natural reproduction

This particular study provides two pieces of the puzzle for lack of spawning success: basic physical information on riffle quality for spawning; and basic chemical characteristics that may hamper egg development.

Additional work must be done to relate the above information to the actual process of egg incubation, fry hatch and swim-up. It appears likely that the major problem may be "entombment" given the armoured nature of the bed. Secondary problems may occur from low oxygen levels.

Promotional Material for the GRFMP

Tactic:
Fisheries Plan Promotional Package

Description of the Project:
The promotional material will develop a multi-media package to improve communication and provide information on the GRFMP, project implementation and marketing. The promotional material will ultimately include brochures and a video.

Target Locations:
The promotional material is planned to be distributed watershed wide.

Lead Partners:
Grand River Conservation Authority
Department of Fisheries and Oceans
Ministry of Natural Resources

Support Partners:
Grand River Fisheries Management Plan Implementation Committee

Timing and/or Project Agenda:
The timeframe of the project is January 2001 – June 2001.

Additional Comments:
The Department of Fisheries and Oceans has already sponsored the entire project.

Regulation Changes

Tactic:
- To expand the special Angling Regulation zone (includes catch-and-release fishing and restricting gear to artificial lures with barbless hooks).
- To introduce regulations, if biologically defensible to protect and enhance the quality of recreational angling (i.e., reduced limits, size limits, catch-and-release, close walleye season from March 15 to second Saturday in May).

Description of the Project:
In response to suggestions received during two rounds of 5 public meetings over a period of several years (1996 and 1997) in the development of the Grand River Fisheries Plan, the Fisheries Plan Committee recommended that MNR implement four fishing regulation changes.

Target Locations:
Regulations which are now in place:
- Special Regulation boundaries: From 100m downstream of the Highway 2 bridge in Paris to the Pedestrian Walkway and Services Bridge, north of Brant Park.
- Harvest Restrictions: Zero harvest (no fish in possession) for rainbow trout, brown trout, smallmouth bass, northern pike and walleye (regular seasons still apply with the exception of the extended season listed below).
- Extended Season: For rainbow trout and brown trout from October 1st until December 31st (catch and release).

Lead Partners:
Ministry of Natural Resources

Support Partners:
Grand River Conservation Authority

Timing and/or Project Agenda:
Regulations which are soon to be in place:
- Pending regulation changes by Jan./02 at the latest.
- Gear Restrictions: Artificial lure only, single barbless hook. No live bait.
- Fish sanctuary on the Grand River from the William Street Bridge in Paris upstream to the Penman Dam from October 1st until Nov. 31st.
- Fish sanctuary from 100m downstream of the Highway 2 bridge in Paris to the Pedestrian Walkway and Services Bridge, north of Brant Park from January 1st until the last Friday in April inclusive.
  (Sanctuaries mean no fishing at all for any species within the boundaries and dates identified)

River Rendezvous

Tactic:
- To promote the values of coldwater systems to the public as a means of obtaining support for efforts being undertaken to protect and rehabilitate them.
- To create an informed public (i.e., problems, awareness, education) to enable future communication regarding management decisions (i.e., Community Action Team, organized angler groups).
- To encourage partners to become involved in monitoring and restoration projects.

Description of the Project:
"A celebration of rivers and an educational weekend for those who seek to improve them. We developed a fun/interesting program while delivering lots of useable information to the general public and professionals alike.

River Rendezvous facilitates communication regarding the use and enhancement of aquatic resources between the various user groups in Ontario. The goal of River Rendezvous is threefold. The first is to inform the various members of the community of the range of needs that rely upon clean water. The second goal is to enhance our water resources by providing networking and partnership opportunities between the various members of our community that do not normally interact or cooperate with one another. The third goal of River Rendezvous is to provide a means for the community to work together in resolving aquatic resource issues in creative and mutually rewarding ways.

Target Locations:
Held in Kitchener at Bingemans Park, but the target audience was Ontario based.

Lead Partners:
Ontario Streams
University of Guelph

Support Partners:
Grand River Conservation Authority
Canada Trust
Department of Fisheries and Oceans
Great Lakes Aquatic Habitat Fund
City of Kitchener
Ministry of Natural Resources

Timing and/or Project Agenda:
River Rendezvous is held every three years (1997, 2000)

Subwatershed Plan Implementation – Aquatic Component

Tactic:
- To integrate municipal initiatives to improve habitat in urban areas
- To support and implement Devil's Creek and Torrance Creek subwatershed plans and integrate fisheries management plan requirements into other resource management planning initiatives

Description of the Project:
In 1997, the City of Cambridge and the GRCA formed a partnership to enhance and restore the Devil's Creek watershed. Projects included barrier removal, natural channel design, instream structure placement, riparian tree and shrub planting, wetland creation, purple loosestrife control, stormwater pond enhancements, and wildlife cavity nesting box construction and placement. Community work days, interpretive signs, media coverage and development of a brochure increased public awareness of the Devil's Creek project.

The Torrance Creek Implementation Committee was formed in 2000 to initiate community projects recommended in the subwatershed study. Landowner contact, project development, fundraising and completion of a monitoring strategy were completed the first season. Activities for 2001 include community involvement through riparian plantings, development of an interpretive display and newsletter, instream habitat improvement, roadside signage and a volunteer monitoring kit. The goal is to employ a community environmental coordinator for the City of Guelph as additional subwatershed plans are completed.

Target Locations:
- Devil's Creek watershed in the City of Cambridge and Township of North Dumfries
- Torrance Creek watershed in the City of Guelph and the Township of Puslinch

Lead Partners:
Devil's Creek - City of Cambridge and the Grand River Conservation Authority
Torrance Creek - City of Guelph and the Grand River Conservation Authority

Support Partners:
Devil's Creek – Toyota Motor Manufacturing Canada, Ministry of Natural Resources, Q Lube, Bob Izumi's Real Fishing Show, St. Augustine School, Ancient Mariners, University of Guelph, John Howard Society, Federal Student Employment Program, K-W Flyfishers, Ontario Stewardship and community volunteers.

Torrance Creek – Clean Water Coalition, University of Guelph, Wellington Stewardship Council, Victoria West Golf Course, Canada Trust Friends of the Environment Foundation and local volunteers and landowners.

Timing and/or Project Agenda:

- The Devil's Creek project was implemented from 1997 – 1999. Some projects are ongoing.
- Torrance Creek restoration efforts were initiated in 2000 and funding has been secured for 2001.

Additional Comments:
Implementation of subwatershed plan recommendations is an important tool to rehabilitating resources and a logical way to involve the public in subwatershed planning and participation.

Species at Risk Recovery Plan

Tactic:
Planning and Information Management
To restore plans for VTE Fishes at Risk

Description of the Project:
The Grand River in southwestern Ontario is a biological treasure. The watershed is home to a wide range of plants and animals. Many of the animals that live in the river are hidden from view and easily go unnoticed. Of the 158 fish species that occur in Ontario, 83 have been documented from the Grand River Watershed. Six of the 29 VTE (COSEWIC) fish species are included in this figure: silver shiner, red-side dace, eastern sand darter, greenside darter, black redhorse and river redhorse. The good news is that most of these rare species are still present in the river. Protecting and improving habitat in the river will help ensure their long-term survival.

Although many recovery plans focus on individual species, it was felt that it would be more effective to have a single plan (Grand River Recovery Plan) that addresses all the fish species at risk in the watershed. As well the Grand River Recovery Plan would then compliment the work already underway as a result of the Grand River Fisheries Management Plan. The report "Recovery Plans for At-Risk Fishes in the Grand River Watershed" contains detailed strategies to address concerns around at-risk fishes.

Target Locations:
Grand River Watershed with an emphasis on the upper reaches and Irvine Creek

Lead Partners:
Ministry of Natural Resources, Guelph District
Grand River Conservation Authority

Support Partners:
Royal Ontario Museum (ROM)
Ontario Streams
Wellington County Stewardship Council

Baitfish Association of Ontario (BAO)

Timing and/or Project Agenda:
The recovery plan is in the final stages of development. However this has not stopped a Red-side Dace action group made up of the above representatives from tackling the challenge of implementing a Recovery Plan. A Terms of Reference paper has been drafted, and they are currently working on assembling a communications plan for this project. The action group is looking at the Irvine Creek sub-watershed on the upper reaches of the Grand River. The goals for the upcoming spring/summer season are:

1) To gather background sampling information using seine nets and a electrofishing backpack with the assistance of Irling Holm (ROM);
2) To communicate with interested stakeholders and landowners as a means of educating them on the Red-side Dace Recovery Plan.

Additional Comments:
Increasing awareness regarding the rare species in the river, developing partnerships, and fostering stewardship initiatives will be important components of the recovery plan.

Tailwater Plan

Tactic:
To create and implement the Grand River Tailwater Fisheries Management Strategy (includes extending the Special Angling zone downstream, consider extending open season for brown trout in conjunction with catch-and-release provisions).

Description of the Project:
To finalize the development of a detailed (5-10 year) plan to manage the brown trout fishery in the ‘tailwater section’ of the Grand River downstream of Belwood Reservoir. The plan will include strategies for research needs, population assessment, regulation changes, promotion and marketing, and barrier maintenance and removal.

Target Locations:
Downstream of Belwood Reservoir (Shand Dam) to West Montrose (Hwy. 86)

Lead Partners:
Ministry of Natural Resources, Guelph District

Support Partners:
Grand River Conservation Authority
Friends of the Grand River
Department of Fisheries and Oceans
Trout Unlimited
Izaak Walton Fly Fishers’ Club
Local Municipalities

Timing and/or Project Agenda:
Completion by December 2001, including a 5 year Plan of Action and annual work plans.

Additional Comments:
Since the completion of the GRFMP, public meetings have been held. Further public discussion is required to build a consensus and to develop the "action plan". (Expected to be completed prior to October 2001.)

Water Steward

Tactic:
Planning and Information Management
Fish Habitat Protection and Management Plan

Description of the Project:
It is a Pilot project for the Province that is funded through the Department of Fisheries and Oceans. The Water Steward position is responsible for:

- Assistance at site assessments with Aquatic Resources and Planning Staff;
- Checking on complaint calls from the general public and other agencies;
- Being the first on scene investigation for GRCA, DFO, MNR and MOE;
- Collecting information to assist in plan review;
- Presentations given to further educate the general public on GRCA and DFO issues.

Target Locations:
Grand River Watershed

Lead Partners:
Department of Fisheries and Oceans
Grand River Conservation Authority

Support Partners:
Ministry of Natural Resources, Guelph District
Ministry of the Environment (MOE)
Local Landowners
Non-Government Organizations
Municipalities and Licensees
Developers
Universities

Timing and/or Project Agenda:
November 2000 to October 2001 (with the possibility of extension).

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Figure 4.7: Quaternary Geology of the Grand River Watershed

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Personal communications with Mr. C.L. Baker of the Ontario Geological Survey, 1998.

Figure 5.1: Fisheries Management Sub-Basins in the Grand River Watershed

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