NONQUON RIVER

FISHERIES MANAGEMENT PLAN

2009

KAWARTHA CONSERVATION

DURHAM REGION

Ontario

TOWNSHIP OF Scugog

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EXECUTIVE SUMMARY

Communities working together to maintain and enhance a healthy, self-sustaining aquatic ecosystem that contributes to the social, cultural and economic well being of the Nonquon River watershed

At a headwaters elevation approaching 305 metres above sea level, the Nonquon River flows north from its origins in the Oak Ridges Moraine to west of Port Perry where it empties into Lake Scugog. The majority of the Nonquon River is located within the Township of Scugog, with smaller portions situated within the Township of Brock and City of Kawartha Lakes. Consisting of both flat and rolling lands, the watershed drains an area of 187.75 km^2 and the main tributary is 43.3 km long. The primary land use in the area is agricultural with some isolated forested areas and one large provincially significant wetland. The Durham Region Official Plan has designated much of this watershed for future industrial and agriculture development.

The Nonquon River watershed provides spawning, nursery, refuge, feeding, transient and resident habitats, all of which are important for supporting the life stages and processes of all 32 fish species that are known to currently reside in the watershed. The Nonquon River supports both a cold and warmwater fishery and is especially known for supporting walleye (*Sander vitreus*) and muskellunge (*Esox masquinongy*) spawning habitat. Other popular fishes found in the watershed include brook trout (*Salvelinus fontinalis*), panfishes (*Lempomis* and *Pomoxis* spp.), largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), common carp (*Cyprinus carpio*) and yellow perch (*Perca flavescens*).

The quality of life that we enjoy is greatly affected by the health of the natural ecosystem around us. As our communities grow, the potential for cumulative environmental impacts from development increases. Such impacts are not limited to the lands in which they originate, but may also affect adjacent or downstream lands. One of the most effective ways of dealing with issues of cumulative environmental impact is to use an integrated, ecosystem approach to guide development. In recognition of this, the Kawartha Region Conservation Authority (KRCA) in partnership with the Township of Scugog and the Regional Municipality of Durham, initiated a planning study for the Nonquon River watershed as an integral part of the municipal land use planning process.

The Nonquon River Subwatershed Study (NRSS), initiated in 2000, was undertaken to satisfy the requirements of Ontario's *Planning Act*, which provides a comprehensive policy basis and regulatory framework for the integration of ecosystem considerations and environmental concerns into the land use planning process. The outcome of the NRSS was a Subwatershed Plan that recommended management strategies to provide a broad framework for protecting, maintaining, and enhancing the important environmental features, resources, and functions unique to the Nonquon River watershed.

The Nonquon River Fisheries Management Plan (NRFMP) is one of the technical tools resulting from the Nonquon River Subwatershed Study process. The information collected during the NRFMP development process was used to assist in developing issues and

management recommendations strategies that can be applied at a watershed wide level and at a zone-specific level. The management recommendations provide information on priority areas for fish habitat conservation, restoration and development.

Protection and enhancement of fish habitat can be implemented based on scientifically defensible data gained through inventories of the benthic macroinvertebrates, fish communities, and physical habitats. Furthermore, Kawartha Region Conservation Authority (KRCA) has a Level III Fish Habitat Agreement with Fisheries and Oceans Canada (DFO), and is responsible for evaluating proposed works within the watershed for their impacts on fish habitat. The data collected from this plan improves KRCA's ability to assess impacts of proposed works on fish and fish habitat.

Historically fisheries management in the watershed was provided by a single agency, the Ontario Ministry of Natural Resources (OMNR), with a primary focus on game fishes and single-species management. Today, OMNR is still the lead agency for fisheries management in Ontario; however, it is now delivered through a collaborative effort. Fisheries management relies upon the shared efforts of the federal, provincial and municipal governments, conservation authorities, Aboriginal people, non-government organizations and other community stakeholders. As additional agency involvement has expanded, so has the focus. Consequently, the NRFMP concentrates on managing fish communities at an ecosystem level.

The Nonquon River watershed is delineated into 5 management zones that are based upon select watershed characteristics that provide a strong rationale/method for their delineation. Watershed characteristics used for zone separation included: unique fish communities (e.g., cold water fishery); unique sub-watersheds (e.g., Layton River); unique habitat reaches (e.g., walleye and muskellunge spawning areas); unique geological landforms (e.g., Oak Ridges Moraine); or any combination of these and other characteristics. In addition, goals were developed for each zone to guide management recommendations for the Nonquon River watershed. The management zones include:

MANAGEMENT ZONE 1 - HEADWATERS OF THE NONQUON RIVER
Management Goal - Maintenance and Enhancement

MANAGEMENT ZONE 2 - GREENBANK AND SURROUNDING AREA
Management Goal – Rehabilitation

MANAGEMENT ZONE 3 - PORT PERRY AND SURROUNDING AREA
Management Goal – Education and Enhancement

MANAGEMENT ZONE 4 - NONQUON RIVER MAIN CHANNEL
Management Goal – Protection and Enhancement

MANAGEMENT ZONE 5 - LAYTON RIVER SUBWATERSHED
Management Goal – Maintenance, Enhancement and Rehabilitation

This watershed based fisheries management plan was developed to achieve specified management objectives for a fishery resource on a local level. The NRFMP provides a format for undertaking compatible, coordinated management measures among the Regional Municipality of Durham, Township of Scugog, Township of Brock, KRCA, OMNR and DFO to specifically address issues unique to the Nonquon River watershed.

The NRFMP began in 2003 and the data collection, analysis, consultation and writing process was a five-year endeavour, which examined the entire Nonquon watershed fishery from 2003-2007. The duration of this plan is for the next five years (2008 – 2012), at which time the document should be reviewed to address improvements and/or new issues that may have arisen during the implementation period.

To ensure the conservation, sustainable use, and (where feasible) restoration of the Nonquon River watershed's resources for the benefit of all citizens, the objectives of the NRFMP are to:

- **Protect and enhance fish and fish habitat.**
- **Promote economic benefits of a healthy fishery.**
- **Promote public awareness, appreciation and understanding of fisheries resources and aquatic habitats.**
- **Involve stakeholders in fisheries management activities.**
- **Develop a greater knowledge of fish populations, fish habitat and aquatic ecosystems.**
- **Provide a framework for fisheries management.**
- **Rehabilitate degraded fish communities and fish habitat.**

Through public information sessions and Management Team meetings, the NRFMP ensured communication with all stakeholders from the onset. A Management Team was assembled in the early stages of the plan as a means for the public, government and industry to participate as a team in sharing knowledge, resources and concerns to develop solutions to relevant issues affecting the health of the fishes in the Nonquon River watershed. The Management Team ultimately defined management boundaries and strategies based upon input from team members and the public.

During the public consultation process, most participants expressed a preference for managing the system to increase walleye production. Shoreline destruction and nutrient loading were also voiced as watershed issues that require management actions. Issues that attracted the most interest and greatest response included: poor water quality, the loss of aquatic habitat and fish population declines, and inadequate fishing opportunities within the river. Consequently, the NRFMP plan provides a comprehensive approach in addressing these issues.

RÉSUMÉ

Des collectivités qui travaillent ensemble pour maintenir et améliorer un écosystème aquatique sain et autonome qui contribue au bien-être social, culturel et économique du bassin hydrographique de la rivière Nonquon

À partir de ses eaux d'amont situées à près de 305 mètres au-dessus du niveau de la mer, la rivière Nonquon coule de son origine dans la moraine Oak Ridges en direction ouest de Port Perry où elle se vide dans le lac Scugog. La majeure partie de la rivière Nonquon est située dans le canton de Scugog. Certains petits tronçons de la rivière se trouvent dans le canton de Brock et la ville de Kawartha Lakes. Comprenant à la fois des terres plates et vallonnées, le bassin hydrographique draine une superficie de 187,75 km^2 et son tributaire principal mesure 43,3 km. L'agriculture constitue l'utilisation principale des sols. Le bassin comprend quelques aires forestières isolées et une grande superficie de terres humides d'importance provinciale. Dans le plan officiel de région de Durham, la majeure partie des terres du bassin hydrographique est désignée à des fins futures d'aménagement industriel et d'exploitation agricole.

Le bassin hydrographique de la rivière Nonquon contient des habitats de frai, de nourricerie, de refuge, d'alimentation, de transition et de résidence. Tous sont importants pour soutenir les étapes et les processus du cycle de la vie des 32 espèces de poisson connues qui résident actuellement dans le bassin. La rivière Nonquon soutient des pêcheries d'eaux froides et d'eaux chaudes; elle est surtout connue pour ses habitats de frai de doré jaune (*Sander vitreus*) et de maskinongé (*Esox masquinongy*). Parmi les autres poissons populaires qu'on trouve dans le bassin, il y a l'omble de fontaine (*Salvelinus fontinalis*, des crapets (*Lempomis* et *Pomoxis* spp.), l'achigan à grande bouche (*Micropterus salmoides*), l'achigan à petite bouche (*Cyprinus carpio*), la carpe commune (*Cyprinus carpio*) et la perchaude (*Perca flavescens*).

La qualité de vie dont nous jouissons dépend énormément de la santé de l'écosystème qui nous entoure. Au fur et à mesure que nos collectivités prennent de l'ampleur, les impacts environnementaux cumulatifs potentiels grandissent. De tels impacts ne se limitent pas sur les terres où ils se trouvent; ils se répercutent aussi les terres auxquelles ils sont adjacents et les terres qui se trouvent en aval. L'un des moyens les plus efficaces pour traiter des questions d'impact environnemental cumulatif est d'adopter une approche intégrée axée sur les écosystèmes pour orienter l'aménagement du territoire. C'est en gardant ce principe à l'esprit que l'Office de protection de la nature de la région de Kawartha, en partenariat avec le canton de Scugog et la municipalité régionale de Durham, a entamé une étude de planification pour le bassin hydrographique de la rivière Nonquon en tant que composante intégrale du processus de planification de l'aménagement des terres municipales.

L'étude du sous-bassin hydrographique de la rivière Nonquon a été entreprise en l'an 2000 pour satisfaire aux exigences de la *Loi sur l'aménagement du territoire* de l'Ontario. Cette loi fournit des politiques de base et un cadre réglementaire exhaustifs pour l'intégration des considérations relatives aux écosystèmes et des préoccupations environnementales au processus de planification de l'aménagement du territoire. Par conséquent, l'étude du sous-

bassin hydrographique de la rivière Nonquon a permis d'élaborer un plan de sous-bassin hydrographique dans lequel sont recommandées des stratégies de gestion fournissant un cadre général pour la protection, le maintien et l'amélioration des importantes caractéristiques, ressources et fonctions environnementales particulières du bassin hydrographique de la rivière Nonquon.

Le Plan de gestion des pêches pour la rivière Nonquon (PGPRN) est l'un des outils techniques qui ont découlé du processus d'étude du sous-bassin hydrographique de la rivière Nonquon. Les données recueillies lors du processus d'élaboration du PGPRN ont été utilisées pour cerner les questions et élaborer les stratégies de gestion recommandées pouvant être appliquées à l'échelle du bassin hydrographique tout entier et à l'échelle de zones en particulier. Les recommandations en matière de gestion fournissent des renseignements sur les endroits prioritaires en ce qui a trait à la protection, la restauration et l'aménagement d'habitats du poisson (ou habitats halieutiques).

La protection et l'amélioration des habitats du poisson peuvent être mises en œuvre en son fondant sur des données scientifiques valables obtenues par l'entremise d'inventaires des macro invertébrés benthiques, des communautés de poisson et des habitats physiques. En outre, l'Office de protection de la nature de la région de Kawartha a une entente de niveau III en ce qui a trait aux habitats de poisson avec Pêches et Océans Canada et est tenu d'étudier les travaux qu'on propose entreprendre dans le bassin hydrographique pour en évaluer l'impact sur les habitats de poisson. Les données recueillies par l'entremise de ce plan améliorent la capacité de l'Office de protection de la nature de la région de Kawartha lorsqu'il s'agit d'évaluer les répercussions de divers travaux sur les poissons et leurs habitats.

Dans le passé, la gestion des pêches dans le bassin hydrographique relevait d'un seul organisme, le ministère des Richesses naturelles de l'Ontario (MRNO), et était surtout axée sur les poissons-gibiers et la gestion d'espèces distinctes. Aujourd'hui, le MRNO est toujours l'organisme chef de file en ce qui concerne la gestion des pêches en Ontario; cependant, la gestion comme telle se fait par l'entremise d'efforts concertés de la part des gouvernements fédéral, provincial et municipaux, des offices de protection de la nature, des groupes autochtones, des organismes non gouvernementaux et autres parties intéressées communautaires. Au fur et à mesure que la charge de gestion s'est répartie entre les organismes, les responsabilités de ceux-ci sont devenues plus précises. Par conséquent, l'Office de conservation de la nature de la région de Kawartha se concentre sur la gestion des communautés de poissons à l'échelle de l'écosystème.

Le bassin hydrographique de la rivière Nonquon est divisé en cinq zones de gestion fondées sur des caractéristiques particulières du bassin, ce qui permet d'établir une méthode et une justification solides lorsqu'il s'agit d'en établir les limites respectives. Parmi les caractéristiques utilisées pour délimiter les zones, il y a les suivantes : communautés de poisson particulières (p. ex., pêcherie d'eaux froides); sous-bassins hydrographiques particuliers (p. ex., rivière Layton); tronçons d'habitat particulier (p. ex., aires de frai du doré jaune et du maskinongé); formations géologiques particulières (p. ex., moraine Oak Ridges) ou toute combinaison de ces caractéristiques, entre autres. Des objectifs ont aussi été élaborés pour chacune des zones afin d'orienter la gestion des recommandations touchant le bassin hydrographique de la rivière Nonquon. Ces zones de gestion sont les suivantes :

ZONE DE GESTION 1 – EAUX D'AMONT DE LA RIVIÈRE NONQUON
Objectifs en matière de gestion : maintien et amélioration

ZONE DE GESTION 2 – GREENBANK ET LES ENVIRONS
Objectif en matière de gestion : restauration

ZONE DE GESTION 3 – PORT PERRY ET LES ENVIRONS
Objectifs en matière de gestion : éducation et amélioration

ZONE DE GESTION 4 – CHENAL PRINCIPAL DE LA RIVIÈRE NONQUON
Objectifs en matière de gestion : protection et amélioration

ZONE DE GESTION 5 – SOUS-BASSIN HYDROGRAPHIQUE DE LA RIVIÈRE LAYTON
Objectifs en matière de gestion : maintien, amélioration et restauration

Ce plan de gestion des pêches axé sur le bassin hydrographique a été élaboré en vue de réaliser des objectifs précis en matière de gestion en ce qui a trait à une ressource halieutique à l'échelle locale. Le Plan de gestion des pêches de la rivière Nonquon fournit un cadre qui nous permettra à la municipalité régionale de Durham, aux cantons de Scugog et de Brock, à l'Office de protection de la nature de la région de Kawartha, au MRNO et à Pêches et Océans Canada d'entreprendre des mesures compatibles et coordonnées pour traiter des enjeux touchant de façon particulière le bassin hydrographique de la rivière Nonquon.

La préparation du Plan de gestion des pêches pour la rivière Nonquon a commencé en 2003 et le processus de collecte de données, d'analyse, de consultation et de rédaction s'est échelonné sur cinq ans (de 2003 à 2007) pendant lesquels les pêches du bassin hydrographique de la rivière Nonquon en entier ont fait l'objet d'examen. Il est prévu que le plan se prolongera pendant encore cinq ans, de 2008 à 2012. À la fin de cette période, le document devrait faire l'objet d'un examen pour tenir compte des améliorations ou de nouveau enjeux ou des deux qui auraient pu avoir lieu ou se manifester lors de la période de mise en œuvre.

Pour garantir la protection, l'utilisation durable et (lorsque cela est possible) la restauration des ressources halieutiques du bassin hydrographique de la rivière Nonquon au bénéfice de tous les citoyens et citoyennes, les objectifs du Plan de gestion des pêches de la rivière Nonquon sont de :

- **Protéger et améliorer les communautés de poissons et leurs habitats.**
- **Promouvoir les avantages économiques de pêcheries saines.**
- **Promouvoir la sensibilisation de la population, l'appréciation et la bonne connaissance des ressources halieutiques et des habitats aquatiques.**
- **Inviter la participation des parties intéressées aux activités de gestion des pêches.**

- **Acquérir une meilleure connaissance des populations de poissons, de leurs habitats et des écosystèmes aquatiques.**

- **Fournir un cadre pour la gestion des pêches.**

- **Restaurer les communautés et les habitats de poissons perturbés.**

Grâce à des séances d'information publiques et de réunions de l'équipe de gestion, les communications avec toutes les parties intéressées ont été établies dès le début du processus de planification. Une équipe de gestion a été mise sur pied lors des premières étapes du plan pour permettre à la population, aux représentants gouvernementaux et de l'industrie de participer en tant qu'équipe en partageant leurs connaissances, leurs ressources et leurs préoccupations afin de trouver des solutions aux enjeux pertinents ayant une incidence sur la santé des poissons du bassin hydrographique de la rivière Nonquon. L'équipe de gestion a établi des limites des zones et les stratégies de gestion en se fondant sur l'apport des membres de l'équipe et de la population.

Au cours du processus de consultation public, la plupart des participants ont exprimé une préférence pour gérer le système de façon à accroître les populations de doré jaune. La destruction des rives et la charge de nutriants ont aussi été signalées comme enjeux touchant le bassin hydrographique exigeant des mesures de gestion. Parmi les enjeux qui ont suscité le plus d'intérêt et le plus grand nombre de réactions, il y a la mauvaise qualité de l'eau, la perte d'habitats aquatiques et le déclin des populations de poissons ainsi que la baisse du nombre de possibilités de faire la pêche le long de la rivière. Par conséquent, le Plan de gestion des pêches de la rivière Nonquon fournit une approche globale pour traiter ces enjeux.

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CHAPTER 1 – PLANNING PROCESS SUMMARY

INTRODUCTION

The Nonquon River (Figure 1) supports the multi-million dollar resources of Lake Scugog, which includes substantial recreational and angling activity (Palmer 2005). The watershed offers a unique opportunity for local residents, cottagers and shorter-term visitors to use these areas for nature viewing, canoeing, hunting and fishing. It is therefore important to manage the watershed as a shared resource.

Water resources are of significant value to Ontario residents. The quality of life that we enjoy is greatly affected by the health of the natural ecosystem around us. As our communities grow, the potential for cumulative environmental impacts from development increases (Palmer 2005). Such impacts are not limited to the lands in which they may originate, but may also affect adjacent or downstream lands. One of the most effective ways of dealing with issues of cumulative environmental impact is to use an integrated, ecosystem approach to guide development (Palmer 2005).

It has long been recognized that rural and urban land uses have the potential to negatively impact biological diversity within watersheds. One of society's greatest challenges includes the cumulative impacts of urban and rural development on the health of ecosystems. Since biological communities live in receiving waters, their health and survival is a reflection of the upstream and adjacent watershed conditions. Local species diversity in aquatic communities is related to local habitat conditions and many rivers no longer sustain socially valued aquatic species and healthy ecosystems (Poff et al. 1997).

There is growing public concern regarding the impacts of land use and development on water quality and quantity. Kawartha Conservation (KRCA) considers the future sustainability of the Nonquon River watershed a high priority as a result of its ecological significance (e.g., headwaters originating in the Oak Ridges Moraine) and increasing development pressures (Palmer 2005). Some development pressures include Port Perry and its large settlement area, the Official Plan designated employment lands known as the Nonquon Industrial Tributary Area (NITA), as well as the Sewage Treatment Plant which discharges treated sewage effluent from Port Perry into the Nonquon River (Palmer 2005). As such, a Nonquon River Subwatershed Study (NRSS) was initiated in 2000 to provide a comprehensive policy basis and regulatory framework for the integration of ecosystem considerations and environmental concerns into the land use planning process.

As part of describing existing watershed conditions for the NRSS, aquatic resources were investigated. It was found that brook trout, a sensitive indicator of high quality coldwater habitats, were residing in the headwaters of the Nonquon River and that the watershed provides valuable spawning and nursery habitat for many fishes including migrating species from Lake Scugog. In recognition of this significant resource, the Township of Scugog, the Regional Municipality of Durham and Fisheries and Oceans Canada (DFO) provided partnership funding for the creation of the Nonquon River Fisheries Management Plan (NRFMP). The Ontario Ministry of Natural Resources (OMNR) also provided valuable in-kind provisions in support of the plan.

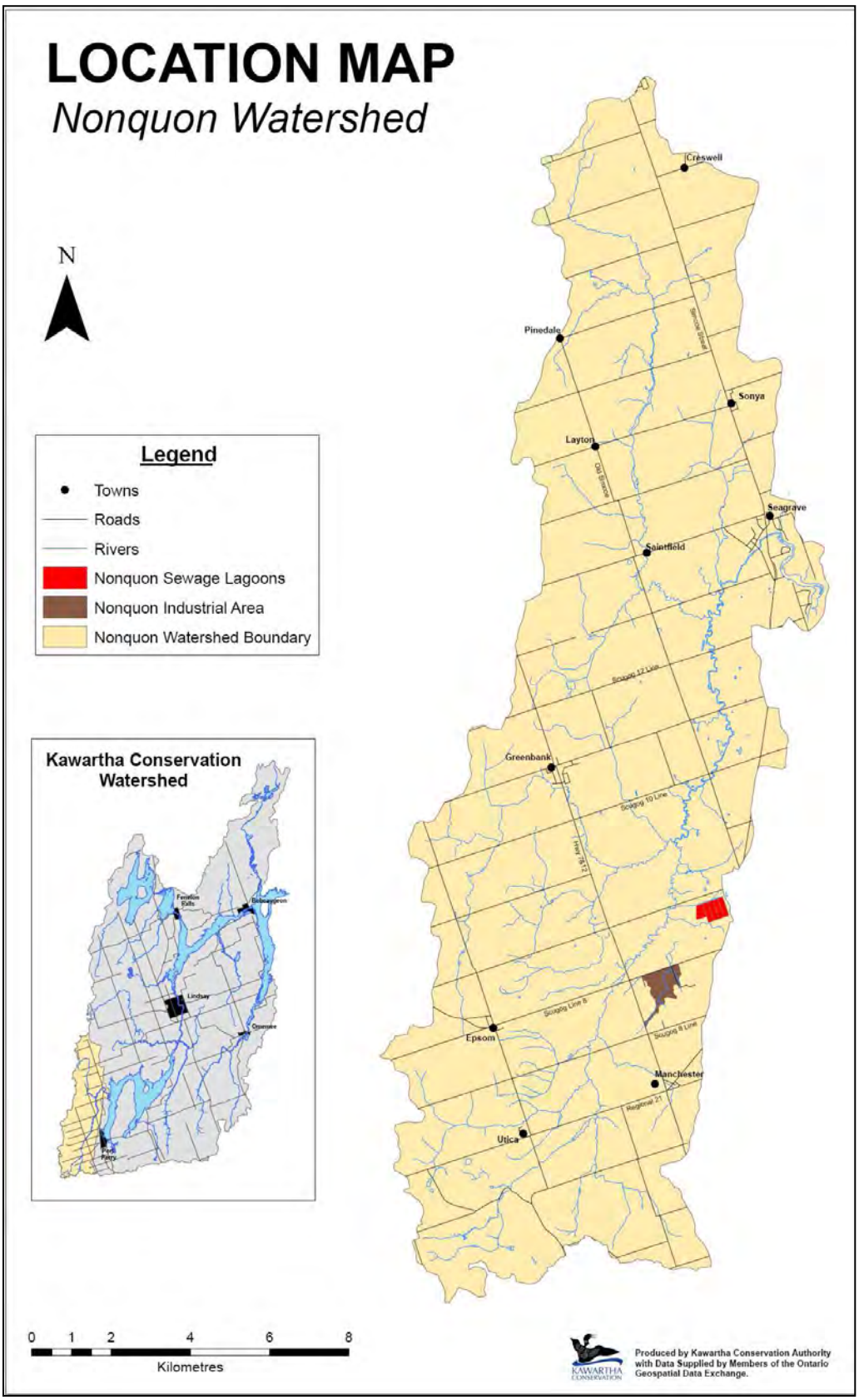

Figure 1: Location of the Nonquon River watershed (highlighted area) within KRCA's watershed boundary (inset).

PLAN DEVELOPMENT

The NRFMP has been prepared in accordance with Watershed-based Fisheries Management Plan Guidelines (Koenig 2005). The NRFMP is a resource document, written for the citizens and stakeholders of the Nonquon River watershed, that provides background information about the:

- Legislative framework with respect to fisheries management.
- Historic and present fish communities.
- Physical conditions within the watershed.
- Management directions for the future.
- Key areas and features that need to be protected.
- Direction for the development and implementation of rehabilitation projects and monitoring needs within the watershed.

Watershed residents, government agencies, land use planners, consultants, land developers, nature enthusiasts and anglers will find the information in this document to be of value. Social, cultural, economic and environmental benefits of the plan will be observed at the local level during implementation of the recommendations.

Support for a localized, ecosystem-based management approach comes from numerous pieces of legislation at the federal, provincial and municipal level (Table 1); detailed legislative summaries can be found in Appendix A.

CONSULTATION AND APPROVAL PROCESS

Watershed-based fisheries management planning provides an opportunity to improve local decision-making through collaborative, multi-stakeholder activities. Gathering information at the local level helps ensure that the fisheries management plan is relevant to each community. Timely identification of ecological changes is critical and it is important to engage Nonquon River communities in the monitoring of their local environment. Management team meetings and public information sessions were held to communicate technical data and identify user issues and concerns about the fishery.

STEERING COMMITTEE

The steering committee consisted of a wide range of stakeholders, demonstrating the breadth of knowledge that went into the plan. These include: OMNR, DFO, Regional Municipality of Durham, Township of Scugog, KRCA, Community Stream Stewards (Ontario Federation of Anglers and Hunters), Durham Land Stewardship Council, Scugog Lake Stewards, Lindsay Bassmasters, Business Improvement Association, Nonquon Environmental Education Centre, Ontario Federation of Agriculture, Ontario Soil and Crop Improvement Association, Trent-Severn Waterway, Ontario Ministry of Agriculture, Food and Rural Affairs and the general public.

Through the development of a Terms of Reference (KRCA 2006), the roles and responsibilities of the committee members were identified as follows:

Kawartha Conservation

- Facilitate, coordinate and provide minutes for both steering committee and public information session meetings.
- Provide materials for consideration to both groups.
- Author the plan.
- Obtain OMNR/DFO/KRCA and municipal endorsement.

Ontario Ministry of Natural Resources

- Provide advice and input on fisheries management.
- Presentation at public information sessions.
- Plan review and endorsement.
- Environmental Bill of Rights submission.

Region of Durham and Townships of Scugog and Brock

- Provide advice/expertise regarding land use planning, municipal Official Plans and provincial planning documents.
- Plan review and endorsement.

Fisheries and Oceans Canada

- Provide advice (to the team) on the 'Principles for the Management of Fish Habitat' and on *Fisheries Act* requirements.
- Plan review and endorsement.

Resource Organizations and Public (e.g., OFAH, Stakeholders)

- Provide advice/guidance/knowledge to the team.
- Plan implementation.

STAKEHOLDER CONSULTATION

Together, stakeholders can develop solutions to common problems and cooperate in the pursuit of continuous improvements. Fisheries management planning seeks to ensure communication with all stakeholders from the onset. In this way, the public, government and industry participate as a team sharing knowledge, resources and concerns to develop meaningful solutions to shared problems (Doyle and Lynch 2005).

Initial public consultation sessions were held June 1 and November 30, 2005 to obtain stakeholder input on issues and priorities for fisheries management within the watershed. Approximately 30 and 25 individuals were in attendance, respectively. Two additional opportunities for public involvement were November 1, 2006 and February 21, 2007, where approximately 36, and 24 individuals signed in, respectively. To provide written comment, questionnaires were provided at these meetings, posted on KRCA's and the Bassmasters websites, and at all KRCA communication events. In addition, a draft version of the plan was posted on the Environmental Bill of Rights registry in February 2009. Oral and written comments and concerns were welcomed at anytime during the planning process.

Tabulated results from the questionnaires can be found in Appendix C.

Table 1: Various pieces of legislation that must be taken into consideration while developing and/or implementing fisheries management plans.

Legislation	Agency	Provisions for Fish and Fish Habitat
Fisheries Act	DFO	regulates activity regarding fish and fish habitat
Navigable Waters Protection Act	Transport Canada, DFO	regulates works built on, over, through or across any navigable water
Species at Risk Act	EC, TSW, DFO	protects species at risk and their critical habitat
Canadian Environmental Assessment Act	EC, TSW, DFO	regulates the process to predict the environmental effects of proposed initiatives before they are carried out
Lakes and Rivers Improvement Act	OMNR	regulates activities affecting lakes and rivers
Fish and Wildlife Conservation Act	OMNR	regulates the capture, sale and possession of fish
Public Lands Act	OMNR	regulates activity on crown land.
Aggregate Resources Act	OMNR	provide for the management of the aggregate resources of Ontario
Ontario Planning and Development Act	OMMAH	provides for the preparation and review of development plans
Oak Ridges Moraine Conservation Act	OMMAH	protects the ecological and hydrological integrity of the Oak Ridges Moraine Area
Greenbelt Act	OMMAH	protects environmentally sensitive and agricultural land in the Golden Horseshoe
Planning Act	OMMAH	provides for a land use planning system led by provincial policy
Drainage Act	OMAFRA	permits individual and municipalities to initiate and maintain drainage works
Nutrient Management Act	OMAFRA	provides for the management of materials containing nutrients
Clean Water Act	OMOE	protects municipal drinking water supplies
Pesticides Act	OMOE	regulates discharge of substances containing pesticides into the environment
Environmental Protection Act	OMOE	provides for the protection and conservation of the natural environment
Ontario Water Resources Act	OMOE	regulates discharge into the waterbodies and withdrawal of water
Environmental Assessment Act	OMOE	provides for assessment of the effects on the environment of public and private projects
Places to Grow Act	OMPIR	provides for the accommodation of future population growth
Conservation Authorities Act	Conservation Authorities (CAs)	provides for regulation of floodplain activities
Municipal Act	CAs, Municipalities	regulates approval for construction over public shores and waters

LIFE CYCLE OF THE PLAN

The initiation of the NRFMP occurred in 2003 and the data collection, analysis, consultation and writing process was a five-year endeavour, which examined the entire Nonquon River fishery from 2003 -2007. The duration of this plan is for the next five years (2009 – 2013), at which time the document should be reviewed to address improvements and/or new issues and that may have arisen during the implementation period.

The following steps were taken to complete the NRFMP:

1. Historic and current data were collected.
2. Public information sessions held.
3. Background report completed and distributed.
4. Management team invitation and formation.
5. Terms of Reference distributed.
6. Management team meetings.
7. Second round of public information sessions.
8. Recommendations and strategies for implementation created.
9. Draft plan distributed for comment.
10. Final approval and endorsement.

VISION

The vision for the Nonquon River is: *Communities working together to maintain and enhance a healthy, self-sustaining aquatic ecosystem that contributes to the social, cultural and economic well being of the Nonquon River watershed*.

OBJECTIVES

The NRFMP was initiated to help government and non-government stakeholders to develop an adaptive management plan that promotes the health and presence of valued fishery resources. To ensure the conservation, sustainable use, and restoration (where feasible) of the Nonquon River watershed's resources, the following objectives were identified:

- **Protect and enhance fish and fish habitat.**
- **Promote economic benefits of a healthy fishery.**
- **Promote public awareness, appreciation and understanding of fisheries resources and aquatic habitats.**
- **Involve stakeholders in fisheries management activities.**
- **Develop a greater knowledge of fish populations, fish habitat and aquatic ecosystems.**
- **Provide a framework for fisheries management.**

- **Rehabilitate degraded fish communities and fish habitat.**

GUIDING PRINCIPLES

The plan must function within the existing framework of national, provincial and regional directives. The guiding principles of the provincial and federal agencies must be followed during the planning process, creation and implementation of this fisheries management plan. These include:

- Ecosystem management approach.
- Adaptive management approach.
- Importance of watersheds and terrestrial environments.
- Sustainable development.
- Identifying limits to the resource.
- Emphasis on natural reproduction of native and naturalized species.
- Science based management.
- Increased social benefits (fishing opportunities).
- Protect native biodiversity and species at risk.

To ensure these guiding principles are thoroughly incorporated into the management process, several guiding documents exist that help guide fisheries management in Ontario. These documents provide resource managers with specific tools to manage fish and water resources within a legislative and governance framework. Examples of relevant guiding documents for managing the fishery of the Nonquon River watershed are listed below. Detailed summaries of each document can be found in Appendix B.

- Policy for the Management of Fish Habitat (DFO 1986)
- Lindsay District Fisheries Management Plan 1989-2000 (OMNR 1989)
- Strategic Plan for Ontario Fisheries II: An Aquatic Ecosystem Approach to Managing Fisheries (OMNR 1992)
- A New Ecological Framework for Recreational Fisheries Management in Ontario (OMNR 2005a)
- Watershed-based Fisheries Management Plan Guidelines (Koenig 2005)
- Protecting What Sustains Us: Ontario's Biodiversity Strategy (OMNR 2005b)
- How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern (EC 2004)
- Provincial Policy Statement (OMMAH 2005b)
- Oak Ridges Moraine Conservation Plan (OMMAH 2002)
- Greenbelt Plan (OMMAH 2005a)
- Durham Region Official Plan (2006)
- Best Management Practices (OMAFRA)
- Provincial Water Quality Objectives (OMOE 1994)

PLAN IMPLEMENTATION

The implementation of the NRFMP will bring various partners and stakeholders together to share their resources, expertise and abilities to implement "best bets" in the watershed. This group of individuals will collectively be known as the NRFMP Implementation Committee, and will utilize the Watershed Issues and Management Recommendations (Chapter 2) as the foundation on which to focus their efforts. The establishment of a highly motivated and committed implementation committee is essential to ensure the management recommendations within the NRFMP are addressed as planned. As noted by Koenig (2005), early successful implementation of small, high profile projects within the watershed will likely generate more private sector interest in the larger, more costly projects.

The NRFMP provides a broad framework for protecting, maintaining, and enhancing the important environmental features, resources, and functions that are unique to the Nonquon River watershed. Through its implementation, the NRFMP will ensure that future development and watershed practices take place in a manner that balances the community's need for economic growth and development with the need for sustaining the long-term health of the fishery.

Fisheries management involves the implementation of management strategies on both a large and small scale. Large-scale management involves implementing recommendations that are applicable to all areas within a watershed. Small scale management may be focused specifically at a management area, tributary, reach or even at a site specific level depending on the particular issue that is to be addressed.

CHAPTER 2 – WATERSHED ISSUES AND MANAGEMENT STRATEGIES

INTRODUCTION

The six tables in the following chapter form the foundation to managing the Nonquon River fishery. These were created from roundtable discussions involving the technical steering committee with input from the public. Each table outlines management initiatives for specific aspects of the watershed and is organized into seven headings: *Issue, Strategy, Recommendation, Implementation, Target, Stakeholder and Priority*.

DELINEATION OF MANAGEMENT ZONES

The Nonquon River watershed is delineated into 5 management zones that are based upon select watershed characteristics that provide a strong rationale for their delineation (Figure 2). A variety of fisheries management options have been developed that apply to the entire watershed and within specific management zones.

Watershed characteristics used for zone separation included: unique fish communities (e.g., cold water fishery); unique sub-watersheds (e.g., Layton River); unique habitat reaches (e.g., walleye and muskellunge spawning areas); unique geological landforms (e.g., Oak Ridges Moraine); or any combination of these and other characteristics. In addition, goals were developed for each zone. The management zones are:

- MANAGEMENT ZONE 1 - HEADWATERS OF THE NONQUON RIVER
  Management Goal - Maintenance and Enhancement
- MANAGEMENT ZONE 2 - GREENBANK AND SURROUNDING AREA
  Management Goal – Rehabilitation
- MANAGEMENT ZONE 3 - PORT PERRY AND SURROUNDING AREA
  Management Goal – Education and Enhancement
- MANAGEMENT ZONE 4 - NONQUON RIVER MAIN CHANNEL
  Management Goal – Protection and Enhancement
- MANAGEMENT ZONE 5 - LAYTON RIVER SUBWATERSHED
  Management Goal – Maintenance, Enhancement and Rehabilitation

NONQUON RIVER WATERSHED

Only a small, headwater portion of the Nonquon River watershed lies within the Oak Ridges Moraine. The majority is located within the Peterborough Drumlin Field. In this area, the Nonquon River has a wide floodplain and low gradient. The largest tributary of the Nonquon River is the Layton River, which flows north-to-south through the Peterborough Drumlin Field. The drainage area for the Layton River is 54.52 km^2 and the main channel length is 20.6 km, joining the Nonquon River southwest of Seagrave. After crossing Simcoe Street in Seagrave, the Nonquon River dramatically changes direction and for the last few kilometres it flows in a southeasterly direction, emptying into Lake Scugog.

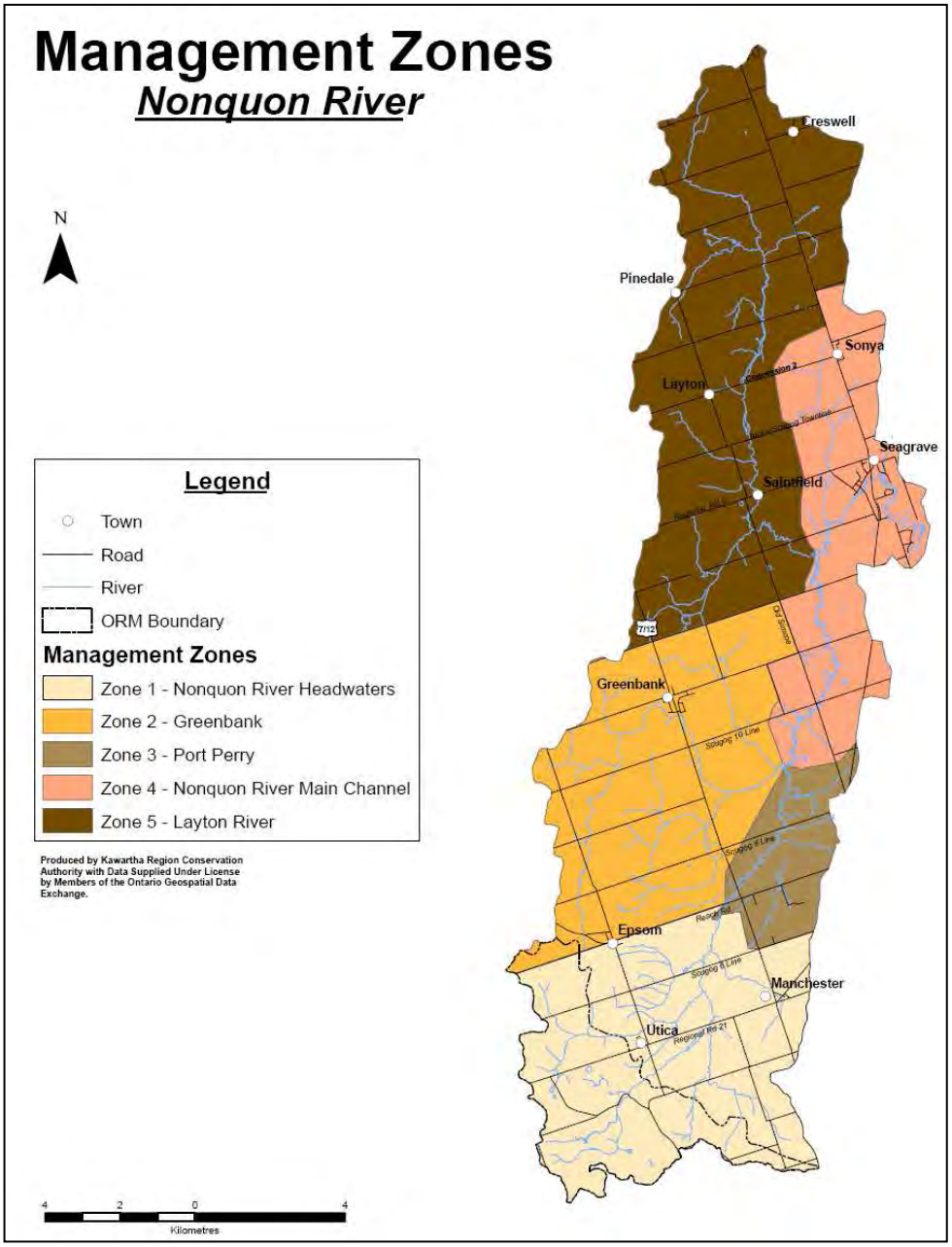

Figure 2: Nonquon River watershed delineated into five management zones.

Table 2: Watershed wide issues and management recommendations.

Watershed Wide Issues and Management Recommendations

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
HABITAT ISSUES														
Insufficient Forest/Wetland cover	Maintain or increase forest/ wetland	Work with existing legislation, guidelines and programs to protect existing forest cover and optimize reforestation activities	Utilize Regional Forest Conservation By-law. Determine optimal areas for reforestation for each Fisheries Management Zone (FMZ). Use existing legislation and grant programs that facilitate reforestation projects (e.g., Oak Ridges Moraine Conservation Plan [ORMCP], Greenbelt Plan, Provincial Policy Statement [PPS], Greenbelt Foundation, Trees Ontario, Managed Forest Tax Incentive Program [MFTIP], Greencover Canada [GC]).	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
		Identify priority areas for reforestation based on land disturbance and recharge areas	Mapping and analysis; focus restoration in key locations. Contact landowners to promote the opportunity and incentives for reforestation projects on their property. All FMZs are a priority.	30% forest cover for Nonquon watershed (presently 19.6%)	**L**	**P**			**P**				**P**	**H**
		Work with existing legislation, guidelines and programs to protect existing wetlands	Utilize the ORMCP, Greenbelt Plan, PPS, Conservation Authority (CA) guidelines, Regional Official Plan and Conservation Lands Tax Incentive Program (CLTIP). Create and maintain naturally vegetated adjacent lands around wetlands as not to disrupt the form and function of the wetland. Continue education programs on the importance of these natural systems.	Ongoing	**L**	**P**			**P**			**P**		**H**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Insufficient Forest/Wetland cover	Maintain or increase forest/ wetland	Identify areas for potential wetland creation	Inventory historical wetlands to identify key areas (e.g., headwaters) for restoration. Consider opportunities to convert off-line ponds into wetlands. Have partners contact Ducks Unlimited to conserve wetland habitat.	10% wetland area for Nonquon watershed (presently 8.8%) and 6% by FMZ	**L**	**P**			**P**				**P**	**L**
Degraded Water Quality	Improve water quality	Monitor water quality in watershed to identify sources of pollution and other problem areas	Identify and monitor water quality problem areas and work with other agencies to improve water quality (e.g., Ontario Ministry of the Environment [MOE], Ontario Ministry of Agriculture, Food and Rural Affairs [OMAFRA]). Continue Lake Scugog Environmental Management Plan (LSEMP) water quality monitoring. Use benthic macroinvertebrate studies as response indicators of organic pollution. Solicit a Kawartha Water Watch (KWW) volunteer.	Ongoing	**L**	**P**	**P**			**P**	**P**		**P**	**H**
		Reduce overland runoff	Maintain or increase permeability of lands through vegetation planting, woodlot conservation, agricultural and non-agricultural beneficial management practices (BMPs). Implement Regional Official Plan policies regarding impervious surfaces in Major Opens Space and Greenbelt Natural Heritage System when processing development applications.	Ongoing	**L**	**P**	**P**		**P**				**P**	**M**
		Sediment and erosion controls pre and post construction activities.	Promote the construction of stormwater ponds and implement BMPs for stormwater management for all construction activities to minimize sedimentation and impacts to water quality. Follow the Erosion and Sediment Control Guidelines For Urban Construction (TRCA 2006).	Ongoing	**L**		**P**	**P**	**P**					**H**

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ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Degraded Water Quality	Improve water quality	Minimize the impacts of shoreline development	Use existing legislation to regulate development and site alteration and promote BMPs. Update watershed policies to correspond with current regulations and scientific knowledge. Encourage understanding and support of habitat protection. Advocate soft stabilization techniques and encourage land management incentive program (e.g., Kawartha Conservation's [KRCA] Shoreline Program). Assess fish community based on habitat conditions and adjacent riparian areas.	Ongoing	**L**	**P**	**P**	**P**	**P**				**P**	**H**
		Discourage aesthetic use of fertilizers and pesticides	Continue education programs and explore the potential and need for pesticide By-laws on private lands.	Ongoing	**L**	**P**	**L**				**P**		**P**	**M**
		Promote buffer strips (naturally vegetated areas) along the riparian area of watercourses	Identify opportunities to restore riparian vegetation and restrict livestock access through collaborative restoration projects in strategic locations.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
			Advertise financial incentives (e.g., KRCA's Shoreline Program, Environmental Farm Plan [EFP]) and ecological benefits of buffer strips.	Ongoing	**L**				**P**				**P**	**H**
		Secure, restore, and/or create wetlands in priority areas to improve water quality	Identify priority locations for restoration.	Ongoing. 10% wetland area for the Nonquon watershed	**L**	**P**	**P**		**P**				**P**	**H**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Degraded Water Quality	Improve water quality	Encourage nutrient management, buffer strips (naturally vegetated areas) around the riparian area of all watercourses, and livestock access initiatives on agricultural land	Promote stewardship activities and incentive programs (e.g., Scugog WATER Fund, EFP) to engage community to implement such practices. Continue education and workshops on the benefits of such practices to producers (e.g., EFP, Community Stream Steward Program [CSSP], Durham Agricultural Advisory Committee [DAAC], Durham Environmental Advisory Committee [DEAC], and Durham Land Stewardship Council [DLSC]). Forward program announcements or fact sheets to the Durham Region Federation Newsletter. Use existing legislation to enforce (e.g., Nutrient Management Act).	Ongoing	**P**	**P**	**P**	**P**	**P**	**P**			**P**	**H**
		Encourage nutrient management initiatives on non-agricultural land	Promote stewardship activities, incentive programs and funding (e.g., KRCA Shoreline Program). Develop strategies to ensure a reduction in nutrients entering the watercourse.	Ongoing	**L**	**P**	**P**		**P**				**P**	**M**
			Work with municipalities and other government agencies to develop/implement policies and access funds to protect water quality (e.g., innovative land drainage, private drain classification system, BMP booklets).	Ongoing	**L**	**P**	**P**		**P**		**P**	**P**		**H**
			Ensure BMPs are communicated and easily accessible to all users within the watershed (i.e., landowners, municipalities).	Ongoing	**P**	**P**	**P**	**P**	**P**				**P**	**H**
Degraded Water Quality	Maintain/enhance zone specific thermal regimes	Expand the existing temperature monitoring to ensure that fish community targets are met	Set data loggers at key locations in all FMZs to monitor annual water temperatures.	Ongoing	**L**				**P**				**P**	**L**

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ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Degraded Water Quality	Maintain/enhance zone specific thermal regimes	Retrofit problem ponds to limit thermal influences (e.g., bottom draws, by-pass)	Inventory problem ponds and mitigate through landowner contact and promoting potential assistance for such projects (e.g., Community Stream Steward Program [CSSP]).	Ongoing	**P**				**P**				**L**	**L**
		Implement BMPs for stormwater management to reduce thermal (and water quality) impacts	Promote the innovative techniques to minimize thermal impacts (e.g., French drains, bottom draw, perimeter tree planting).	Ongoing	**P**		**P**	**P**	**P**				**P**	**H**
Insufficient Water Quantity	Maintain or enhance water levels to satisfy fish community objectives	Determine appropriate water levels (peak and low) for each management zone	Establish a peak flow sampling program and expand low flow sampling.	Ongoing	**L**	**P**	**P**		**P**		**P**		**P**	**H**
			Consider opportunities to involve the public (e.g., regular recording of water levels from stakes in the watercourse, involvement in Check Your Watershed Day).	Water levels by zone 2009	**L**				**P**				**P**	**L**
		Establish flow regime (peak and low flow) objectives based on the results of the water level study	Develop zone specific objectives for water levels.	Completed by 2010, into policy by 2012	**L**	**P**	**P**		**P**		**P**			**H**
		Mitigate areas with altered flow	Develop project aimed at restoring natural flow.	2010	**L**				**P**		**P**		**P**	**H**
			Implement BMPs for stormwater management to reduce peak flow. Work with the municipality to develop or review operational guidelines to manage future development in the watershed to ensure that site alterations support the water level objectives.	Ongoing	**P**		**L**	**P**						**M**
			Secure, restore, and or create wetlands for flow regulation. Compare existing to historic/potential wetlands. Set targets for restoration based on differences. Create priority list of areas for wetland restoration projects.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**

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					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Insufficient Water Quantity	Maintain or enhance water levels to satisfy fish community objectives	Support and incorporate the results of the water budget (balance water withdrawals with gains) from the Nonquon River Subwatershed Study	Review and revise existing water budget.	Initiate 2008	**L**	**P**	**P**				**P**			**H**
		Incorporate flow objectives into a regulatory framework	Incorporate flow objectives into the generic guidelines.	2010	**L**		**P**		**P**		**P**			**M**
		Develop a better understanding of surface and groundwater interactions and how they are affected by groundwater supply	Determine areas of significant recharge and discharge, including historic wetland information. Continuation of the York-Peel-Durham-Toronto Groundwater Management Study.	Ongoing	**L**	**P**	**P**		**P**		**P**			**H**
		Restore/secure overland runoff through maintaining/increasing recharge areas (increase permeability)	Maintain or increase permeability of lands through vegetation management/planting (woodlot conservation, agricultural BMPs, reforestation).	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
			Use existing legislation to limit development and site alteration which would result in the increase of impervious surfaces. Inform residence of tax incentives for conservation easements, MFTIP and CLTIP where applicable.	Ongoing	**P**	**P**	**L**		**P**					**H**
		Promote seasonal overland water storage outside of the floodplain (off-line ponds) for irrigation/water taking purposes as opposed to direct withdrawals	Educate community on existing financial incentive programs and conduct workshops. Work with CSSP, DAAC, DEAC, and DLSC to implement.	Ongoing	**L**	**P**	**P**			**P**			**L**	**H**
		Determine the location and extent of tile drains and assess how/whether they impact water levels	Communicate with OMAFRA to acquire information on tile drain locations and monitor flows throughout the year.	2009	**L**					**P**				**H**

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Insufficient Water Quantity	Maintain or enhance water levels to satisfy fish community objectives	Regulate and monitor all water extractions to avoid adverse impacts to aquatic species and habitats	Conduct water-taking surveys to document extent of water extraction. Support ongoing initiatives to monitor, regulate and enforce all water extractions. Consider increased monitoring and enforcement if necessary.	Ongoing	**P**	**P**					**L**			
		Monitor degree and extent of water level fluctuation to identify if problems exists and where further modification to the water level regime would improve the fishery	Communication with Trent-Severn Waterway (TSW) and KRCA's Flood Forecasting Program. Develop and implement a comprehensive water level control plan so other agencies are aware of critical areas and water levels. Negotiate/ maintain acceptable water level control agreements.	As needed	**P**				**P**			**L**		**L**
		Monitor the effects of seasonal draw-downs	Conduct spawning surveys to identify timing of migration, followed by observations of water levels post spawn. Communicate with local landowners to see whether winterkill is a problem.	ongoing	**L**	**P**	**P**		**P**			**P**	**P**	**M**
Insufficient In-stream Habitat	Protect and enhance/ rehabilitate	Enable protection of existing habitat	Use existing legislation to limit development and site alteration that would impact habitat. Update watershed policies to correspond with current regulations and scientific knowledge. Encourage partners to use information gathered within this document to identify and protect significant areas.	Ongoing	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**		**H**
			Increased compliance (education / enforcement) with existing legislation to prevent habitat degradation.	Ongoing	**P**			**P**	**P**		**P**	**P**		**H**
		Ensure watershed approach to addressing in-stream habitat improvements	Regularly monitor habitat quality and quantity, and restoration activities. Establish measurable targets to evaluate success.	Ongoing	**L**	**P**	**P**	**P**	**P**				**P**	**H**

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Insufficient In-stream Habitat	Protect and enhance/ rehabilitate	Require mitigation measures for all in-channel works	Appropriate mitigative guidelines and implications of failure to comply to be incorporated into all work permits, tenders and orders. Review all watercourse alterations with consideration for free passage of woody material, sediment, fish, flow, etc.	Initiate 2008	**L**		**P**	**P**						**M**
		Ensure future work on stream crossings satisfies this plan	Through permitting and plan review of projects including in-water timing windows.	Ongoing	**L**	**P**	**P**	**P**	**P**					**H**
		Integrate watercourse management with the planning process and take cumulative impacts into consideration.	During plan review advocate for the natural channel design approach to watercourse alterations and drainage systems and identify benefits to the proponent.	Ongoing	**L**	**P**	**P**	**L**					**P**	**H**
		Protect habitat essential to maintain productive fisheries	Monitor changes in habitat with changes in land use practices.	2010	**L**	**P**	**P**	**P**	**P**				**P**	**H**
		Evaluate limiting and critical habitat	Promote research studies to identify habitat requirements for all species and life stages and determine factors limiting production. Educate the public on the importance of fish habitat.	Ongoing	**L**	**P**	**P**		**P**					**H**
		Enhance existing conditions. Conduct surveys to identify needs for habitat rehabilitation	Prioritize rehabilitation efforts. Encourage and promote local interest groups and private landowners to initiate habitat rehabilitation projects.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
			Develop a cost effective watershed-wide sampling approach to help track changes in habitat. Consider public education to facilitate involvement in surveys.	Ongoing	**L**								**P**	**H**
	Balance sediment regime	Maintain natural downstream movement of sediment and woody debris	Explore the need for and/or feasibility of improving sediment and wood transport through the watershed.	2010	**L**				**P**				**P**	**L**

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Insufficient Riparian-Floodplain Habitat	Protect and enhance	Encourage floodplain connection to maintain healthy, diverse riparian vegetation	Determine areas where the river is not connected to the floodplain. Restore floodplain connections in areas of adverse channelling.	Achieve the appropriate connection where needed	**L**	**P**	**P**		**P**			**P**	**P**	**L**
		Use existing legislation to manage development and site alteration near natural features	Implement ORMCP, Greenbelt Plan and Official Plan where new developments occur. In areas where regulations and legislation do not apply, encourage the 30 m naturally vegetated riparian area around watercourses.	Ongoing	**L**	**P**	**P**							**M**
		Identify areas for riparian and floodplain habitat enhancement	Evaluate the current buffer width size by FMZ and the important ecological relationships between the watercourses, their associated riparian and floodplain systems and the watershed. Implement stewardship opportunities where appropriate.	Achieve the appropriate buffer width where needed.	**P**	**P**	**L**		**P**				**P**	**H**
In-stream Barriers, Water Crossings, and Ponds	Modify barriers to ensure zone specific strategies are met	Identify all barriers and on-line ponds and assess the potential long term impacts/benefits to fish, sediment and wood movement	Use imagery to identify potential barriers and draw on watershed residents to help locate problem barriers having them participate in barrier surveys and questionnaires.	2009	**L**	**P**	**P**	**P**	**P**				**P**	**M**
		Consider retrofitting/removing problematic on-line ponds and beaver dams	Inventory problem ponds and mitigate through landowner contact. Promote BMPs and potential assistance for such projects (e.g., CSSP). Education about the role of beaver in natural systems. Respond to public concern and manage beaver populations as required.	Ongoing	**P**			**P**	**P**				**L**	**L**
		Identify and mitigate problem water crossings due to narrowing or perching of the watercourse	Have the public involved with Check Your Watershed Day program to describe existing water crossings. Upgrade when existing structures are scheduled for replacement.	2009	**L**	**P**	**P**	**P**	**P**					**M**

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					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
BIODIVERSITY ISSUES														
Native/ Naturalized Species Abundance and Distribution	Maintain or enhance native/ naturalized species populations	Expand knowledge of native aquatic species population size and distributions and factors limiting them (e.g., spawner abundance, habitat, water quality) to production with consideration of whole watershed effects	Secure funding for ongoing monitoring. Develop a regular, recurring, watershed-wide sampling regime to track aquatic species distribution and trends in abundance.	2009	**L**	**P**	**P**		**P**				**P**	**H**
			Through research and partnerships.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
		Bait and forage fish population assessment	Ongoing monitoring to identify where deficient bait and forage fish populations may occur.	2009	**L**	**P**	**P**		**P**					**H**
			Encourage wise use of the baitfish resource. Continue to regulate the baitfish harvest.	2009	**P**				**L**					**L**
	Reduce competition by invasive species	Protect populations of native species from invasive species	Monitoring program will evaluate potential impacts of invasives.	Ongoing	**P**	**P**	**P**		**L**					**M**
Invasive Species Abundance and Distribution	Prohibit movement and or entry of invasive species into the Nonquon watershed	Monitor for the presence of invasive species and assess the magnitude of the problem	Develop a watershed-wide sampling approach to track fish community trends. Encourage public involvement - promote the Invasive Species Hotline (1-800-563-7711).	Ongoing	**L**	**P**	**P**		**P**				**L**	**M**
		Educate public about impacts of invasive species introductions	Prepare presentations about invasive species. Discuss pond specific issues (escapement of fish from on-line ponds). Use of interpretive signs posted at the Nonquon Environmental Education Centre (NEEC), at bridges and parking areas (e.g., Don't dump bait or aquarium fishes, Invading Species Hotline).	Ongoing	**P**			**P**	**L**				**L**	**M**
		Assess the socio-economic benefits to the fishery and the impacts invasive species may have	Work with partner agencies and local businesses to assess the impact.	2009	**L**	**P**	**P**		**P**				**P**	**M**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Invasive Species Abundance and Distribution	Prohibit movement and or entry of invasive species in the watershed	Support feasible strategies to prevent the transfer of aquatic invasive species	Educational signage and promote the Invasive Species Hotline. Engage enforcement staff (municipal and provincial) to assist with compliance.	Ongoing	**P**		**P**		**L**				**P**	**H**
		Regulate introduction pathways/vectors of invasions	Restrict private stocking of invasives in ponds with the potential for escapement into the system. Identify potential areas for pond stocking (e.g., rainbow trout/koi) within the floodplain using imagery.	Ongoing	**P**				**L**				**P**	**L**
RESOURCE USE ISSUES														
Insufficient Awareness of Aquatic Ecosystems	Optimize educational opportunities	Assess education needs	Identify topics/issues where additional education/information is required.	2009	**L**				**P**				**P**	**H**
		Expand public education programs	Develop and update fisheries information and education packages for school groups and the public. Distribute existing literature (e.g., BMP booklets/fact sheets). Use the NEEC to educate the public.	Ongoing	**L**				**P**				**P**	**H**
			Organize meetings with key users groups and attend association meetings as required.	2009	**L**				**P**				**P**	**H**
		Promote benefits of a healthy aquatic environment to raise profile of aquatic issues	Provide news releases regarding specific fisheries concerns. Produce or use existing educational materials (e.g., Helping our Fisheries brochure [KRCA], Yellow Fish Road Program, Adopt a Stream [Ontario Streams]. Disseminate information on proper land management practices and means to reduce water quality impacts.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
	Increase public awareness	Keep public informed	Use of interpretive signs in areas with high spawner densities. Have landowners investigate and report fish and fish habitat changes within their own backyards.	Ongoing	**L**								**P**	**H**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Insufficient Awareness of Aquatic Ecosystems	Increase public awareness	Keep public informed	Produce regular updates (e.g., annual state of the watershed/fishery report) to inform public of watershed issues, needs and accomplishments of projects and opportunities for involvement.	2009	**L**	**P**	**P**		**P**				**P**	**H**
		Conduct workshops	Conduct workshops as a tool for attracting those interested in stream stewardship and increasing awareness and involvement.	Ongoing	**P**	**P**	**P**		**P**				**L**	**H**
Encourage Public Involvement	Increase public involvement	Promote community involvement	Encourage public to participate in fisheries management programs (e.g. Community Fish and Wildlife Involvement Program [CFWIP]) and promote involvement (e.g., World Water Day, Earth Day, Check Your Watershed Day and National Family Fishing week). Encourage communities to "adopt a reach" or FMZ.	Ongoing	**P**	**P**	**P**	**P**	**P**				**L**	**H**
			Promote co-operative rehabilitation projects with other agencies and resource users. Develop an outreach program with partners.	Ongoing	**P**	**P**	**P**	**P**	**P**				**L**	**H**
			Provide updates on community involvement that has made a difference.	2009	**P**	**P**	**P**	**P**	**P**				**L**	**H**
	Create linkages with area stewardship initiatives	Use and promote stewardship initiatives to facilitate public involvement in the watershed	Hold CSSP and DEAC workshops specific to the Nonquon watershed as a tool for attracting those interested in stewardship and increasing awareness and involvement. Other workshops attendees may include lake Scugog Stewards Inc., Monitoring the Moraine, Stewardship Ontario, OMAFRA and DAAC.	Ongoing	**P**	**P**			**P**	**P**			**L**	**H**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Encourage Public Involvement	Offer incentives for public involvement/ action	Promote existing or newly developed incentives through advertisements or contests.	Formally recognize achievements that agencies, industry, partners and individuals have made in improving water quality and fish communities (i.e., tree planting, garbage clean-up). Inform residence of Shoreline Demonstration Sites on public lands, and funding incentives to complete stewardship activities on private lands.	As needed	**L**	**P**	**P**		**P**				**L**	**H**
	Develop an implementation committee for the FMP	Establish a committee directed by local community members and landowners with expert input provided by associated agencies	Through public meetings, identify key individuals to adopt leadership roles. Promote public involvement opportunities. Task the committee with holding regular events, projects, workshops, etc. to engage public and maintain interest.	2009	**L**		**P**	**P**	**P**		**P**		**L**	**H**
Under-utilization	Education on harvest opportunities for under-utilized species	Promote angling for panfish, common carp and white sucker	Use existing educational material and promote at workshops, festivals, etc.	2007	**P**	**P**	**P**		**L**				**P**	**H**
Over-harvest	Optimize catch and release	Encourage wise use of the resources and promote catch-release for pressured species	Through education.	Ongoing	**P**				**L**					**M**
	Advertise new fishing regulations	Promote new fishing regulations and track implementation	Through education. All efforts to enhance the fishery should be monitored to determine if strategies are meeting desired targets.	2009	**P**				**L**				**P**	**H**
	Reduce fishing mortality	Promote proper catch and release techniques. Explore alternative angling techniques (e.g., barbless hooks, artificial bait)	Through education at local festivals, in MNR regulations, and in other promotional materials	Ongoing	**P**				**L**				**P**	**L**
Conflicts Between Users	Improve landowner-angler relationships	Assess needs based on public input to determine if conflicts are real or perceived	Continue with periodic open houses to exchange information between groups.	As needed	**L**	**P**	**P**		**P**				**P**	**L**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Conflicts Between Users	Improve landowner-angler relationships	Encourage partners and landowners to report fishing violations and fish habitat destruction	Educate partners and citizens to report violations.	Ongoing	**L**			**P**	**L**				**P**	**H**
		Develop strategy for reducing litter	Clean-up days and signage. Develop a partnership and schedule to clean up access areas.	As needed	**L**				**P**				**P**	**L**
		Promote ethical practices for anglers	Collaborate with the OFAH to engage anglers to clean up after themselves and other anglers.	As needed	**L**				**P**				**P**	**M**
		Have angler groups involved with rehabilitation initiatives on private land	Promote involvement programs and incentives (e.g. CFWIP) and provide news releases.	Ongoing	**P**				**P**				**L**	**H**
Lack of Access for Fishing Opportunities	Promote the use of existing access areas	Create map or signage to inform anglers of public access areas	Access information provided in signage at NEEC, bait shops, Township Office etc.	2009	**L**				**P**				**P**	**L**
		Explore landowner – user agreements	Explore creative resource user/landowner agreements to increase access to the watercourse and fishery.	As needed	**L**								**P**	**L**
		Provide improved access through partnership arrangements	Boat ramp and fishing access improvements through written access agreements.	As needed	**L**				**P**				**P**	**L**
SCIENCE AND INFORMATION REQUIREMENTS														
Lack of Habitat Information	Identify and address information gaps and develop a research plan	Monitor for environmental and land use change using a reliable sampling approach to provide relevant information across multiple habitats while remaining cost effective	Prioritize information and research needs. Track changes in physical and chemical habitat overtime.	2009	**L**	**P**	**P**							**H**
			Establish a monitoring program which involves measurable targets to evaluate successes of restoration activities.	2009	**L**	**P**	**P**	**P**						**H**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Lack of Fish Species Distribution Information	Identify and address information gaps and develop a research plan	Continued monitoring to provide current information to make defensible management decisions. New monitoring approaches may be explored to track trends in migratory species	Develop a cost effective standard, sustainable, recurring, watershed-wide sampling approach to track fish community distribution and trends. Ensure basic inventory data collection every 3-5 years. Consider supplementing regular monitoring surveys with additional sampling to evaluate changes in abundance and distribution.	2010	**L**	**P**	**P**		**P**				**P**	**H**
			Promote research opportunities with colleges and universities and the collection of data by user groups (e.g., spawning surveys).	2009	**L**				**P**				**P**	**H**
		Monitor changes in fish distribution and abundance pre and post construction and restoration activities	Implement adaptive management through monitoring of construction and restoration activities.	2009	**L**	**P**	**P**		**P**					**H**
Lack of Resource Use Information	Determine to what extent fisheries exploitation is occurring in the watershed	Document resource use in areas lacking information	Conduct creel surveys at bridges and road crossings. Mail out questionnaires to landowners to obtain information on historical/current fishing in the watershed.	2009	**L**	**P**	**P**		**P**				**P**	**M**
Lack of Information on the Economic Benefits of a Healthy Fishery	Evaluate the contribution of healthy fish and fish habitat on the local economy	Create a document on the economic value of a healthy local fishery. Incorporate into the Lake Scugog Environmental Management Plan to evaluate the importance of a healthy watershed and the benefits to local landowners (tourism, property value etc.).	Build a local model to evaluate natural assets. Involve private sector and local businesses. Educate the public about the economic connection between tourism, property value and a healthy fishery.	ASAP		**P**			**P**					**H**

Watershed Wide Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

MANAGEMENT ZONE 1: HEADWATERS OF THE NONQUON RIVER

With a drainage area of 44.75 km^2, the boundaries for Management Zone 1 extend from the western, southern and eastern limits of the Nonquon River watershed north to Reach Street, including the villages of Utica, Manchester and Epsom. Situated within the Oak Ridges Moraine, the primary land use in this zone is agriculture, forest and meadow (Table 3). This zone supports coldwater fishes and consequently, it is the only zone in which brook trout are present (Table 4).

Table 3: Management Zone 1 land use.

Type	Area (km^2)	Percentage
Agriculture	25.87	57.81
Forest	8.92	19.93
Meadow	5.09	11.37
Urban / Rural Development	2.60	5.81
Wetland	1.95	4.36
Other	0.94	2.10

Table 4: Management Zone 1 fishes

Common Name	Scientific Name
Brook trout	*Salvelinus fontinalis*
Central mudminnow	*Umbra limi*
White sucker	*Catostomus commersoni*
Northern redbelly dace	*Phoxinus eos*
Finescale dace	*Phoxinus neogaeus*
Common shiner	*Luxilus cornutus*
Bluntnose minnow	*Pimephales notatus*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
Pearl dace	*Margariscus margarita*
Brook stickleback	*Culaea inconstans*
Pumpkinseed	*Lepomis gibbosus*
Yellow perch	*Perca flavescens*
Johnny darter	*Etheostoma nigrum*

Table 5: Zone 1 issues and management recommendations.

Fisheries Management Zone 1: Headwaters of the Nonquon River
Issues and Management Recommendations

GOAL: Maintenance and Enhancement

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
HABITAT ISSUES														
Insufficient Wetland cover	Increase wetland area	Identify areas for potential wetland creation	Inventory historical wetlands to identify areas for rehabilitation. Create priority list of areas for wetland restoration projects. Consider opportunities to convert off-line ponds into wetlands. Have partners work with Ducks Unlimited to conserve wetland habitat.	Minimum 6% wetland area (presently this zone is only 4.4%, Table A2)	**L**	**P**	**P**		**P**				**P**	**H**
Degraded Water Quality	Improve water quality	Decrease phosphorous and nitrogen levels in this zone	Continue to monitor levels of nitrogen and phosphorous in the headwaters. Ongoing water quality analysis with Lake Scugog Environmental Management Plan (LSEMP). Use benthic macroinvertebrate studies as biological response indicators of organic pollution. Promote ongoing agricultural improvements (e.g. upgraded manure storage, nutrient management).	Meet or exceed Provincial Water Quality standards. Increase Hilsenhoff rating to good or better	**L**	**P**	**P**			**P**	**P**		**P**	**H**
		Promote how a healthy fisheries benefits everyone	Education on brook trout as indicators of high quality coldwater habitats and their importance within the ecosystem.	Ongoing	**P**		**P**		**P**				**P**	**H**
Seasonal Habitat Functions	Protect and enhance/ rehabilitate habitat	Evaluate limiting (summer and winter) brook trout habitat	Investigate various options to protect and maintain coldwater inputs and thermal refuges (e.g., storm water management, natural vegetation around all watercourses). Use low flow monitoring to investigate whether water quantity is limiting brook trout distribution in summer and winter.	2009	**L**		**P**	**P**	**P**					**H**

Zone 1 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Seasonal Habitat Functions	Protect and enhance/ rehabilitate habitat	Evaluate critical habitat (spawning and nursery) and identify areas with the potential to support brook trout spawning through visual spawning surveys	Conduct spawning surveys annually in the fall. Encourage the public to investigate their own backyard for brook trout.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
In-stream Barriers, Water Crossings, and Ponds	Ensure all stream crossings enable fish migration, substrate and wood transport	Identify areas that impede fish passage	Mitigate perched culverts. Reconnect brook trout habitat currently separated by old Mill dams. Areas may include Mast Road, Marsh Hill Road and North side of Regional Road 21 (Utica).	Increase health of brook trout populations	**L**	**P**	**P**	**P**	**P**					**M**
		Identify and mitigate ponds that alter flow, temperature regime, or prevent fish movement	Investigate large pond south of Regional Road 21 for fish presence and passage. Consider retrofitting pond with a bottom draw if thermal impacts are detected.	Ongoing	**L**			**P**	**P**				**P**	**H**
RESOURCE USE ISSUES														
Over-harvest	Encourage catch and release	Investigate whether brook trout regulations are needed	Continue monitoring of brook trout populations to evaluate changes in abundance and distribution.	2009	**L**	**P**	**P**		**P**				**P**	**L**
SCIENCE AND INFORMATION REQUIREMENTS														
Lack of Habitat Information	Identify and address information gaps and develop a research plan	Identify key spawning locations for brook trout throughout this zone	Conduct intense spawning surveys annually. Investigate areas for potential habitat rehabilitation projects. Approach landowners in areas where brook trout restoration is viable and arrange to conduct habitat improvements. Monitor any restoration efforts.	2009	**L**	**P**	**P**		**P**				**P**	**H**
Lack of Fish Species Distribution Information	Maintain and enhance brook trout populations	Expand knowledge of brook trout distributions and density, and factors limiting production.	Continue monitoring of brook trout populations to evaluate changes in abundance and distribution.	Ongoing	**L**	**P**	**P**	**P**	**P**				**P**	**H**

Zone 1 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

MANAGEMENT ZONE 2: GREENBANK AND SURROUNDING AREA

With a drainage area of 42.52 km^2, the boundaries for Management Zone 2 encompass a large tributary that flows into the Nonquon River main channel from the west. The boundaries extend south to Reach Street and north to Scogog Line 12, including the village Greenbank and Epsom. The primary land use in this zone is agriculture and wetland (Table 6). The fishes that are present in this zone are listed in Table 7.

Table 6: Management Zone 2 land use.

Type	Area (km^2)	Percentage
Agriculture	32.42	76.25
Forest	5.08	11.95
Meadow	4.01	9.43
Urban / Rural Development	2.22	5.22
Wetland	7.73	18.18
Other	0.40	0.94

Table 7: Management Zone 2 fishes.

Common Name	Scientific Name
Central mudminnow	*Umbra limi*
Northern redbelly dace	*Phoxinus eos*
Common shiner	*Luxilus cornutus*
Brassy minnow	*Hybognathus hankinsoni*
Fathead minnow	*Pimephales promelas*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
Brook stickleback	*Culaea inconstans*
Pumpkinseed	*Lepomis gibbosus*
Yellow perch	*Perca flavescens*
Iowa darter	*Etheostoma exile*

Table 8: Zone 2 issues and management recommendations.

Fisheries Management Zone 2: Greenbank and Surrounding Area
Issues and Management Recommendations

GOAL: Rehabilitation

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
HABITAT ISSUES														
Insufficient Forest	Increase forest cover	Identify priority areas for reforestation based on land disturbance and recharge areas	Utilize Regional Forest Conservation By-law to protect existing woodlands. Use existing legislation and grant programs that facilitate reforestation projects (e.g., Trees Ontario Foundation, Greenbelt Plan, Provincial Policy Statement [PPS], Greenbelt Foundation, Managed Forest Tax Incentive Program [MFTIP]).	Increased forest cover (presently this zone is only 12% forest, Table A2)	**L**	**P**	**P**		**P**				**P**	**H**
Degraded Water Quality	Improve water quality	Mitigate erosion and runoff issues in this zone	Use existing funding programs to foster stewardship opportunities and promote funding opportunities for these works to landowners.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
Insufficient Riparian Habitat	Restore habitat	Establish a naturally vegetated riparian zone around the tributaries in this zone	This zone would benefit greatly from riparian restoration and should be considered a priority. Contact landowners to promote stewardship opportunities and appropriate tax incentives.	Achieve the appropriate riparian zone size where needed.	**L**	**P**	**P**		**P**				**P**	**H**
In-stream Barriers and Ponds	Modify barriers to ensure impacts to the fishery are minimized	Consider retrofitting/removing problematic on-line ponds and dams	Mitigate habitat currently separated by an old Mill dam close to Greenbank and on-line, bermed ponds with a drop inlet device that also exist in this zone on private property.	Remove barriers	**L**			**P**	**P**				**P**	**H**

Zone 2 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
BIODIVERSITY ISSUES														
Native and Naturalized Species	Improve species diversity	Improve habitat and migration routes	Secure funding for ongoing monitoring. Develop a regular, recurring sampling regime to track aquatic species distribution and trends in abundance. Work with partners to gain access to properties for assessments.	Increased species diversity	**L**	**P**	**P**		**P**				**P**	**H**
SCIENCE AND INFORMATION REQUIREMENTS														
Lack of fish habitat and species distribution information	Identify and address information gaps and develop a research plan	Increase sampling locations within this zone to better understand fish habitat availability and species distribution	Develop a regular, recurring sampling regime to track habitat changes, and aquatic species distribution and trends in abundance.	2009	**L**	**P**	**P**		**P**				**P**	**H**
		Improve habitat so that it may support brook trout populations	Expansion of brook trout in this zone could be accomplished through adult transfers or stocking. Currently not a priority.	2010	**P**				**L**				**P**	**L**

Zone 2 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

MANAGEMENT ZONE 3: PORT PERRY AND SURROUNDING AREA

With a drainage area of 10.63 km^2, Management Zone 3 is located west of Port Perry and encompasses the Nonquon Industrial Tributary Area. The southern limit of the boundary is Scogog Line 6 and the northern limit extends to where the western tributary (Management Zone 2) enters the Nonquon River main channel. The primary land use is wetland, agriculture and urban/rural development (Table 9). The fishes that are present within this zone are listed in Table 10.

Table 9: Management Zone 3 land use.

Type	Area (km^2)	Percentage
Agriculture	3.37	31.70
Forest	0.61	5.74
Meadow	0.60	5.64
Urban / Rural Development	1.22	11.48
Wetland	4.92	46.28
Other	0.59	5.55

Table 10: Management Zone 3 fishes.

Common Name	Scientific Name
Central mudminnow	*Umbra limi*
White sucker	*Catostomus commersoni*
Northern redbelly dace	*Phoxinus eos*
Finescale dace	*Phoxinus neogaeus*
Brassy minnow	*Hybognathus hankinsoni*
Golden shiner	*Notemigonus crysoleucas*
Common shiner	*Luxilus cornutus*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*Pimephales promelas*
Creek chub	*Semotilus atromaculatus*
Pearl dace	*Margariscus margarita*
Brown bullhead	*Ameiurus nebulosus*
Banded killifish	*Fundulus diaphanus*
Brook stickleback	*Culaea inconstans*
Rock bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Largemouth bass	*Micropterus salmoides*
Yellow perch	*Perca flavescens*

Table 11: Zone 3 issues and management recommendations.

Fisheries Management Zone 3: Port Perry and Surrounding Area
Issues and Management Recommendations

Goal: Education and Enhancement

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER								PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
HABITAT ISSUES														
Insufficient Forest	Increase forest cover	Work with existing legislation and Official Plans to protect existing forests and identify priority areas to optimize reforestation activities based on land disturbance and recharge areas	Utilize Regional Forest Conservation By-law to protect existing woodlands. Utilize existing legislation and grant programs that facilitate reforestation projects (e.g., Trees Ontario Foundation, Greenbelt Plan, Provincial Policy Statement [PPS], Greenbelt Foundation, Managed Forest Tax Incentive Program [MFTIP]).	Increased forest cover (presently this zone is only 5.7% forest, Table A2)	**L**	**P**	**P**		**P**				**P**	**H**
Insufficient Water Quantity and Quality - Future Development	Enhance water quality and quantity	Road ditching activities should be documented and mitigation attempted to reduce sediment and contaminant impacts	Provide workshops to Works Department on Construction Impacts to Fish and Fish Habitat and beneficial management practices (BMPs).	Annual workshop as needed	**L**	**P**	**P**	**P**						**M**
		Implement BMPs for stormwater management to reduce peak flows, maintain thermal and sediment regimes and minimize contamination	Municipalities to develop or review operational guidelines to manage future development in the watershed.	2009	**P**	**P**	**L**	**P**						**H**
		Continue to investigate upgrades to sewage treatment plant	Proposed upgrades to Nonquon River WPCP currently being reviewed by MOE. Continue effluent monitoring program. Continue public education on upgrades.	As per Provincial Water Quality Guidelines (OMOE 1994)	**P**	**L**	**P**				**P**			**H**

Zone 3 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Insufficient Water Quantity and Quality - Future Development	Enhance water quality and quantity	Minimize the impacts of urban/rural development	Ensure, through the plan input and review process, that land development projects minimize or prevent impacts to fish habitat through stormwater, erosion and sediment control planning, building setbacks, vegetation retention, encourage 'green' development etc. Educate and assist landowners to protect fish habitat by providing information and advice. Ensure BMPs are communicated and easily accessible to all users within the watershed (i.e., landowners, municipalities).	Ongoing	**L**	**P**	**P**	**P**	**P**		**P**		**P**	**H**
			Promote incentive programs and funding opportunities with planning applications.	Ongoing	**P**	**P**	**P**	**P**	**P**		**P**		**P**	**H**
Insufficient In-stream Habitat	Enhance existing conditions	Protect habitat essential to maintain productive fisheries	Monitor changes in habitat with changes in land use practices.	2010	**L**		**P**	**P**	**P**				**P**	**H**
Seasonal Habitat Functions	Monitor use	Presently a beaver dam limits muskellunge migration into this zone. If the dam blows out, or an alternative route is created, there is potential for muskellunge to use this zone for spawning.	Monitor changes in water movement.	Ongoing	**L**			**P**	**P**				**P**	**M**
BIODIVERSITY ISSUES														
Invasive Species	Monitor for presence of invasive species	Monitor for the movement of black crappie in this zone	Conduct standardized sampling to monitor population variation.	2010	**L**		**P**		**P**				**P**	**M**

Zone 3 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

MANAGEMENT ZONE 4: NONQUON RIVER MAIN CHANNEL

With a drainage area of 30.57 km^2, the boundaries for Management Zone 4 extends south to where the western tributary (Management Zone 2) enters the Nonquon River main channel, east to Lake Scugog and includes the villages of Seagrave and Sonya. The primary land use is agriculture and wetland (Table 12). Unique fishes to this Zone are blackchin shiner, troutperch, smallmouth bass, black crappie, walleye and brook silverside (Table 13).

Table 12: Management Zone 4 land use.

Type	Area (km^2)	Percentage
Agriculture	14.66	47.96
Forest	2.84	9.29
Meadow	1.78	5.82
Urban / Rural Development	2.66	8.70
Wetland	7.91	25.88
Other	1.14	3.74

Table 13: Management Zone 4 fishes.

Common Name	Scientific Name
Central mudminnow	*Umra limi*
White sucker	*Catostomus commersoni*
Brassy minnow	*Hybognathus hankinsoni*
Golden shiner	*Notemigonus crysoleucas*
Common shiner	*Luxilus cornutus*
Blackchin shiner	*Notropis heterodon*
Bluntnose minnow	*Pimephales notatus*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
Pearl dace	*Margariscus margarita*
Brown bullhead	*Ameiurus nebulosus*
Banded killifish	*Fundulus diaphanus*
Brook silverside	*Labidesthes sicculus*
Brook stickleback	*Culaea inconstans*
Trout perch	*Percopsis omiscomaycus*
Rock bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
Black crappie	*Pomoxis nigromaculatus*
Yellow perch	*Perca flavescens*
Walleye	*Sander vitreus*
Iowa darter	*Etheostoma exile*
Johnny darter	*Etheostoma nigrum*

Table 14: Zone 4 issues and management recommendations.

Fisheries Management Zone 4: Nonquon River Main Channel
Issues and Management Recommendations

Goal: Protection and Enhancement

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER								PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
HABITAT ISSUES														
Insufficient Forest	Increase forest cover	Work with existing legislation and Official Plans to protect existing forests and identify priority areas to optimize reforestation activities based on land disturbance and recharge areas	Utilize Regional Forest Conservation By-law to protect existing woodlands. Use existing legislation and grant programs that facilitate reforestation projects (e.g., Trees Ontario Foundation, Greenbelt Plan, Provincial Policy Statement [PPS], Greenbelt Foundation, Managed Forest Tax Incentive Program [MFTIP]).	Increased forest cover (presently this zone is only 9.3% forest, Table A2)	**L**	**P**	**P**		**P**				**P**	**H**
Degraded Water Quality	Improve water quality	Continue monitoring water quality and determine the assimilative capacity of the wetland	Continue Lake Scugog Environmental Plan (LSEMP) and Provincial Water Quality Monitoring Network (PWQMN) sampling projects.	Ongoing	**L**	**P**	**P**				**P**			**H**
		Encourage nutrient and pesticide management initiatives	Continue education programs regarding beneficial management practices (BMPs) and pesticide use. Provide education on the importance of maintaining your septic system and environmentally friendly lawn care to residents along lower Nonquon River. Promote ongoing golf course improvements.	Ongoing	**L**	**P**	**P**		**P**		**P**		**P**	**M**
Insufficient Water Quantity	Maintain wetland water levels	Continue peak and low flow monitoring including water level documentation	Create partnerships to monitor water levels.	Ongoing	**P**	**P**	**P**		**P**			**L**		**H**
Insufficient Riparian Habitat	Protect the nearshore zone	Education on the importance of shoreline habitat to the fishery and the impacts of shoreline development	Provide workshops and encourage local interest groups and private landowners to initiate habitat rehabilitation projects.	Ongoing	**P**	**P**	**P**		**P**				**L**	**H**

Zone 4 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Insufficient Riparian Habitat	Protect the nearshore zone	Encourage the use of soft stabilization techniques to minimize shoreline erosion	Promote bioengineering and the importance of native shoreline vegetation.	Ongoing	**L**	**P**	**P**	**P**	**P**				**P**	**H**
		Encourage no-mow zones along the river to establish naturally vegetated buffers	Educate and assist landowners with shoreline gardens and plantings. Promote buffer strips in areas where the river passes through yards.	Ongoing	**L**		**P**		**P**				**P**	**H**
		Provide low impact access points	Develop an access plan with Nonquon Environmental Education Centre (NEEC). Build boardwalks to increase angler access and reduce wetland trampling.	2010	**L**				**P**				**P**	**L**
Insufficient In-stream Habitat	Habitat management	Minimize the impacts of urban/rural development	Ensure, through the plan input and review process, that land development projects minimize or prevent impacts to fish habitat through stormwater, erosion and sediment control planning, building setbacks, vegetation retention, encourage 'green' development etc. Educate and assist landowners to protect fish habitat by providing information and advice. Ensure BMPs are communicated and easily accessible to all users within the watershed (i.e., landowners, municipalities).	Ongoing	**L**	**P**	**P**	**P**	**P**		**P**		**P**	**H**
			Promote incentive programs and funding opportunities with planning applications.	Ongoing	**P**	**P**	**P**	**P**	**P**				**P**	**H**
Seasonal Habitat Functions	Critical habitat evaluation	Regularly monitor habitat quality and quantity	Assess use of natural walleye spawning areas through visual spawning surveys.	2009	**L**		**P**		**P**				**P**	**H**
			Assess use of natural floodplain systems by muskellunge through visual spawning surveys.	2009	**L**	**P**	**P**		**P**				**P**	**H**

Zone 4 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
Seasonal Habitat Functions	Critical habitat evaluation	Evaluate walleye and muskellunge spawning success	Monitor to evaluate whether walleye and muskellunge spawning areas are in need of rehabilitation.	2009	**L**	**P**	**P**		**P**				**P**	**H**
			Identification and evaluation of high use spawning and rearing locations by setting drift nets (fry surveys) downstream of spawning sites for walleye and muskellunge.	2010	**L**	**P**	**P**		**P**				**P**	**H**
	Document seasonal characteristics of wetland fish habitat	Expand fish community assessment in marsh habitats to include seasonal sampling to document species use	Establish seasonal (May/June and Fall) fish sampling protocol with multiple gear types.	2010	**L**	**P**	**P**		**P**					**H**
In-stream Barriers, Water Crossings, and Ponds	Modify barriers to ensure fish passage and maintain downstream water quantity	Consider removal (partial) of beaver dam upstream of Scugog Line 10	Respond to public concern and manage beaver populations as required.	2009	**L**			**P**	**P**				**P**	**L**
BIODIVERSITY ISSUES														
Native and Naturalized Species	Enhance native and naturalized species populations unique to this zone	Determine why bullhead populations have declined	Monitor communities every 3-5 years in a standard manner to assess trends in species abundance and distributions.	2011	**L**	**P**	**P**		**P**					**H**
Invasive Species	Promote the black crappie fishery	Monitor presence and abundance of black crappie in this zone and promote the black crappie fishery	Conduct standardized sampling to monitor population variation.	Declines in species presence / abundance	**L**	**P**	**P**		**P**				**P**	**L**

Zone 4 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
RESOURCE USE ISSUES														
Over-harvest	Reduce harvest rates of walleye	Promote other fishing opportunities	Through media and education. Promote alternate fishing techniques to harvest coarse fishes (carp and suckers) and other species (e.g., panfish, perch), through angling clubs and local festivals. Promote this fishery to various media sources. Host a family fishing derby during family fishing week.	2009	**P**	**P**	**P**		**L**				**P**	**H**
		Evaluate the degree to which new fishing regulations are impacting the stocks	Develop a trend through time analysis.	2009	**P**				**L**				**P**	**H**
	Consider sanctuaries	Explore whether fish sanctuaries are required in the watershed	Discuss the option of a sanctuary with MNR.	As needed	**P**				**L**				**P**	**L**
	Optimize catch and release	Encourage wise use of the resources and promote catch-release for pressured species	Through education. Obtain creel information on walleye and muskellunge.	Ongoing	**L**				**P**					**M**
Insufficient awareness of aquatic ecosystems	Optimize educational opportunities	Promote benefits of a healthy aquatic environment to raise profile of aquatic issues	Promote watershed health and awareness by developing ecosystem health activities at the NEEC. Support educational activities at the NEEC.	2010	**L**								**P**	**M**
Access	Minimize wetland disturbance	Control pedestrian access	Develop an access plan with NEEC. Build boardwalks to increase angler access and reduce wetland trampling.	2009	**L**								**P**	**L**
	Promote the use of existing access areas	Promote the use of existing non-motor boat access areas such as Scugog Line 8 and 10	Access information provided in signage at the NEEC, bait shops, Township Office etc.	2009	**L**				**P**				**P**	**L**
SCIENCE AND INFORMATION REQUIREMENTS														
Lack of fish species distribution information	Identify and address information gaps and develop a research plan	Migratory species assessment	Conduct sampling in this zone to increase our knowledge of wetland use by lake species (e.g., walleye and muskellunge) and of warm-water natives.	2009	**L**	**P**	**P**						**P**	**H**

Zone 4 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

MANAGEMENT ZONE 5: LAYTON RIVER SUBWATERSHED

With a drainage area of 59.34 km^2, the boundaries of Management Zone 5 extend south to Scogog Line 12 and east to where the Layton River enters the Nonquon River main channel, including the villages of Layton, Pinedale and Saintfield. The primary land use is agriculture, forest and wetland (Table 15). Fishes unique to this Zone include hornyhead chub, longnose dace, central stoneroller and logperch (Table 16).

Table 15: Management Zone 5 land use.

Type	Area (km^2)	Percentage
Agriculture	35.87	60.45
Forest	10.97	18.49
Meadow	2.89	4.87
Urban / Rural Development	2.64	4.45
Wetland	7.23	12.18
Other	0.51	0.86

Table 16: Management Zone 5 fishes.

Common Name	Scientific Name	Common Name	Scientific Name
Central mudminnow	*Umbra limi*	Creek chub	*Semotilus atromaculatus*
White sucker	*Catostomus commersoni*	Pearl dace	*Margariscus margarita*
Northern redbelly dace	*Phoxinus eos*	Central stoneroller	*Campostoma anomalum*
Finescale dace	*Phoxinus neogaeus*	Brown bullhead	*Ameiurus nebulosus*
Brassy minnow	*Hybognathus hankinsoni*	Brook stickleback	*Culaea inconstans*
Hornyhead chub	*Nocomis biguttatus*	Rock bass	*Ambloplites rupestris*
Common shiner	*Luxilus cornutus*	Pumpkinseed	*Lepomis gibbosus*
Bluntnose minnow	*Pimephales notatus*	Largemouth bass	*Micropterus salmoides*
Fathead minnow	*Pimephales promelas*	Yellow perch	*Perca flavescens*
Blacknose dace	*Rhinichthys atratulus*	Iowa darter	*Etheostoma exile*
Longnose dace	*Rhinichthys cataractae*	Logperch	*Percina caprodes*

Table 17: Zone 5 issues and management recommendations.

Fisheries Management Zone 5: Layton River Subwatershed
Issues and Management Recommendations

Goal: Maintenance, Enhancement and Rehabilitation

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER								PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
HABITAT ISSUES														
Degraded Water Quality	Improve water quality	Decrease phosphorous and nitrogen levels in this zone	Continue to monitor levels of nitrogen and phosphorous. Supplement the current water quality analysis with Lake Scugog Environmental Management Plan (LSEMP) with an additional sampling location in the headwater area. Use benthic macroinvertebrate studies as biological response indicators of organic pollution.	Meet or exceed Provincial Water Quality standards. Increase Hilsenhoff rating to good or better	**L**	**P**	**P**				**P**		**P**	**H**
Insufficient Riparian Habitat	Restore	Establish a naturally vegetated riparian zone around the tributaries in this zone	This zone would benefit greatly from riparian restoration and should be considered a priority. Promote stewardship opportunities and appropriate incentive programs.	Achieve the appropriate riparian zone size where needed.	**L**	**P**	**P**		**P**				**P**	**H**
Insufficient In-stream Habitat	Protect and enhance	Prepare a habitat protection and rehabilitation plan, identifying priority areas for restoration	Continue monitoring and identify critical and degraded habitat. Identify potential of tributaries to support coldwater fishes.	Ongoing	**L**	**P**	**P**		**P**				**P**	**H**
In-stream Barriers, Water Crossings, and Ponds	Rehabilitate	Monitor the recent dam blow-out at Brock Concession 2	Assess fish community and habitat changes.	Increase in coldwater fishes	**L**	**P**	**P**		**P**					**H**

Zone 5 Issues Table **L = Lead, P = Partner** **Priority Level: L = low, M = medium, H = high**

ISSUE	STRATEGY	RECOMMENDATION	IMPLEMENTATION	TARGET	STAKEHOLDER									PRIORITY
					Kawartha Conservation	Reg. of Durham	Municipalities	Fisheries and Oceans	Min. of Nat. Resources	Min. of Agr. And Food	Min. of Environment	Trent Severn-Waterway	Stewards	
BIODIVERSITY ISSUES														
Invasive Species	Monitor for presence of invasive species	Monitor for the potential movement of black crappie into this zone	Conduct standardized sampling to monitor presence and impacts to the native fishes.	2009	**L**	**P**	**P**		**P**				**P**	**M**
RESOURCE USE ISSUES														
Insufficient awareness of aquatic ecosystems	Promote how a healthy fisheries benefits everyone	Education on coldwater systems and their importance within the ecosystem	Provide news releases regarding specific fisheries concerns. Produce or use existing educational materials (e.g., Helping our Fisheries brochure [KRCA], Yellow Fish Road Program, Adopt a Stream [Ontario Streams]. Disseminate information on proper land management practices and means to reduce water quality impacts. Promote naturally vegetated buffer strips along all watercourse within agricultural and non-agricultural land such as golf courses and shoreline residences.	Ongoing	**P**	**P**	**P**	**P**	**P**	**P**			**L**	**H**
SCIENCE AND INFORMATION REQUIREMENTS														
Lack of fish habitat and species distribution information	Identify and address information gaps and develop a research plan	Increase sampling locations within this zone to better understand fish habitat availability, species distribution and factors limiting production	Expand monitoring within this zone to better understand fish habitat availability and species distribution. Monitor communities every 3-5 years to assess native species abundance and distributions.	2009	**L**	**P**	**P**		**P**					**H**
			Expand sampling in this zone to increase our knowledge of fish communities due to the changing conditions (dam blow-out).	2009	**L**	**P**	**P**		**P**					**H**
		Improve habitat so that this zone may support brook trout populations	Expansion of brook trout in this zone could be accomplished through adult transfers or stocking. Currently not a priority.	2010	**P**				**L**				**P**	**L**

Zone 5 Issues Table **L = Lead, P = Partner** **Priority: L = low, M = medium, H = high**

CHAPTER 3 – WATERSHED CHARACTERISTICS

PHYSIOGRAPHY

The physiographic characteristics within the Nonquon River watershed were formed from a series of glacial advances and retreats that occurred in a time period known as the Pleistocene Epoch. The primary units represented are the Oak Ridges Moraine located to the south and the Peterborough Drumlin Field (Till Plain) located throughout the remainder of the watershed (Figure 3). The Oak Ridges Moraine is characterized by a complex mix of glacially deposited sands, gravel and till with outcrops of boulder clay, kettle lakes and knobby hills (Palmer 2005). The Till Plain lies to the north of the Oak Ridges Moraine and consists of rolling, drumlinized terrain. In the southern portion of the Drumlin Field near the Oak Ridges Moraine, materials are sandy. Toward the north of this region, clay tills are common (Palmer 2005). Many of the river valleys in this area are very flat and many of the wetlands occur at similar elevations as the lakes into which their rivers drain. Percent physiography by management zone is listed in Appendix D.

LAND USE

All natural systems within a watershed are linked in some way and as a result, aquatic resources are significantly affected by land use. Water connects the entire watershed through overland, groundwater and watercourse flow. What happens to the water on land directly affects the composition of groundwater and surface water. The Nonquon River watershed is predominantly rural with urban settlement areas located in Layton, Seagrave, Greenbank, Epsom, Utica and Manchester. Industrial development is also located to the west of Port Perry and to the south of Reach Street.

Ecological Land Classification (ELC) is a tool developed by the OMNR to describe ecological communities in southern Ontario by dominant vegetation, soil type, drainage and physiography (Lee et al. 1998). It provides a consistent, standardized approach for the description, inventory, and interpretation of ecosystems. However, the ELC focus on natural communities has excluded some useful cultural land use classification. As a result, Credit Valley Conservation Authority developed a protocol to complement existing ELC categories. KRCA adopted this protocol for the classifications of Urban and Rural Development, Manicured Open Space, Intensive Agriculture, and Non-Intensive Agriculture (KRCA 2004). Major land use categories within the Nonquon River watershed include Agriculture, Forest, Meadow, Urban and Rural Development, Wetlands and Other (Table 18, Figure 4).

KRCA delineated land use categories to classify the Nonquon River watershed from available 1988 and 2002 aerial photography. The primary land use within the watershed has not changed extensively over this 14-year period; predominantly agriculture and forest. The greatest land use changes over the past 14 years have been a decrease in meadow area and an increase in urban/rural development (Table 19). Detailed ELC land uses for each management zone are listed in Appendix D.

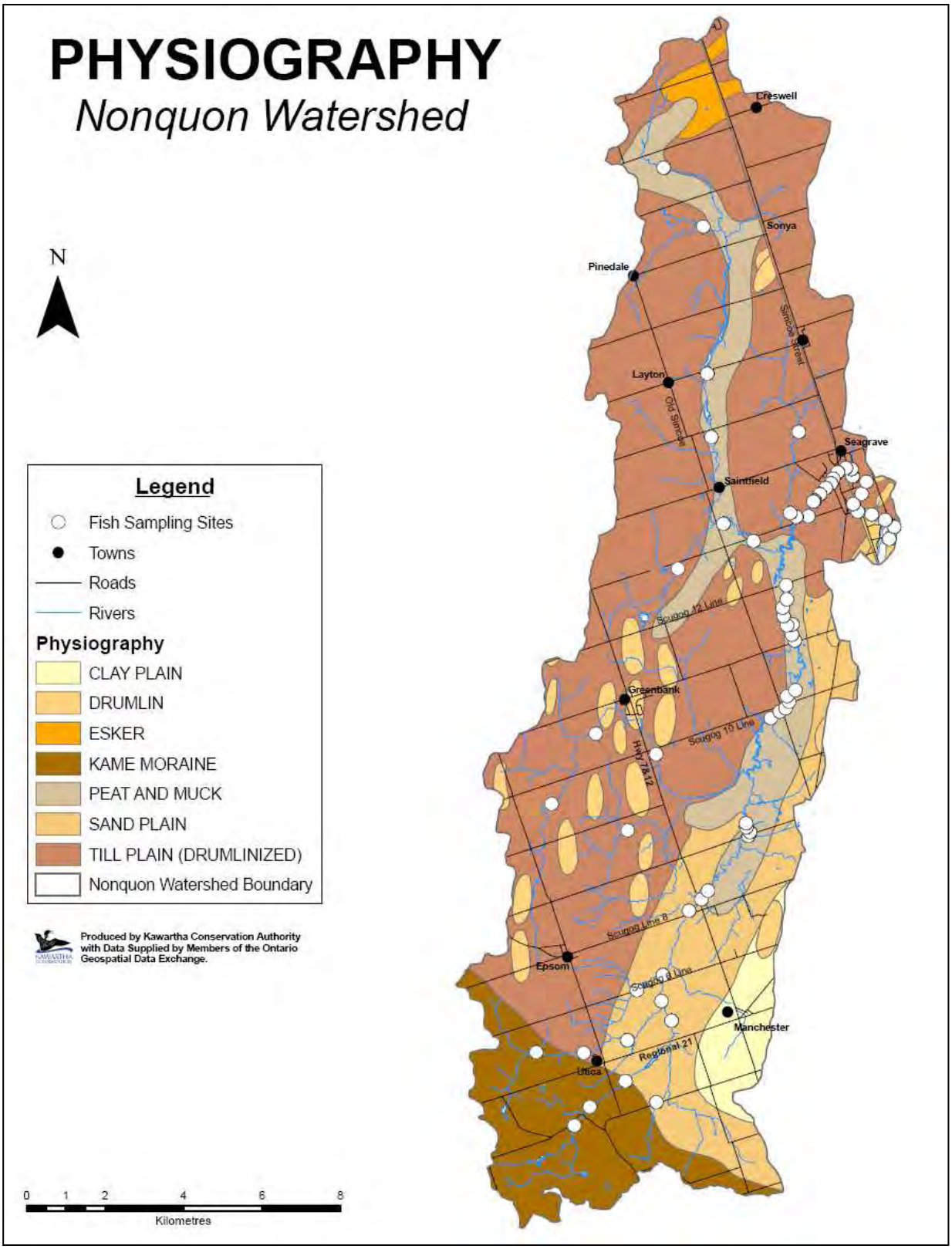

Figure 3: Physiographic regions of the Nonquon River watershed.

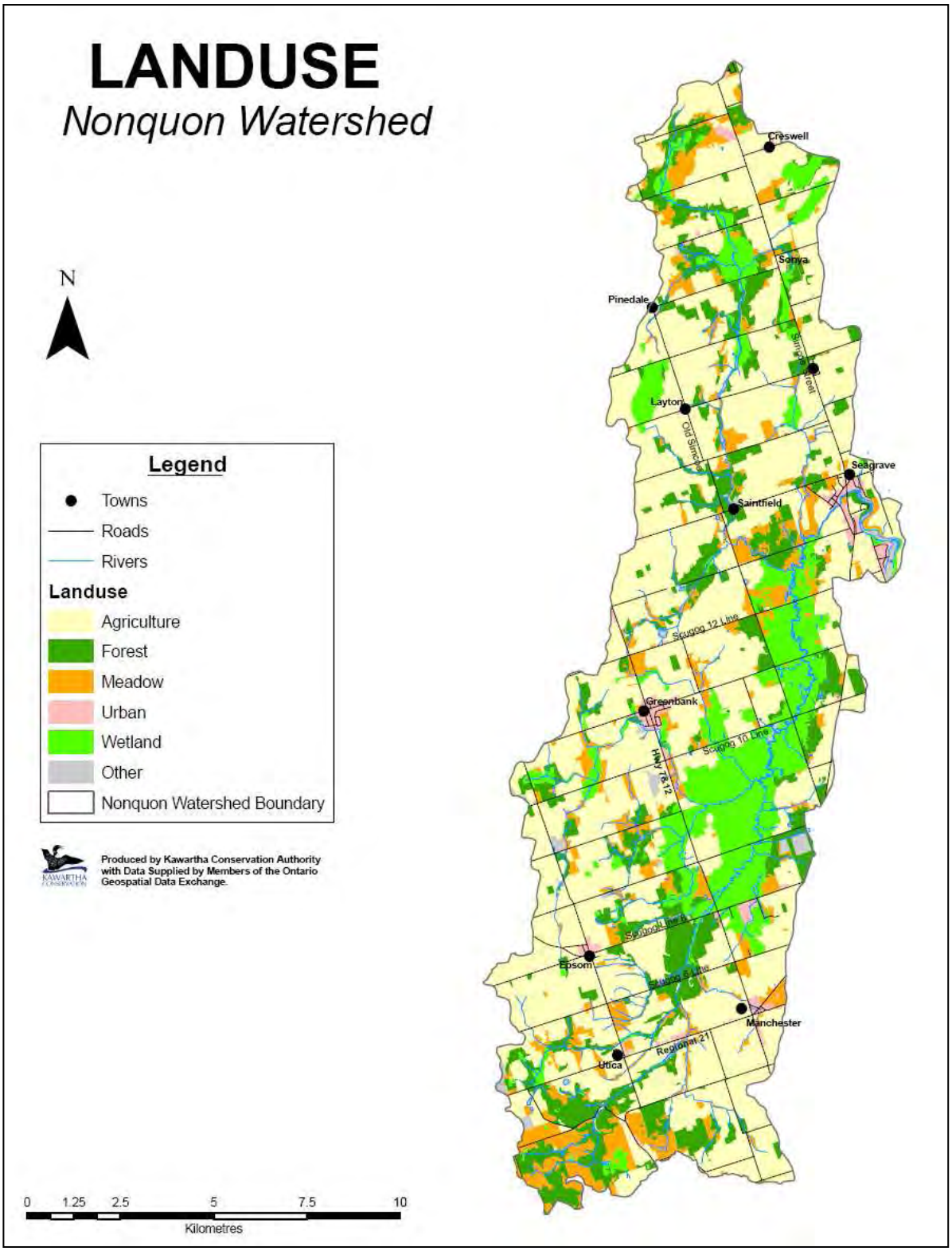

Figure 4: Ecological land classification summarized into Agriculture, Forest, Meadow, Urban, Wetland and Other land uses for the Nonquon River watershed using 1988 air photos that were updated and verified using 2002 orthophotography.

Table 18: Ecological Land Classification definitions.

Land Use Category	Definition
Agriculture	Includes both intensive (annually cultivated: crop fields, gardens, nurseries, tree farms) and non-intensive (no cultivation: grasses, hay, pasture, grazing).
Forest	Consists of both upland and lowland forest habitats including coniferous, deciduous, mixed, coniferous swamp, deciduous swamp, and mixed swamp.
Meadow	Communities resulting from, or maintained by, cultural or anthropogenic-based disturbances including cultural meadow, thicket, plantation, woodland and thicket swamp.
Urban/Rural Development	Containing residential developments not associated with agriculture.
Wetlands	Areas with variable flooding regimes, water depths < 2 m and/or standing water >20% of the ground coverage including meadow marsh, shallow marsh, mixed shallow aquatic marsh, submerged shallow aquatic marsh.
Other	Includes areas of manicured open space (communities resulting from or maintained by human activity e.g., regularly maintained parks, cemeteries), open water, and active aggregate.

Table 19: Percent Ecological Land Classification for the major land use categories found within the Nonquon River watershed. Changes in land use are compared between 1988 and 2002. The direction of arrow indicated whether the class of land use has increased (↑) or decreased (↓).

Land Use	% ELC		↓ / ↑	% Change
	1988	**2002**		
Agriculture	55.72	56.37	↑	0.65
Forest	20.07	19.55	↓	0.52
Meadow	14.77	8.77	↓	6.00
Urban/Rural Development	0.85	4.47	↑	3.62
Wetland	7.06	8.77	↑	1.71
Other	1.54	1.78	↑	0.24

CLIMATE

Monthly temperature and precipitation data were available for the Port Perry Nonquon climate station monitored by Environment Canada for the period of 2001-2006 (EC 2007). The monthly mean maximum temperature was 26.5°C and occurred in July, while the monthly mean minimum average was -12.2°C and occurred in February (Table 20). The overall mean temperature for the period of record on the Nonquon River was 6.8°C. The mean monthly rainfall and snowfall was greatest in May (102.15 mm) and January (48.90 cm), respectively. The overall yearly average precipitation for the Nonquon River was 873.47 mm. All of these values, other than the mean monthly rainfall which was greater for this study period, are similar to the climate normals from 1971 to 2000 for the area.

Table 20: Environment Canada climate data for the Nonquon River based on monthly mean (Â) data collected from February 2001 through to June 2006.

Temperature (2001-2006)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Max (ÂC)	-2.68	-0.68	3.77	12.18	19.20	24.70	26.50	25.68	22.76	13.68	7.70	0.40
Mean Min (ÂC)	-12.00	-12.15	-6.93	0.12	6.67	11.66	13.66	12.76	8.54	3.28	-0.86	-7.86
Overall Mean (ÂC)	-7.38	-6.45	-1.58	6.17	12.98	18.20	20.10	19.16	15.66	8.50	3.44	-3.80

Precipitation (2001-2006)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Total Rain (mm)	18.32	24.13	22.23	66.78	102.15	66.46	65.64	69.42	73.50	71.72	89.54	27.58
Mean Total Snow (cm)	48.90	38.57	24.63	11.33	0.00	0.00	0.00	0.00	0.00	0.20	15.80	36.56
Mean Total Precip (mm)	67.22	62.70	46.87	78.12	102.15	66.46	65.64	69.42	73.50	71.92	105.34	64.14

AQUATIC THERMAL REGIME

Stream temperature is one of the most central features in determining the distribution of fishes. In streams water temperature, and consequently thermal habitat, are influenced by a number of factors including: air temperature, precipitation, relative humidity, flow, geology, topography, land use, watershed vegetation, channel and floodplain morphology, and riparian vegetation (Poole and Berman 2001).

Species such as brook trout and mottled sculpin are often associated with coldwater systems whereas species such as central mudminnow, largemouth bass and pumpkinseed are often associated with warmwater systems. Coldwater fishes (brook trout in particular) are akin to the "canary in the coal mine" and are more sensitive to habitat changes than fishes found in

warmer waters (OMNR 2005c); therefore it is important to identify areas that currently or are capable of supporting coldwater fishes.

In 2006, temperature loggers that record hourly data were deployed throughout the watershed (Table 21, Figure 5). Water temperature data are often used in the classification of the thermal stability of a stream. One method of classification involves fitting the data into one of three categories: coldwater, coolwater, or warmwater based on the relationship between maximum air temperature and maximum water temperature during low-flow periods in hot weather (Stoneman and Jones 1996). Another, similar method of classification assumes streams with maximum water temperatures less than 26°C are defined as coldwater (Bowlby 2008). The data below illustrates that there are many potential sites throughout the watershed that are capable of supporting coldwater fishes. Long-term data for stream temperatures within the Nonquon River watershed does not exist; therefore, these data can be used to form a baseline from which future comparisons can be made.

Table 21: 2006 average, maximum and minimum monthly temperatures for sites within the Nonquon River and Layton River. September temperatures have been trimmed to the 10th as recommended in the Ontario Stream Assessment Protocol (Stanfield et al. 2005).

2006		July (1-31)			August (1-31)			September (1-10)		
Watercourse Section	Logger ID	Average	Max	Min	Average	Max	Min	Average	Max	Min
Nonquon River	TL_NQN-001	19.7	22.0	15.4	18.4	20.7	13.0	15.3	18.3	12.0
Nonquon River	TL_NQN-002	18.7	23.7	14.4	17.3	24.8	11.8	14.2	17.5	10.3
Nonquon River	TL_NQN-003	13.4	13.9	10.9	12.5	17.9	9.8	11.2	12.5	8.3
Nonquon River	TL_NQN-004	22.6	27.9	18.5	21.0	28.2	16.3	17.3	20.4	13.4
Nonquon River	TL_NQN-005	22.5	25.8	19.6	20.7	25.6	17.5	16.5	18.6	14.3
Nonquon River	TL_NQN-006	20.6	25.6	15.4	18.6	26.5	12.5	15.8	18.7	11.3
Nonquon River	TL_NQN-007	18.5	22.4	15.4	17.9	22.5	15.4	15.4	17.8	14.1
Nonquon River	TL_NQN-008	21.6	26.6	17.1	20.1	26.8	14.6	16.8	19.8	13.8
Nonquon River	TL_NQN-009	17.0	22.3	12.2	15.7	23.3	9.9	13.4	16.3	9.3
Nonquon River	TL_NQN-010	14.7	17.4	11.8	13.9	17.7	11.1	12.4	14.1	10.1
Nonquon River	TL_NQN-011	21.0	27.8	15.4	19.0	28.7	12.8	15.6	19.9	11.2
Nonquon River	TL_NQN-012	19.0	24.3	14.5	17.3	25.2	9.9	15.1	20.3	10.5
Layton River	TL_LR-001	20.9	26.7	16.4	19.4	27.5	12.9	15.3	19.4	11.4
Layton River	TL_LR-002	22.2	30.9	16.7	21.0	30.4	16.2	16.9	19.5	14.7
Layton River	TL_LR-003	20.3	28.1	14.9	19.2	27.5	11.5	15.4	21.6	9.8
Layton River	TL_LR-004	15.9	19.2	12.7	14.6	20.0	14.6	12.8	14.7	9.5
Layton River	TL_LR-005	12.6	16.0	19.4	15.6	21.2	9.2	13.0	16.9	8.3

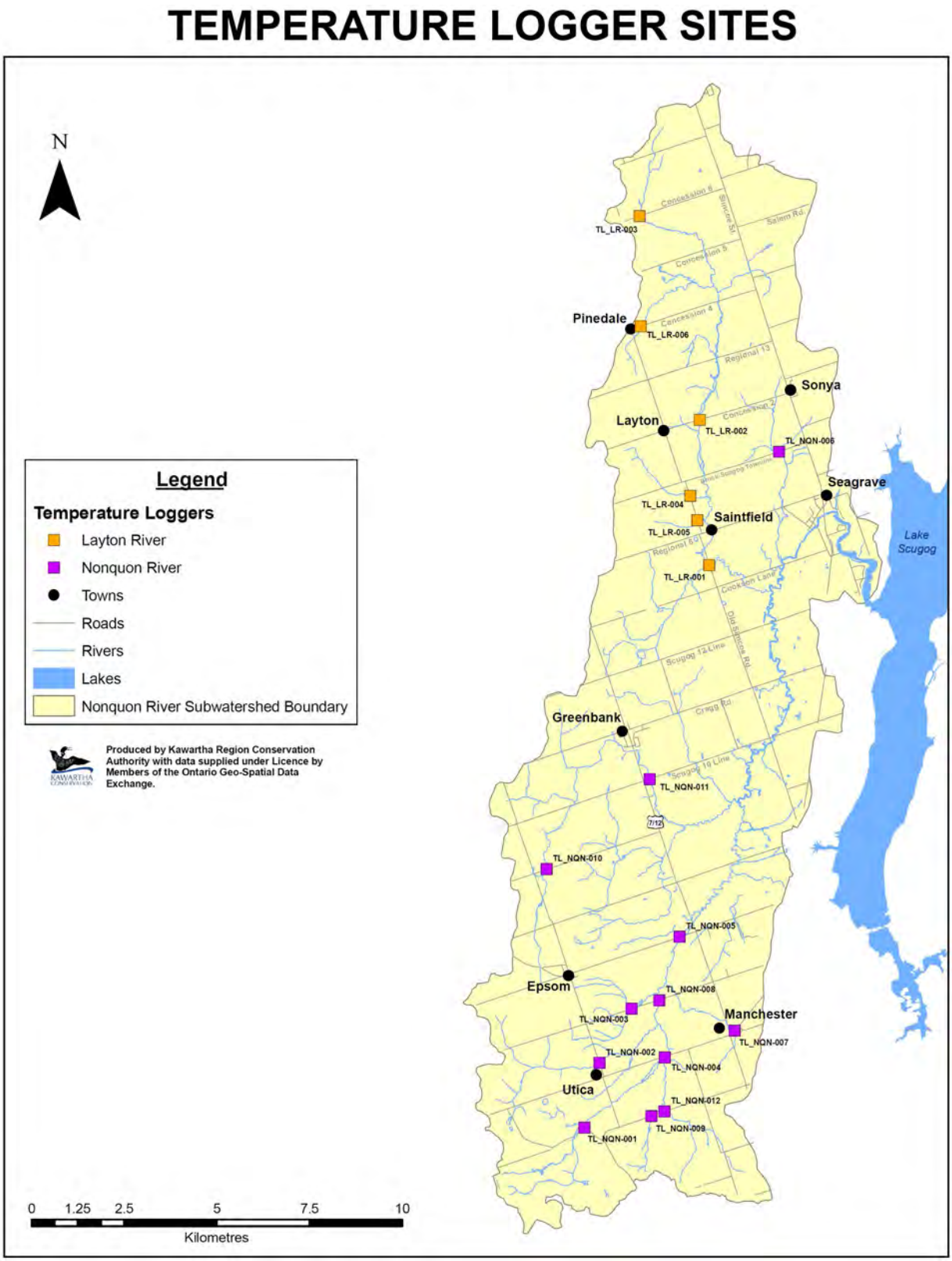

Figure 5: Temperature data logger deployment sites.

MORPHOLOGY

While stream temperature is of great importance in determining the broad distribution pattern of stream fishes, gradient (the number of metres drop per kilometre of stream) is often of equal importance (Moyle and Cech 2000). This is because gradient has a profound influence on water velocity and substrate distribution. Stream gradient and water temperature both contribute to the impact of the third factor, stream order, which is a means of classifying streams according to a pattern of branching (Moyle and Cech 2000). The headwater streams are first-order and unite to form second-order streams, which in turn unite to form third-order streams, and so on until the main river is reached. In most systems first-order streams are the smallest, coldest, and highest-gradient streams, and usually contain the fewest species of fish. As stream order increases habitat diversity, stream size, turbidity, and temperatures usually increase as well, while gradient and environmental fluctuations usually decrease (Moyle and Cech 2000). As a consequence, the number of fish species tends to increase with stream order.

The upstream-downstream gradient is probably the most well-known, large-scale pattern affecting in-stream fish assemblages. Longitudinal changes along physical and chemical gradients generally reflect an increase in fish species richness with increasing stream size (Matthews 1986). This question was raised by Fausch et al. (1984), who observed higher species richness in collections near mouths of tributaries entering large rivers. Gorman (1986) first considered the effects of discontinuity on tributary streams for river fish assemblages and suggested that small streams directly joining large rivers should have different assemblages than small streams that increase gradually in size downstream.

A large portion of the tributaries draining the Nonquon River and Layton River are situated in flat areas that are approximately at the same elevation as Lake Scugog (Palmer 2005). The watercourse slopes vary from 1.8% near the headwaters within the Oak Ridges Moraine to 0.01% for the lower sections of the Nonquon River

The tributaries and headwaters of the Nonquon River all have well-defined channels dominated by gravel and sand. However, the Nonquon River main channel, for the most part, does not have clearly defined channels. Throughout this reach of river sand and muck deposits are extensive. There are sections of gravel, pebble, cobble and boulders; however these areas are generally restricted to areas in the vicinity of Seagrave. Channel widths in the Layton River are well defined, with gravel and sand accounting for about 70% to 80% of the channel substrate. Silt and muck were observed in sections, although this was mainly limited to depositional areas.

SURFACE WATER

The majority of water discharging annually from the Nonquon River watershed into Lake Scugog originates from surface water runoff. During periods of high runoff, instream flow volumes of the Nonquon River watershed will be proportionately high whereas periods of dry conditions will result in low flows. This situation is characteristic of the till plain environment (Palmer 2005).

Historical (continuous) surface water monitoring flow data for the Nonquon River were obtained from a flow gauge located at Scugog Line 6, west of Highway 7/12. This station has been active since 1993, and has 12 years (1993-2004) of reliable data published in the Environment Canada's HYDAT database.

Surface flows for the Nonquon River have a well-defined seasonal pattern, reflecting the seasonal variations of water inflow (Figure 6). Long-term normals show highest flows are typically observed in March, generally caused by spring freshet (Table 22). Occasionally high spring water levels, coupled with extensive precipitation events, can cause flooding in the floodplains and low-lying areas. Long-term normal low flows are usually observed in August, when sporadic precipitation and high evapotranspiration rates bring surface water inflow to the minimum level. The main source of water supply to the river during that time is groundwater. Water levels remain low in September-October and rise again in November-December, responding to the greater precipitations and lower level of evapotranspiration. During the winter months, ice cover establishes on the Nonquon River. During this time, groundwater inflow is often the only source of water supply to the river system.

Water levels in Nonquon River during the sampling period (2004-2006) were higher than normal. Flows observed in 2004 were closest to the long-term normal (average daily flow averaging 105% of long-term value). Flows in 2006 were significantly higher than normal with monthly values varying from 114 to 344% of the normal long-term value. Temporal distribution of flows was close to the normal: high water levels during the spring freshet and lower levels in summer time. However, all years show water levels increase in July due to periodic storm events.

Table 22: Monthly Flows of Nonquon River near Port Perry (station:02HG002), discharge in m^3/sec.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Normal Mean (NM) 1993-2004		0.312	0.386	0.518	0.496	0.282	0.203	0.137	0.08	0.123	0.163	0.26	0.261	0.268
2004	Mean Flow	0.213	0.161	0.811	0.445	0.381	0.193	0.298	0.189	0.125	0.087	0.208	0.27	0.282
	% of NM	68.3	41.7	156.6	89.7	135.1	95.1	217.5	236.3	101.6	53.3	80	103.5	105.2
2005	Mean Flow	0.623	0.859	0.925	0.938	0.225	0.192	0.218	0.128	0.143	0.133	0.346	0.361	0.424
	% of NM	199.7	152.6	178.6	189.1	79.8	94.6	159.2	160	116.2	81.6	133.1	138.3	158.2
2006	Mean Flow	0.632	0.755	0.787	0.564	0.36	0.411	0.535	0.275	0.212	0.389	0.391	0.494	0.492
	% of NM	202.6	195.6	151.9	113.7	127.6	202.5	257.7	343.8	172.4	238.6	150.4	189.3	183.5

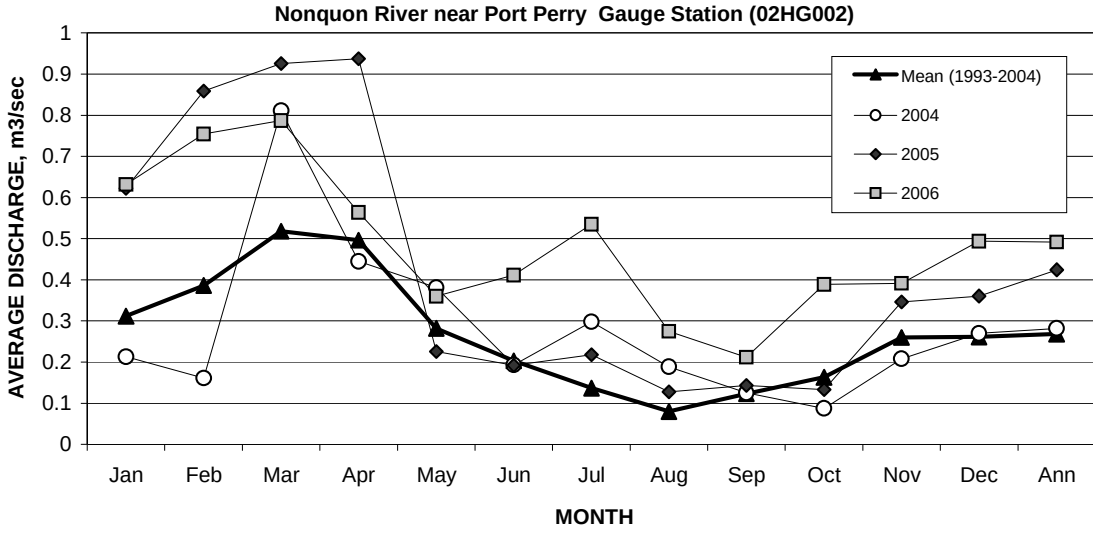

Figure 6: Monthly average flows for the Nonquon River watershed from 2004, 2005 and 2006 compared to the monthly average flows for the 12 years (1993-2004) of verified Environment Canada HYDAT data.

GROUNDWATER

Groundwater accumulates in the ground within recharge areas and surfaces at discharge points. Generally, watercourses interact with groundwater in three ways: they lose water to groundwater by outflow through the streambed (recharge area), they gain water from inflow of groundwater through the streambed (discharge area), and they do both, gaining in some reaches and losing in others. Groundwater recharge occurs whenever the field capacity of surficial soils has been exceeded. This allows for infiltrating water to percolate down to the water table (Palmer 2005).

The majority of recharge occurs in the fall, winter and spring, with water tables lowering during much of the summer. The amount of infiltration occurring during the winter depends largely on the snow conditions at the beginning of winter. An early blanket of snow prevents frost from forming, allowing recharge to occur throughout the winter, particularly during brief thaws common in southern Ontario (Palmer 2005). Groundwater recharge is expected to be greatest on the Oak Ridges Moraine, due to the high recharge potential of more permeable soils (Palmer 2005). The majority of the Nonquon River watershed is an area of groundwater recharge (Figure 7).

In areas where groundwater recharge is restricted, surface runoff becomes the principal source of stream flows. This results in "flashier" stream systems that are prone to flooding and severe erosion. Draining wetlands and other low-lying storage areas and channelization of streams alter a watershed's hydrology and reduce aquatic biodiversity. If recharge areas are affected then the water supplying baseflow conditions will also be affected.

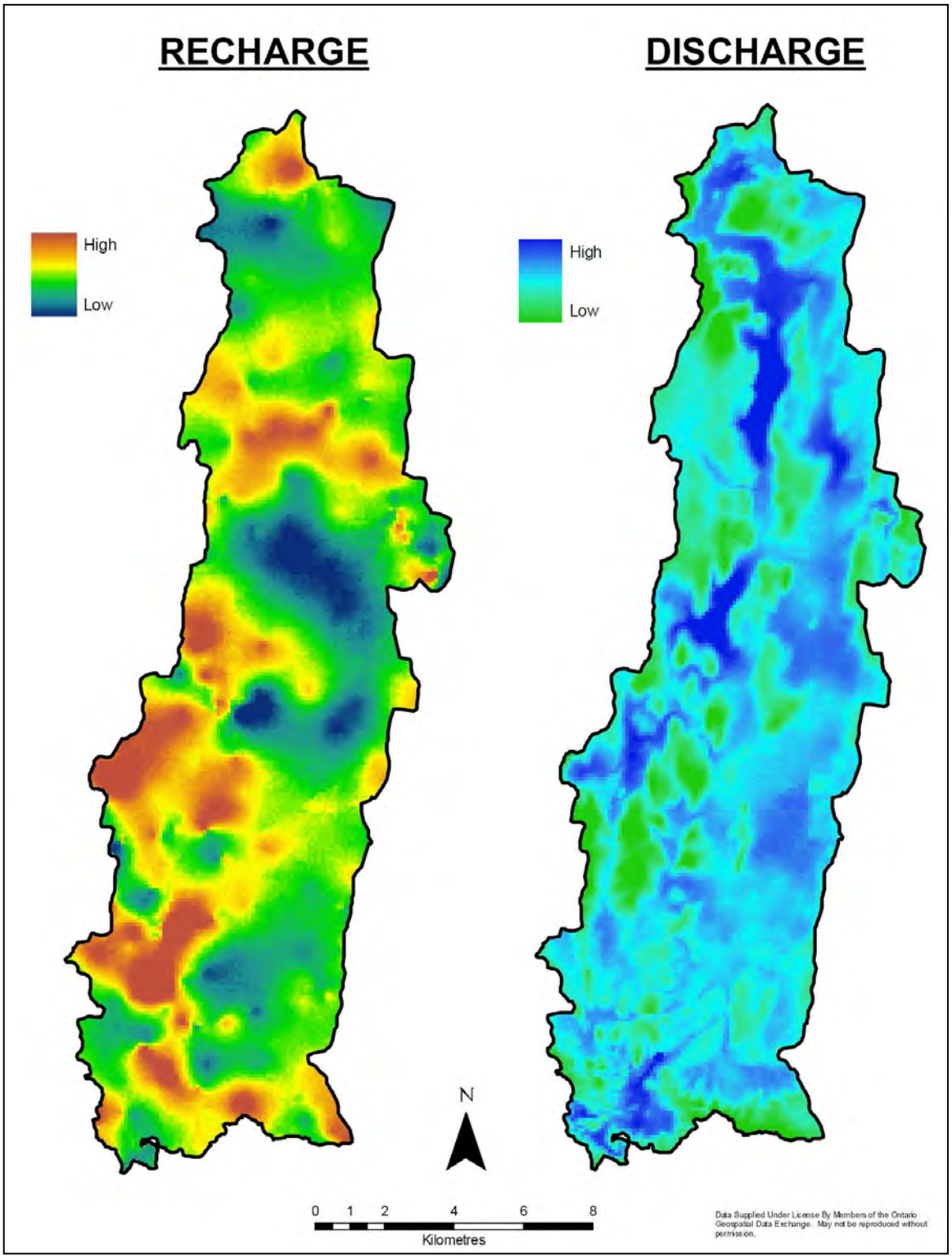

Figure 7: Recharge and discharge areas for the Nonquon River watershed.

The results of the NRSS found that Layton River was gaining water and that discharge increased as the distance downstream increased. Layton River is therefore considered to be located in an area fed by groundwater discharge. Similarly, baseflow data shows that the Nonquon River system was also gaining water.

The general conclusions from the baseflow study by Palmer (2005) for the Nonquon River watershed are as follows:

- Although some portions of the streams are losing water to ground penetration, the majority of the streams are gaining water.
- Stream baseflow values vary from stream to stream and within each stream.
- Stream baseflow values have generally remained at similar levels from 1983 to 2001.
- Groundwater aquifers and wetlands play an important role in providing water to streams.
- The streams are mainly slow flowing.
- The streams not located in wetlands are mainly lower order.
- The Nonquon River and Layton River have coldwater sections along them.
- Humans are impacting on the hydrology and ecology of the streams.

WATER BALANCE and ECOLOGICAL FLOWS

An accounting of all the inputs and outputs of surface and ground water is termed the water balance. The total quantity and distribution of flow is linked to the hydrologic cycle. It describes the process of water inflow from precipitation and the outflow of water by evapotranspiration, groundwater recharge, stream flow and extraction for human uses.

The major connecting link in a watershed ecosystem is the flow of water. There is increasing recognition that natural flow regimes are needed to maintain and restore the natural form and function of aquatic ecosystems (Conservation Ontario 2005). Stream flow is strongly linked to many critical physiochemical characteristics of rivers, such as water temperature, channel morphology and habitat diversity; all of which can limit the distribution and abundance of aquatic species (Poff et al. 1997). Human modifications of natural hydrological processes, including the creation of dams, water diversions, urbanization, tiling, drainage, channelization and groundwater pumping often disrupts the dynamic equilibrium between the movement of water and the movement of sediment (Poff et al. 1997).

Headwater streams of first and second 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 losses in fish spawning success and abundance of adult and juvenile fish. Medium sized streams (3rd or 4th order) usually have deeper water refugia and since flow is contributed by a larger stream network, they may have more variability in flow. However, low-flow characteristics are not as variable in relation to channel characteristics as in headwater systems. In the Nonquon River watershed, the major input of water is from precipitation (in the form of rain, snow, sleet and hail) and output is from evapotranspiration. Approximately 63% of water within the Nonquon River watershed is lost to evapotranspiration (Palmer 2005).

The Tennant method can be used for determining instream flow requirements (IFR) and habitat quality for fish. The method compares mean monthly flows, averaged over two seasons (April to September and October to March, to accommodate seasonal biologic needs) for any given year, to the natural or near natural long-term mean annual flow (MAF) record (Table 23). The Tennant method is an applicable technique to use to compare similar low gradient streams (slope less than 1%), which is typical for the Nonquon River. In higher gradient streams the Tennant method should be used with caution (Mann 2006).

For the study area, maximum flows in 2004 did not meet the flushing recommendations to meet the recommended habitat quality for fishes, whereas flows in 2006 and 2005 achieved and surpassed the recommended rate, respectively (Table 24). For all sampling years and seasons the flow was within the optimum range and provided outstanding habitat for fishes.

High flows are often necessary to maintain ecosystem productivity and diversity. For example, high flows remove and transport fine sediments that would otherwise fill in spawning areas; woody debris is imported into the channel where it creates high quality habitat; and these flows maintain the connectedness with wetland riparian habitat that provides important spawning and nursery grounds for fish (Poff et al. 1997). Many channel features, such as river bars and riffle-pool sequences, are formed and maintained by discharges that can move significant quantities of sediment and that occur frequently enough to continually modify the channel (Conservation Ontario 2005). On the other hand, sustained high flows and flashiness may also have negative effects on individual species by displacing eggs and fry and limiting reproductive success.

Droughts (infrequent low flows) have a role in sustaining overall ecosystem integrity, with either negative or positive effects on individual species. Periods of low flow can present recruitment opportunities for riparian plant species, and tributaries that dry temporarily have aquatic and riparian species with special behavioural or physiological adaptations that suit them to these conditions (Poff et al. 1997). Although natural droughts can benefit the aquatic community, frequent or prolonged low flows will have negative consequences such as: physiological stress or mortality due to increased temperature and low dissolved oxygen, disruption of fish migration, reduced invertebrate production, and increased predation by birds and mammals. A low-flow event of a particular magnitude may be healthy as long as it can be described as a random event, whereas low flows which become chronic or repeating (ie. with a recurrence interval on the order of one year) are likely to be unhealthy (Conservation Ontario 2005).

Table 23: Recommended flows, represented as a percent of the mean annual flow (MAF), to mimic the natural hydrograph to accommodate seasonal biologic needs. Taken from Establishing Instream Flow Requirements (Conservation Ontario 2005).

Narrative Description of Flow [a]	April to September	October to March
Flushing/maximum flow (from 48 - 96 hours)	200% MAF	na
Optimum range of flow	60 - 100% MAF	60 - 100% MAF
Outstanding habitat	60% MAF	40% MAF
Excellent habitat	50% MAF	30% MAF
Good habitat	40% MAF	20% MAF
Fair or degrading habitat	30% MAF	10% MAF
Poor or minimum habitat [b]	10% MAF	10% MAF
Severe degradation	<10% MAF	<10% MAF

[a] - for fish, wildlife, recreation and related environmental resources

[b] - this is only for short term survival

Table 24: (A) Mean maximum monthly flows for 2004 to 2006 expressed as a percent of the mean annual flow (MAF). (B) Mean monthly flows for 2004 to 2006 expressed as a percent of the MAF calculated for the two seasons.

A

% MAF	April to September
2004	166.04
2005	350.00
2006	210.45

B

% MAF	April to September	October to March
2004	98.59	91.89
2005	87.20	49.52
2006	68.22	46.64

Within the Nonquon River watershed, a balanced water budget and healthy ecological flows are intertwined. Where and how much water flows determines the quality of the water at any time and resulting potential for flooding, the shape and stability of stream banks, the health and diversity of vegetation, and the availability of fish and wildlife habitat. As human use of the river basin increases, anthropogenic needs (which are often ecological stressors) can change the water budget.

Changes to the water budget cause direct and significant changes to the above resources. These changes can be extreme, in the case of hazard floods and droughts, and will reduce the ability of the human population to use and enjoy the resources of the watershed.

WATER CHEMISTRY

Traditional water quality sampling methods have emphasized analyses of physical and chemical parameters such as dissolved oxygen, pH, temperature, nitrates, phosphates, and others. Although useful, this approach has several limitations. For instance, there are many chemical constituents that could theoretically result in water quality degradation. In addition, a single sample can only provide a "snapshot" of water quality on the day of sampling, and may provide no information on recent degraded conditions which have since cleared up, but whose effect upon aquatic biota may be long lasting.

The surface water quality results from the NRSS indicate that higher than average aluminum and iron concentrations were measured in the Layton River; high coliform counts were periodically measured upstream and downstream of the Nonquon River Water Pollution Control Plant discharge point in the river, as well as in the Layton River; and the Provincial Water Quality Objectives (OMOE 1994) limit for total phosphorus was exceeded at all stations for the majority of samples taken. In all but one sampling location, total suspended solids (TSS) and total phosphorous levels have dropped since 1975. TSS may reduce light penetration through the water column and affect the food chain of fish. Suspended solids can accumulate on watercourse beds and cover up fish spawning grounds.

The biological oxygen demand (BOD) is an indirect measure of the concentration of biologically degradable material present in organic wastes. Decomposition of dissolved organic matter in effluents also consumes the oxygen contained in the water. The BOD that accompanies this decomposition changes the quality of the aquatic habitat. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic waste BOD. A high BOD threatens the health of fish populations and may even become a direct cause of mortality.

The presence of high BOD may indicate faecal contamination or increases in particulate and dissolved organic carbon from non-human and animal sources that can restrict water usage and development, and necessitate expensive treatment and impair ecosystem health. Threats to groundwater quality within the Nonquon River watershed, such as inorganic compounds, pathogens and organic compounds, can affect the health of humans, fish and wildlife (Palmer 2005). Therefore, it is important to monitor organic pollution to identify areas posing a threat to health, to identify sources of contamination, to ensure adequate

treatment, and provide information for decision making to enhance water sustainability. Future efforts that improve the ability to detect and manage surface and groundwater quality in the Nonquon River watershed have been outlined in the recommendations tables in Chapter 2.

BENTHIC MACROINVERTEBRATES

Water quality in the Nonquon River watershed can also be measured using benthic macroinvertebrates (stream-dwelling bugs). This sampling technique was developed more than 50 years ago to complement traditional chemical water quality approaches, as well as to provide new information not available through other methodologies (Logan and Gadwa 1998).

For the purposes of this study, water quality ratings are based on benthic macroinvertebrates that were collected at various sites within the watershed. At each site approximately 100 organisms are collected and randomly sampled from a variety of habitats within the stream, including erosional and depositional areas (e.g., riffles and pools). A variety of useful indices or measurements have been developed for assessing the health of streams through benthic macroinvertebrate sampling (e.g., taxa richness, EPT Index or richness, percent abundance of EPT, percent dominance, percent dominance of scrapers, Hilsenhoff s Biotic Index, EPT to chironomid ratio, Pinkham and Pearson community similarity index, etc.).

Hilsenhoff's biotic index (HBI) is a commonly used stream biosurvey that requires collection and identification of macroinvertebrates to Family level (Hilsenhoff 1988). This method assigns a numerical score (biotic index) ranging from 0 to 10 to the most common stream macroinvertebrate taxa. The biotic index is directly related to the degree of pollution-tolerance and is based on field and laboratory responses of organisms toward organic pollution. Taxa with a value of zero (0) are extremely intolerant of low dissolved oxygen and organic pollution; taxa with scores of 2 through 9 are tolerant to varying degrees; taxa that can survive great amounts of pollution are scored 10. The index is calculated by summarizing the number in a given taxa multiplied by its tolerance value, then divided by the total number of organisms in the sample. The value is then compared with the HBI ranges to identify the degree of organic pollution for that particular site (Table 25).

The HBI water quality conditions, based on the benthic macroinvertebrate collections made at 24 sample sites range between 4.41 to 7.82 (Figure 8) indicating that the sites range from good to very poor water quality.

Percent EPT is an index of the total number of distinct taxa within the Orders of Ephemeroptera, Plecoptera and Trichoptera based on the raw data collected at each site. A healthy community is dominated by pollution sensitive representation in the Ephemeroptera, Plecoptera and Trichoptera groups. The EPT Index generally increases with increasing water quality.

Table 25: Hilsenhoff index ratings with corresponding water quality and degree of organic pollution based on benthic macroinvertebrates tolerance values.

Hilsenhoff Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very Good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial organic pollution likely
5.76-6.5	Fairly Poor	Substantial organic pollution likely
6.51-7.25	Poor	Very substantial organic pollution likely
7.26-10	Very Poor	Severe organic pollution likely

A ratio of EPT to Chironomidae is a metric that uses relative abundance of these indicator groups as a measure of community balance. Good biotic condition is reflected in communities having a fairly even distribution among all four major groups and with substantial representation in the sensitive groups: Ephemeroptera, Plecoptera, and Trichoptera. A skewed population with large amounts of Chironomidae in relation to EPT indicates environmental stress. Percent contribution of dominant taxa is also a measure of community balance. A community dominated by relatively few species may also indicate environmental stress. In addition, both pollution sensitive and tolerant forms may be present in 'clean' waters; however, it is the absence of the sensitive species coupled with the presence of the tolerant species, which may indicate damage. All the composition percentages are illustrated in Figure 9.

Pollution Tolerance Index classifies each taxon as either being sensitive (organisms that are sensitive to pollution and are typically found in good quality water), moderate (organisms that are somewhat sensitive to pollution and are typically found in fair quality water) or tolerant (organisms that are tolerant of pollution and are typically found in poor quality water to pollution). The tolerance level ratings are based on a manual created by KRCA (1999). Percent abundance of pollution-sensitive taxa is the percent abundance contribution of taxa classified as pollution-sensitive to the total abundance of organisms in a sample. All the pollution tolerance percentages are illustrated in Figure 10.

It is well documented that pollution of streams reduces the number of species in an aquatic ecosystem (i.e., species diversity), while frequently creating an environment that is favorable to only a few species (i.e., pollution-tolerant forms) (e.g., Logan and Badwa 1998). Thus, in a polluted stream, there are usually large numbers of a few species, while in a clean stream there are moderate numbers of many species. Simpson's Diversity Index (Simpson 1949) considers both taxonomic richness and evenness (Nalepa et al. 2003). The values range from 0 (low diversity) to 1 (high diversity). Healthy benthic macroinvertebrate communities tend to have a higher Simpson's Diversity Index value.

Some pristine streams have a low diversity of macroinvertebrates because of the cold temperature and/or relatively low nutrient levels. Furthermore, headwater streams may have only two or three dominant species. In most cases, however, an unpolluted stream will support a diverse population of macroinvertebrates, with pollution-sensitive species well

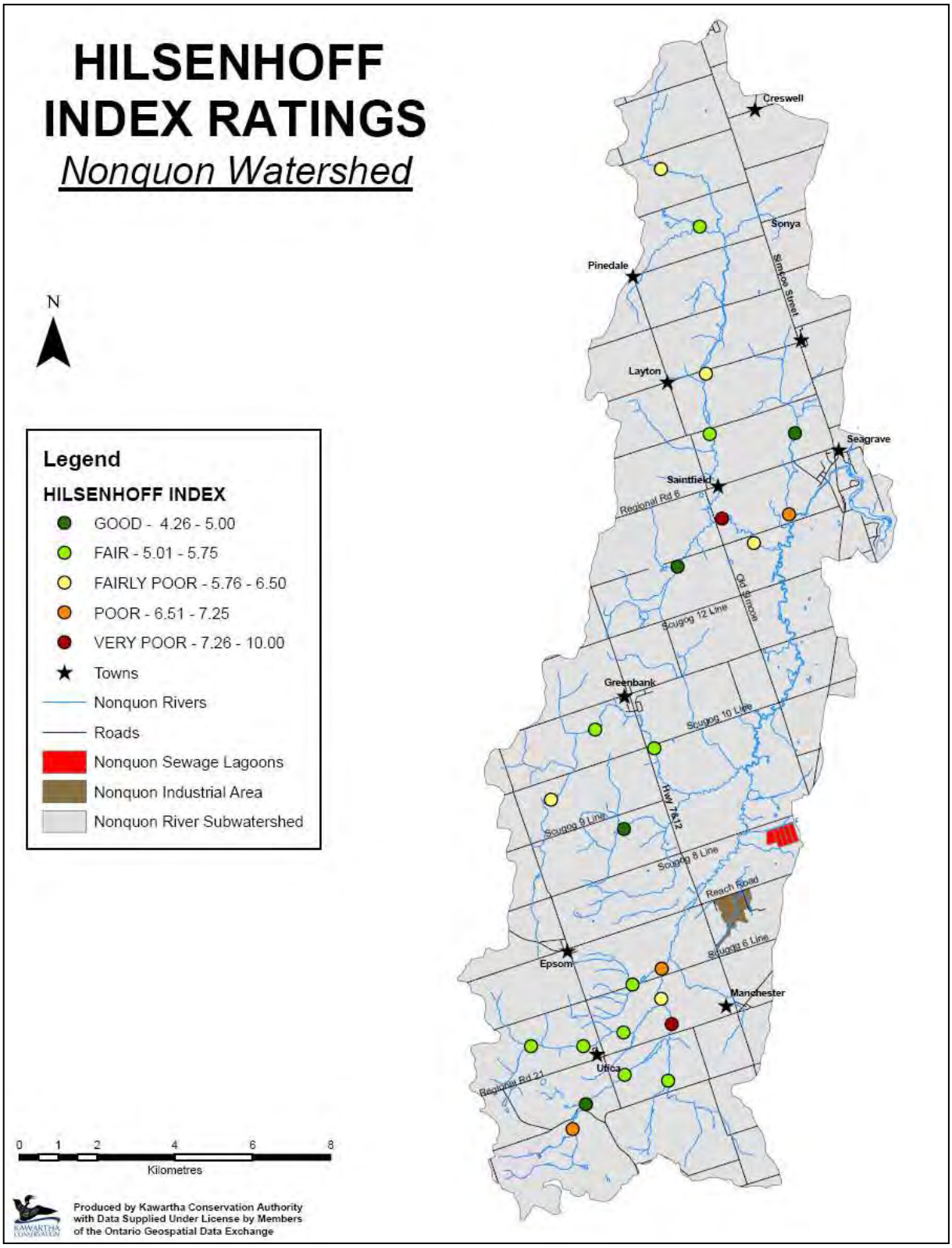

Figure 8: Hilsenhoff Biotic Index water quality rating values at each sample site.

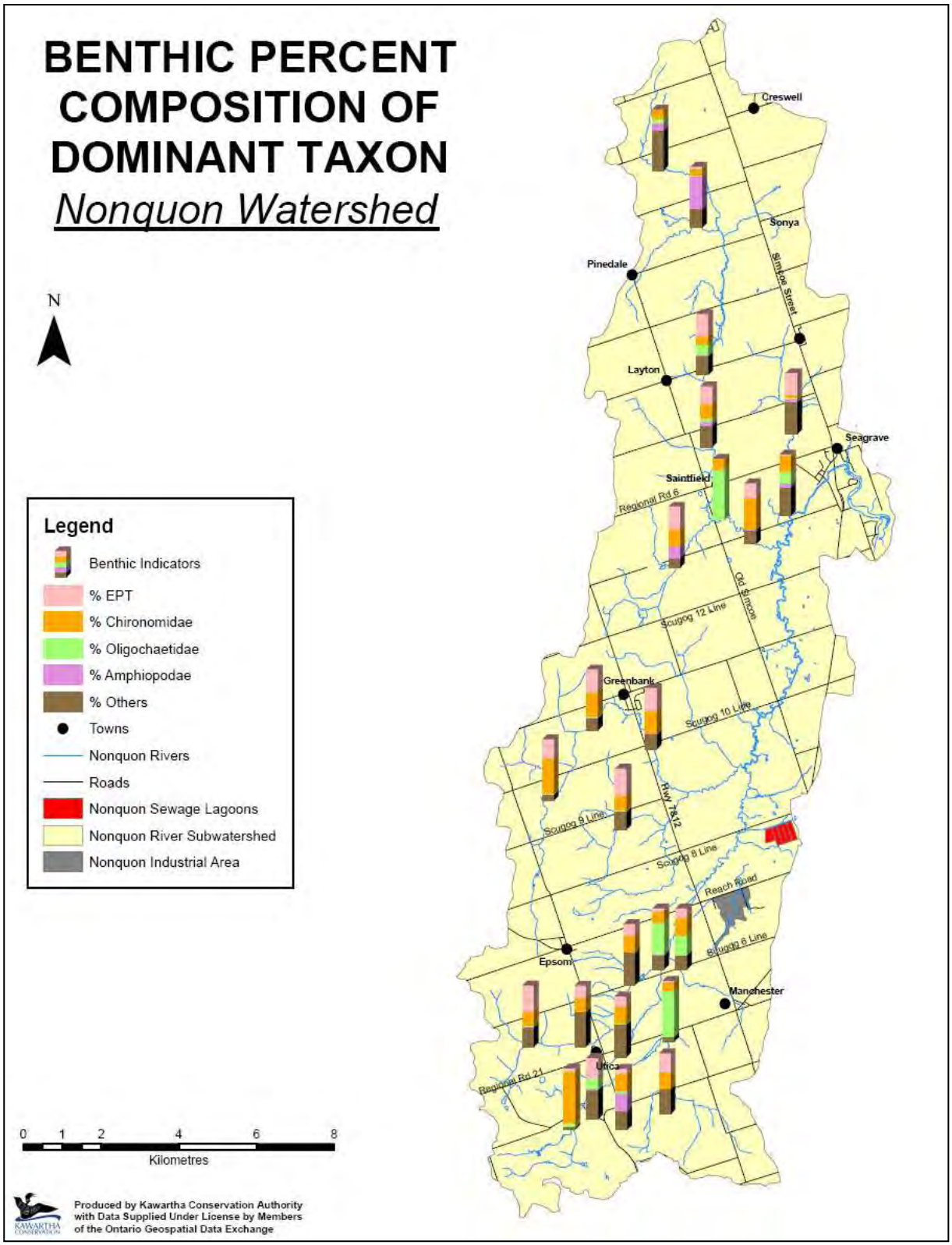

Figure 9: Percent of combined Ephemeroptera, Plecoptera and Trichoptera taxa, and individual percents for Chironomidae, Oligochaeta, Amphipoda and other taxon.

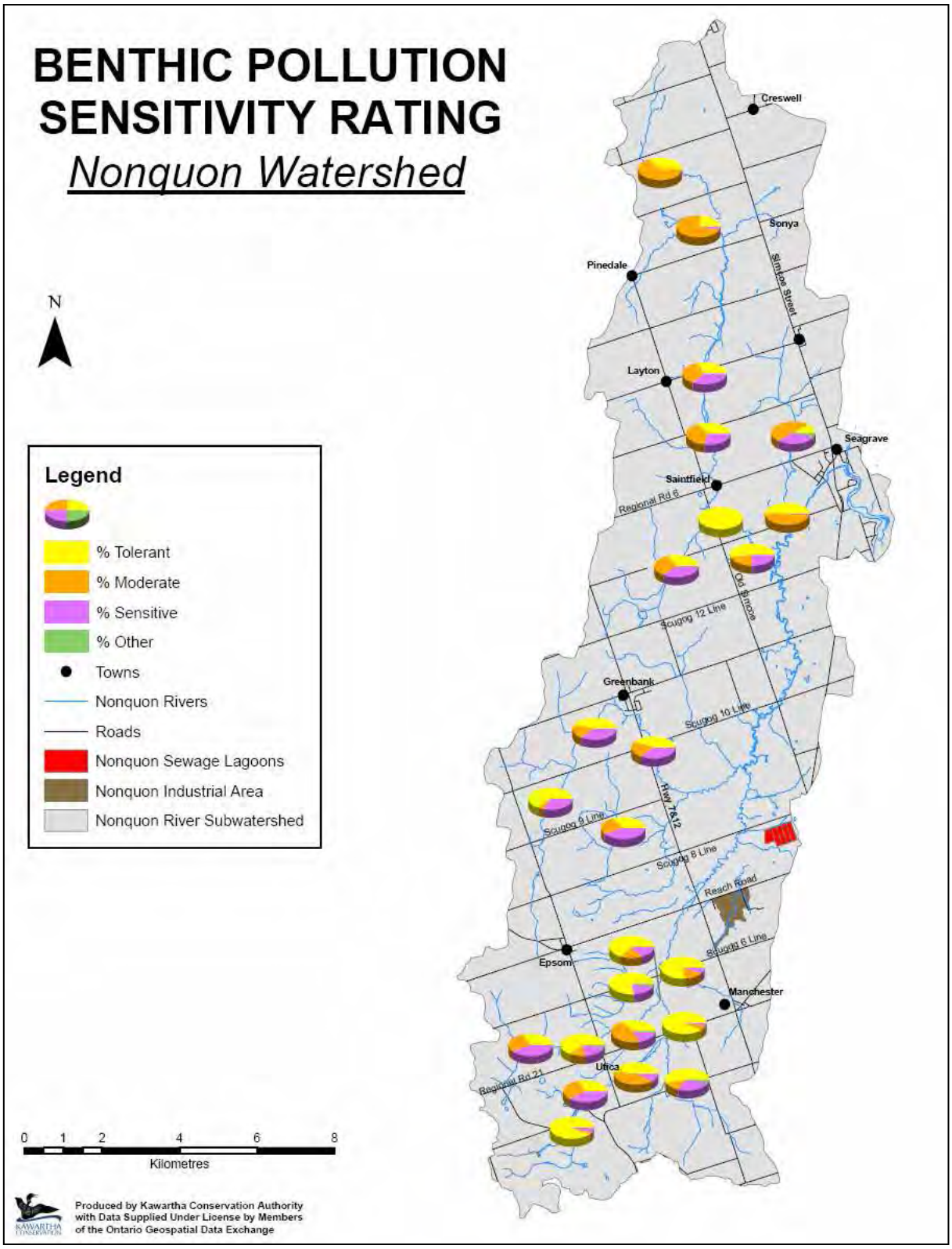

Figure 10: Pollution Tolerance Index rating values based on percent sensitivity of combined taxa found at each sample site.

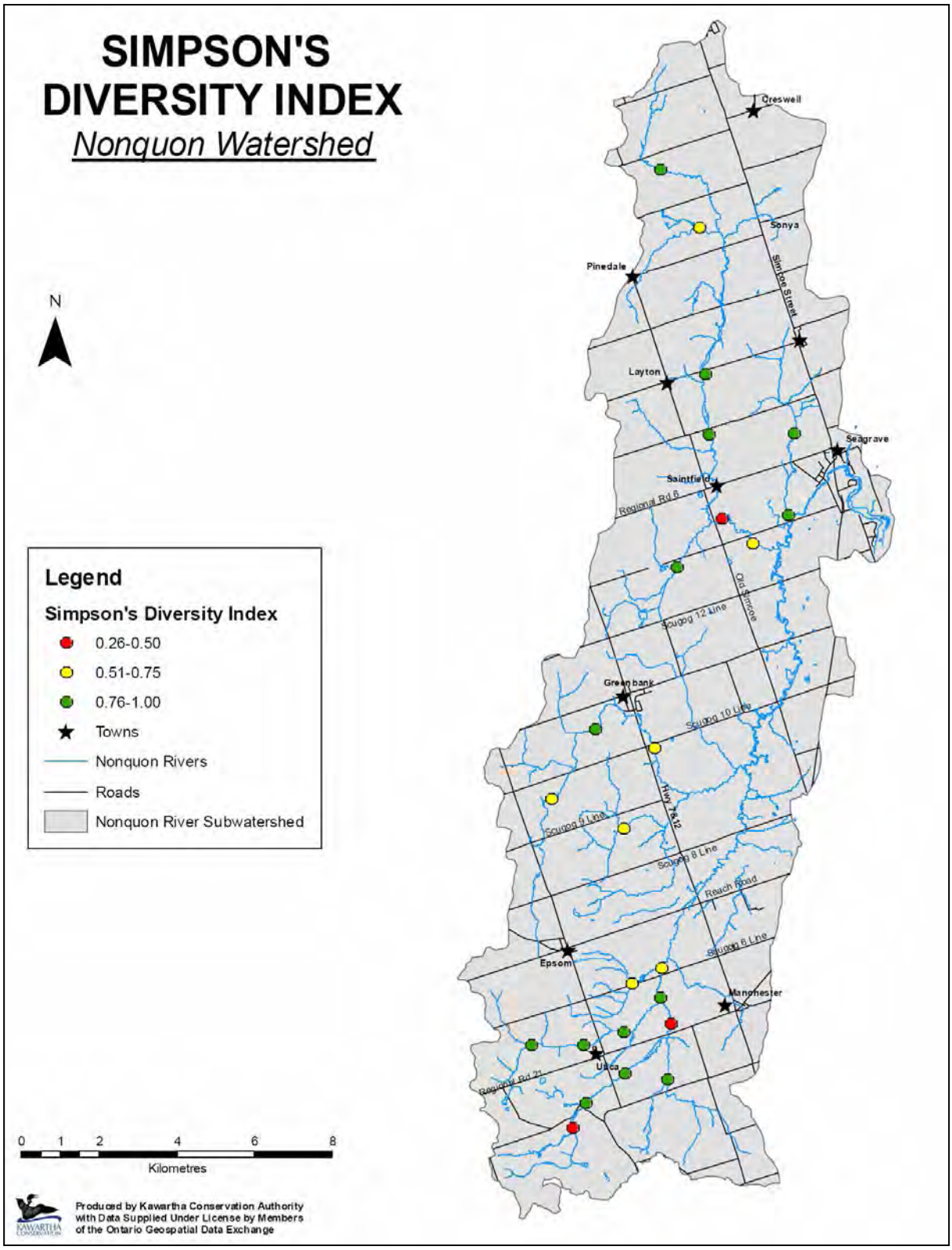

Figure 11: Simpson's Diversity Index rating values at each sample site.

represented. However, species diversity declines as water quality deteriorates and pollution-tolerant organisms become increasingly dominant. The Simpson's Diversity Index ranges from 0.26 to 0.88 with approximately 87% of sites producing values greater than 0.50 (Figure 11). Simpson's Index values for each site, along with pollution tolerance index values, percent taxa relationships and HBI scores are located in Appendix E.

In summary, the benthic macroinvertebrate data illustrates that water quality varies considerably among sites within the Nonquon River watershed. Since these data were collected within a relatively recent time period, it is difficult to specifically identify the sources of these variations without the benefit of a long-term data set. However, the data collected to-date provides excellent baseline information from which long-term monitoring data can be compared.

FISH COMMUNITY: HISTORIC AND CURRENT

The Nonquon River watershed provides spawning, nursery, refuge, feeding, transient and resident habitats, all of which are important for supporting the life stages and processes of fishes. The watershed supports a coldwater and warmwater fishery but is especially known for its spawning populations of walleye (*Sander vitreus*) and muskellunge (*Esox masquinongy*). While muskellunge are native to the area, walleye were introduced in 1922 (Greenland International Consulting Inc. 2002). Other more popular fishes found in the watershed include brook trout (*Salvelinus fontinalis*), panfishes (*Lempomis* and *Pomoxis* spp.), largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), common carp (*Cyprinus carpio*) and yellow perch (*Perca flavescens*).

HISTORICAL FISH SAMPLING

Historically, there have been very little fisheries data collected in the the Nonquon River watershed. The majority of the fisheries data collected by the OMNR has been concentrated in the central areas of the watershed and dates back to 1975. The tributary headwaters of the Nonquon River support coldwater species such as brook trout, whereas the Nonquon River main channel and Layton River support warmwater fish communities. A baseline for the historic condition of the fish community was compiled and compared to more recent information collected to assess whether there has been changes in the fish community over time.

Aurora District OMNR and the Royal Ontario Museum were contacted to attain available records (i.e., fish community and/or physical and chemical habitat information) for the Nonquon and Layton Rivers. From these searches, data were acquired on fish species composition and abundance, as well as qualitative habitat features from seven sites sampled in 1975 (Figure 12). Data were also available from 2002 when Greenland Consulting International sampled four areas for the NRSS.

CURRENT FISH SAMPLING: WADEABLE SECTIONS

SITE SELECTION

To examine the effects of landscape and adjacent land use on fish communities it is important to sample various physiographic regions and across areas characterized by differing land uses. Sites were chosen based on both physiography and land use. The physiographic units included: clay plain, drumlin, esker, Kame moraine, peat and muck, sand plain and till plain. Land use units were divided into agriculture, forest, meadow, urban, wetland and other; however, for site selection land use was broadly categorized as either forested or non-forested.

SAMPLING PROTOCOL

The Ontario Stream Assessment Protocol (OSAP) (Stanfield 2005) contains a series of accepted methods for evaluating a number of components of stream ecosystems, (i.e., physical habitat, water quality and water quantity and fish communities). There were 32 sites chosen in total, 25 on the Nonquon tributaries and 7 within the Layton River (Figure 13). Seventeen of the 25 sites were completed on the tributaries; 5 were dry and 3 could not be accessed, and all 7 sites on the Layton River were studied (Table 26). The sections of the OSAP that were completed at each location included: site identification, water quality assessment, physical processes and channel structure and single-pass electrofishing. The single pass survey provides a comprehensive fish species list and a qualitative estimate of species abundance at the site.

CURRENT FISH SAMPLING: NON-WADEABLE SECTIONS

SITE SELECTION

The selection of the nonwadeable sampling locations was based on four criteria: (1) re-sampling historical sites; (2) sampling a diversity of habitats; (3) a minimum of 100 m between sites; and, (4) the ability to sample the site effectively with the chosen sampling methods. Historical sites were selected based on sampling performed by the OMNR in 1975. Sites were chosen to reflect a variety of physical conditions (e.g., substrate and depth) and across a variety of land uses (e.g., agriculture, urban and wetlands), as well as to ensure coverage of the entire channel to the greatest extent possible.

SAMPLING PROTOCOL

A standardized sampling protocol currently does not exist for nonwadeable river habitats. Physical and chemical habitat features were recorded for each site sampled (e.g., depth, substrate, aquatic vegetation, riparian conditions, adjacent land use, pH, dissolved oxygen) for any future characterization of habitat change.

In sampling fish communities, hoop nets (passive sampling) coupled with bag seines (active sampling) were the methods chosen to sample the nonwadeable areas of the Nonquon River

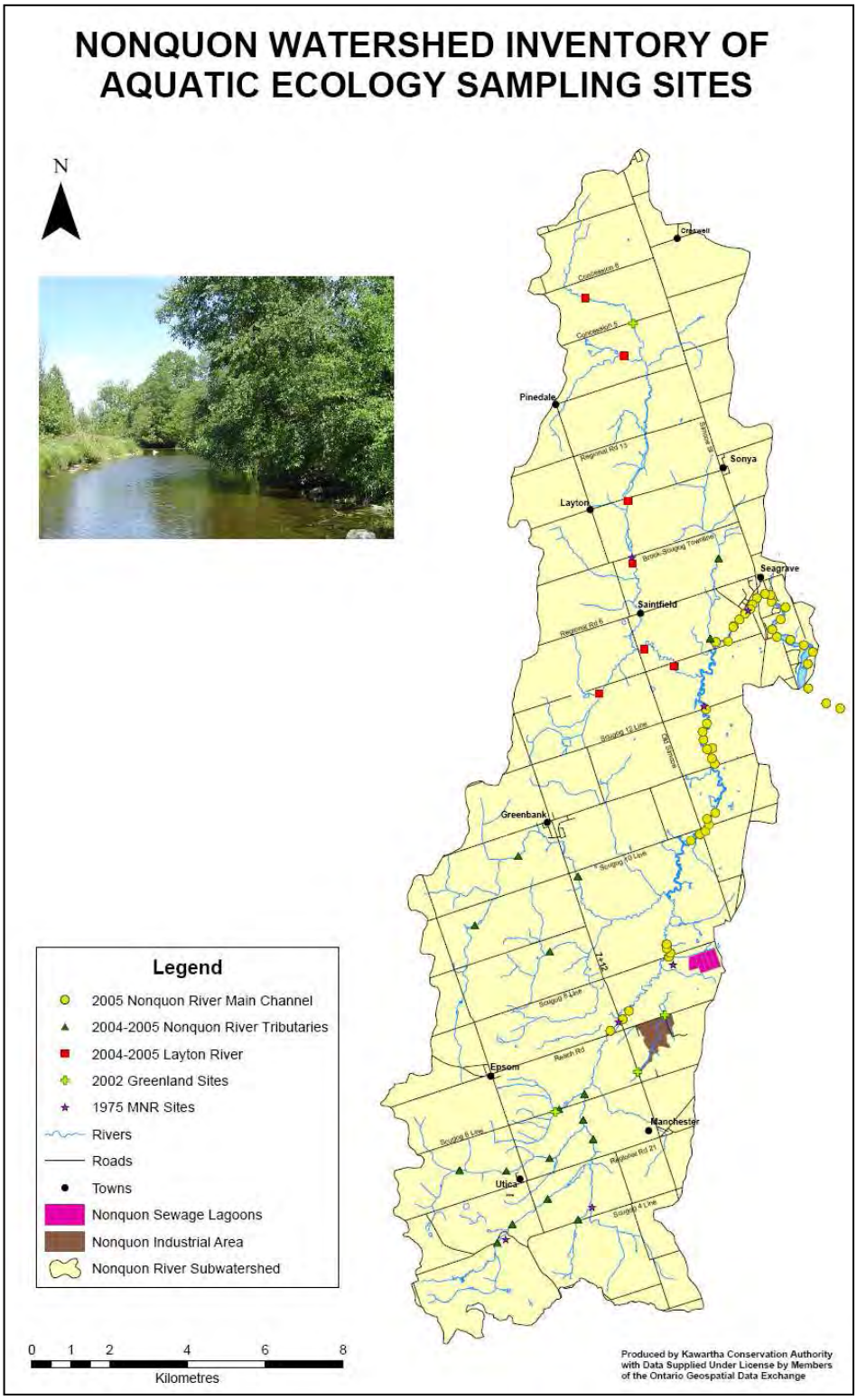

Figure 12: Historic and current aquatic sampling locations within the Nonquon River watershed. The Nonquon River main channel (44 sites) and tributaries (17 sites), and the Layton River (7 sites) sampling sites include fish and benthic macroinvertebrate community data, as well as habitat data. The Greenland sites (4 sites) have exclusively fish data. The OMNR sites (7 sites) have both fish data and physical and chemical habitat data.

Table 26: Corresponding land use and physiographic descriptions for each OSAP sampling location in the Nonquon River tributaries and Layton River and the year the site was sampled.

Site Code	River	Land-use	Physiography	Year Sampled
NQN0103	Nonquon	Agriculture	Clay Plain	DRY
NQN0203	Nonquon	Agriculture	Sand Plain	2005
NQN0303	Nonquon	Agriculture	Moraine	No Access
NQN0403	Nonquon	Forest	Clay Plain	2003
NQN0503	Nonquon	Forest	Moraine	2003
NQN0603	Nonquon	Agriculture	Moraine	2003
NQN0703	Nonquon	Agriculture	Sand Plain	2004
NQN0803	Nonquon	Forest	Sand Plain	2004
NQN0903	Nonquon	Forest	Sand Plain	2004
NQN1003	Nonquon	Forest	Till Plain	2003
NQN1103	Nonquon	Forest	Moraine	2005
NQN1203	Nonquon	Forest	Sand Plain	2004
NQN1303	Nonquon	Forest	Sand Plain	2005
NQN1403	Nonquon	Agriculture	Till Plain	No Access
NQN1503	Nonquon	Forest	Sand Plain	2005
NQN1603	Nonquon	Agriculture	Sand Plain	DRY
NQN1703	Nonquon	Forest	Sand Plain	DRY
NQN1803	Nonquon	Agriculture	Sand Plain	2004
NQN1903	Nonquon	Agriculture	Till Plain	No Access
NQN2003	Nonquon	Agriculture	Sand Plain	2004
NQN2103	Nonquon	Forest	Till Plain	2005
NQN2203	Nonquon	Forest	Clay Plain	DRY
NQN2303	Nonquon	Agriculture	Clay Plain	DRY
NQN2403	Layton	Forest	Clay Plain	2005
NQN2503	Layton	Agriculture	Clay Plain	2004
NQN2603	Layton	Forest	Clay Plain	2004
NQN2703	Layton	Agriculture	Clay Plain	2003
NQN2803	Layton	Agriculture	Sand Plain	2004
NQN2903	Layton	Forest	Till Plain	2005
NQN3003	Layton	Forest	Till Plain	2005
NQN3103	Nonquon	Agriculture	Clay Plain	2005
NQN3203	Nonquon	Forest	Clay Plain	2003

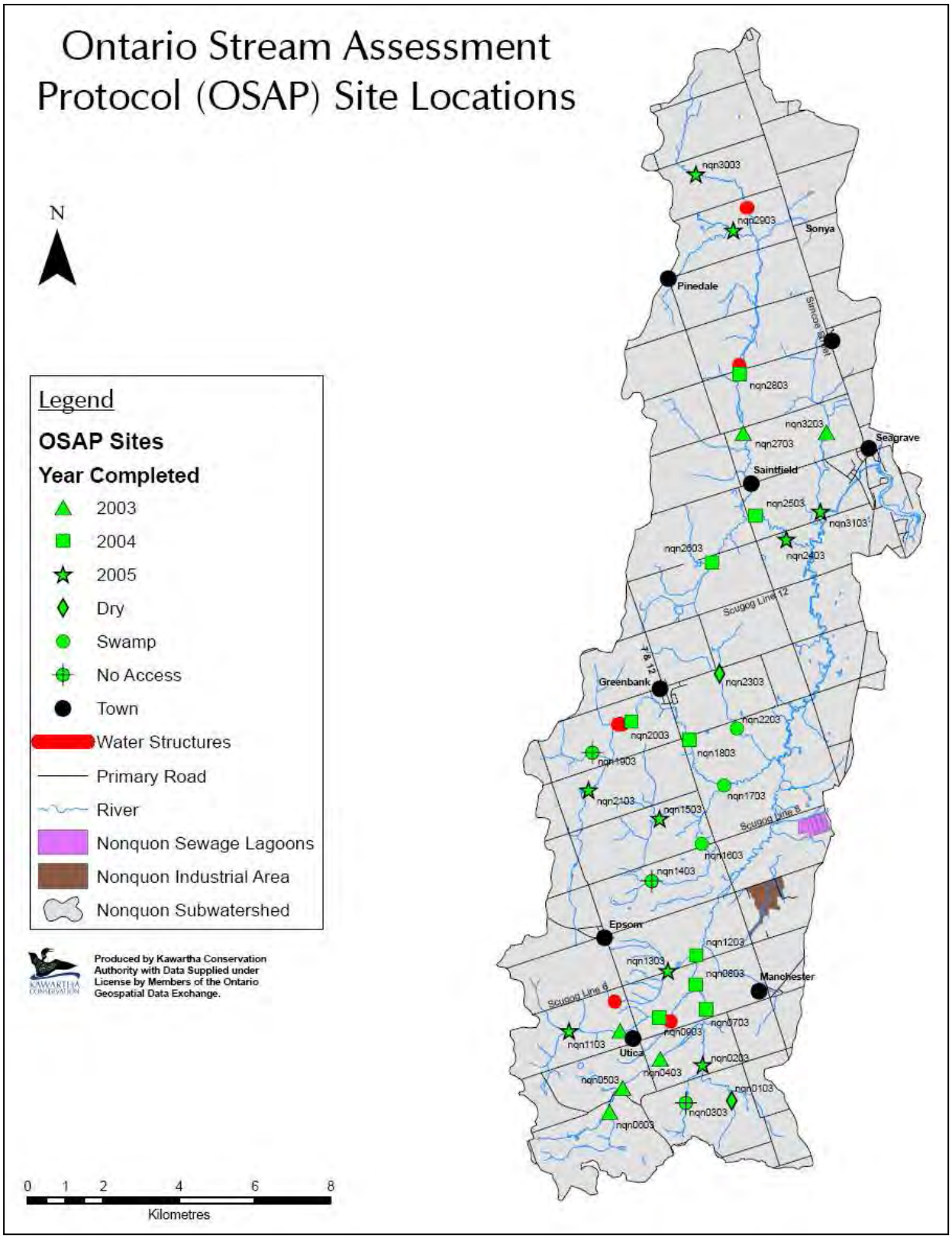

Figure 13: Ontario Stream Assessment Protocol sampling locations in the Nonquon River watershed identified by the year the sampling was completed.

main channel. Some research has found that hoop nets detect the greatest number of species and the largest range of fish sizes (Pugh and Schramm, Jr. 1998; Surette unpublished data 2006), and seine collections add species that are not caught by other gear types (Penzod 1998).

Time allocated to each hoop net deployment was consistent, with overnight sets between 18 and 24 hours, with an average set of 21 hours. Where suitable habitat was present, hoop net sites were supplemented with seining. Since Angermeier and Schlosser (1989) found that at least 75 percent of the species captured after eight passes were usually captured in the first three passes, three seine hauls were performed at each non-wadeable site. Due to the substrate conditions and depth, only three locations were sampled with both methods.

SPECIES RICHNESS

Both species richness and abundance estimates are frequently biased by sample gear selectivity. Comparing species richness for two or more gear types will generally produce misleading results, as active and passive sampling comparisons are difficult to evaluate due to the nature of sampling (Weaver et al. 1993; Jackson et al. 1997; Fago 1998), and no clear interpretation can be made (Hurlbert 1971). However, with a standardized measure of species richness and abundance, it is possible to compare species inventories from different times or those compiled with different sampling techniques (Moreno and Halffter 2000).

A species accumulation curve is a graph of the number of observed species as a function of some measure of the sampling effort required to observe them (Colwell 2005). Raw species richness counts can be compared only when species accumulation curves have reached a clear asymptote; however, if one or more curves fail to reach an asymptote the curves themselves may be compared after appropriate scaling (Gotelli and Colwell 2001). Since the species richness of a collection generally increases with sampling effort, a comparison of species richness of different collections requires that collections be reduced to a common size (Hurlbert 1971). In addition, species accumulation curves can also be generated to examine the difference in species richness over time. The simulation generates a curve representing the average number of species found versus the number of sites sampled.

Rarefaction is a statistical method for estimating the number of species expected in a random sample of individuals taken from a collection. Rarefaction curves are generated by repeatedly re-sampling the pool of individuals, at random, without replacement. Thus, the rarefaction generates the expected number of species in a collection of individuals drawn from a random pool of individuals (Gotelli and Colwell 2001). Rarefaction methods allow for meaningful standardization and comparisons of differences among datasets at comparable levels of sampling effort (Hurlbert 1971; Gotelli and Colwell 2001). The 95% confidence intervals are estimated rigorously using the analytical formula created by Colwell (2005); therefore statistical inferences can be made.

HISTORICAL COMPARISON

Historic and present collections were compared for 6 sites from the Nonquon River watershed to indicate how a site changes with time (Figure 14). The OMNR seine collections

were completed August 5-13, 1975, whereas the KRCA collections involved two backpack electrofishing (July 21, 2004 and July 25, 2005) and four hoop net sites (August – September 2005). Methods and effort were not standardized between surveys, and differences in species richness and abundance were compared by constructing rarefaction curves based on individuals captured for each sampling effort (number of net sets), and compared using 95% confidence intervals to make statistical inferences (Gotelli and Colwell 2001).

Seventeen species were detected in 1975 and 22 species were found in 2004 and 2005; and there were species unique to each year (Table 27). Overall, there was a significant difference observed in the abundance of fishes caught, and species richness between the two sampling years (Figure 15). The fish community of 2004 and 2005 was more speciose than in 1975; however, the community remains functionally similar. One fish species, smallmouth bass, went undetected in the 2005 sampling year.

PRESENT COMPARISON

For this study, the area and effort were not standardized between locations; therefore, differences in species richness were compared using constructed rarefaction curves based on data collected from 2004 and 2005 sampling. The results of each sampling event were standardized to a common number of individuals, to match the size of the smallest collection and compared using 95% confidence intervals (Gotelli and Colwell 2001).

To evaluate the sampling sufficiency for all areas sampled, species accumulation curves were generated (Jones 2004). Species accumulation curves derive information on the amount of effort required for detecting the greatest species richness. Observations for a particular level of sampling effort are influenced by the order in which samples were taken (Bowen and Freeman 1995; Flather 1996). Therefore, to obtain a more robust estimate of sampling effort required to obtain the maximum species richness, a randomization procedure was added. The procedure randomly sorted the fishes caught from each site 1000 times, and then computed the average number of new species found in each successive sample from the randomized data set, without replacement.

The simulation generates a curve representing the average number of species found versus the number of sites sampled. Data from the randomization were plotted and used to assess the rates of species accumulation and to estimate the relationship between sampling effort and species richness. The curves were based on the presence of a species for each sampling unit. The relationship between sampling effort and species richness usually resembles a positive asymptotic curve (Flather 1996; Bowen and Freeman 1998). The point where the curves for each site levels off to approach an asymptote on successive sampling indicates a sample size necessary for completing the species list at a location (Glowacki and Penczak 2000).

There were 19, 21 and 26 species observed in the Nonquon River tributaries, Layton River and Nonquon River main channel, respectively, and there were species unique to each sampling location (Table 28). Both cold and warm water species were detected in the Nonquon River tributaries, whereas only warm water species were found throughout the Layton River and Nonquon River main channel. Species richness and abundances for the

Table 27: Fish species composition, abundance and relative abundance based on the six-paired sampling events by the OMNR in 1975 and KRCA in 2005. Shaded areas represent species unique to that sampling year.

	MNR 1975		KRCA 2005	
Species Name	**Abundance**	**Relative Abundance**	**Abundance**	**Relative Abundance**
Central Mudminnow	2	1.03	74	3.13
White Sucker	6	3.09	8	0.34
Northern Redbelly Dace	3	1.55	1000	42.25
Finescale Dace	0	0.00	755	31.90
Brassy Minnow	7	3.61	56	2.37
Hornyhead Chub	0	0.00	4	0.17
Golden Shiner	2	1.03	15	0.63
Common Shiner	8	4.12	7	0.30
Bluntnose Minnow	8	4.12	2	0.08
Fathead Minnow	16	8.25	25	1.06
Blacknose Dace	13	6.70	68	2.87
Longnose Dace	7	3.61	84	3.55
Creek Chub	76	39.18	39	1.65
Pearl Dace	0	0.00	26	1.10
Brown Bullhead	0	0.00	6	0.25
Banded Killifish	4	2.06	1	0.04
Brook Stickleback	0	0.00	30	1.27
Rock Bass	11	5.67	11	0.46
Pumpkinseed	4	2.06	22	0.93
Bluegill	0	0.00	4	0.17
Smallmouth Bass	4	2.06	0	0.00
Largemouth Bass	2	1.03	75	3.17
Yellow Perch	21	10.82	55	2.32

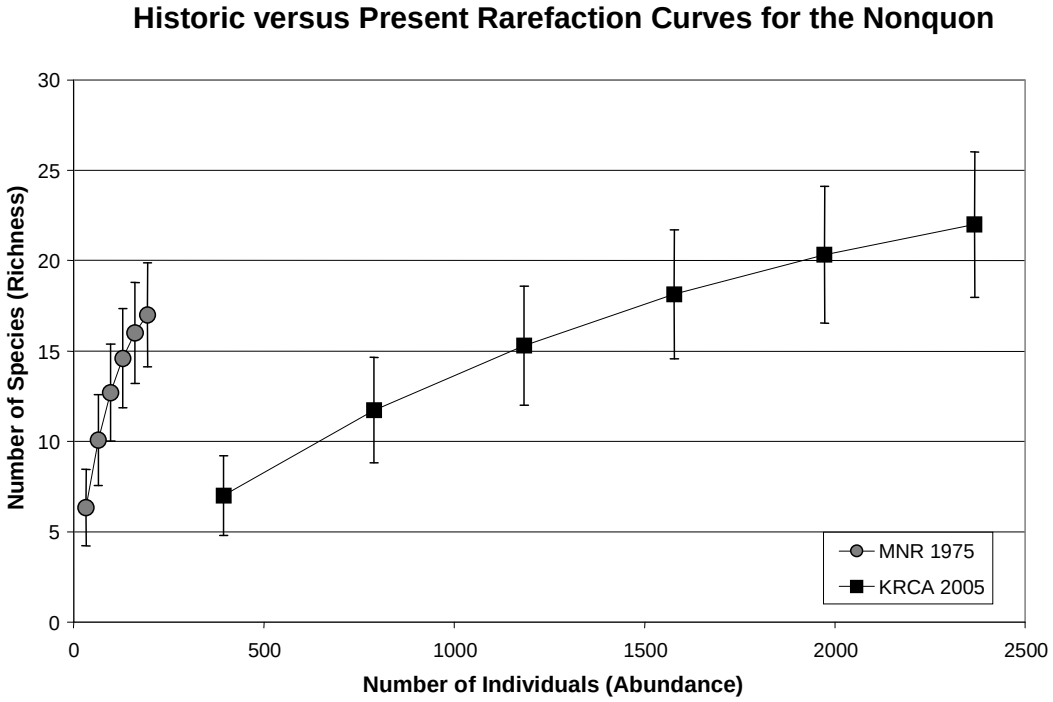

Figure 14: Species rarefaction curves with 95% confidence intervals calculated for OMNR 1975 (circles) and KRCA 2005 (squares) stations for 6 sites. Rarefaction-based estimates of species richness are based on a standard sample size of 194 individuals.

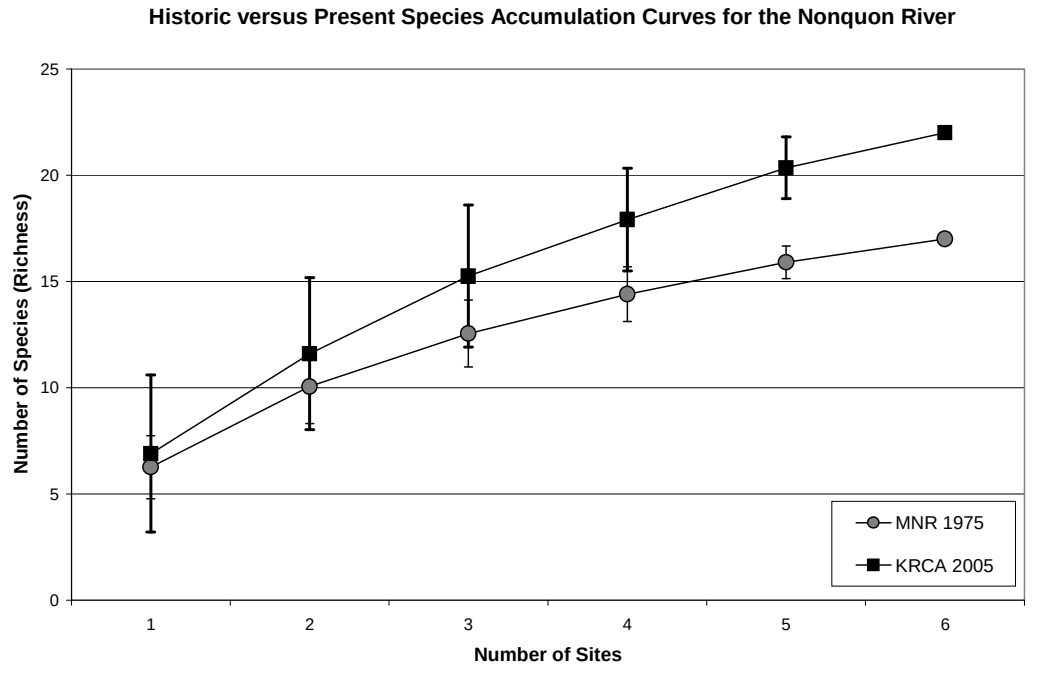

Figure 15: Species accumulation curves OMNR 1975 (circles) and KRCA 2005 (squares) stations for 6 sites.

three locations did vary; however, once effort had been standardized using the rarefaction method, similar estimates in species richness was obtained (Figure 16). Fishes caught in each management zone are listed in Appendix D.

Species richness greatly increased as sample size increased for all three locations, but richness increased more rapidly for the Layton River (Figure 17). From these data it is clear that sampling effort may not have been sufficient to capture representatives of all species present in the Nonquon River tributaries and Layton River.

SPRING SPAWNING SURVEYS

Since walleye and muskellunge are fish species that were identified by the public as being top candidates for management, KRCA initiated a spring spawning survey to obtain a better understanding of walleye and muskellunge spawning habitat and numbers of spawners at a given time. The sites that were surveyed in 2006 are shown in Figure 18.

WALLEYE SPAWNING SURVEY

Walleye spawning usually occurs at night, in water temperatures ranging from 5.6 to 11.1°C (Scott and Crossman 1973). Walleye spawning surveys were conducted mainly at night, between April 9 and 26, 2006. These observations commenced at approximately 9 p.m. in Seagrave at the Mariposa Estates boat launch. Two persons per boat would work their way slowly upstream along one shoreline and downstream along the other using an electric motor. The water was scanned using a million candlepower spotlight. Once walleye were visibly identified, water depth, air temperature, water temperature, water clarity, abundance and GPS coordinates were recorded.

Observations spanned the Mariposa Estates boat launch and continued upstream of the Seagrave bridge (Table 29). Water temperatures ranged from 4.5 to 18 °C. In total, 13 walleye were observed; however, no spawning activity was witnessed. The majority of walleye (10) were observed on April 9, 2006 during the day and the maximum size observed was approximately 30 cm. Other fishes observed included common carp, bluegill, white sucker, bullhead, largemouth bass, and muskellunge. The ice was out early this year and it is likely that the peak spawn was missed.

MUSKELLUNGE SPAWNING SURVEY

Muskellunge spawn in late April or early May when water temperatures are between 9.4 – 15.0°C over heavily vegetated flooded areas (Scott and Crossman 1973). Muskellunge spawning surveys were conducted during the day from April 18 to May 9, 2006. These observations were made from Scugog Line 8 downstream to Seagrave out of a canoe; paddling upstream to the start location and recording fish observed upon returning downstream.

Observations were made from Reach Street downstream to Scugog Line 12 and in the lower reaches during the walleye spawning survey (Table 30). Water temperatures ranged between 9 and 17°C. Muskellunge were only observed on April 20, 2006 and not observed upstream

of Scugog Line 10. Only one observation was made in which spawning behaviour was witnessed.

The data from the spawning surveys not only illustrates that many fishes migrate great distances to carry out life processes that are essential to their survival (e.g., reproduction), but also demonstrates the important biological linkages between the Nonquon River watershed and Lake Scugog.

Table 28: Fish species composition, abundance and relative abundance of the Nonquon River watershed, based on locality. Shaded areas represent species unique to that sampling location.

	Nonquon River Trbutaries		Layton River		Nonquon River Main Channel	
Species Name	**Abundance**	**Relative Abundance**	**Abundance**	**Relative Abundance**	**Abundance**	**Relative Abundance**
Brook Trout	26	2.25	0	0.00	0	0.00
Central Mudminnow	59	5.10	18	2.88	436	7.16
White Sucker	52	4.49	22	3.53	21	0.34
Northern Redbelly Dace	31	2.68	30	4.81	1443	23.69
Finescale Dace	56	4.84	6	0.96	775	12.73
Brassy Minnow	3	0.26	1	0.16	115	1.89
Hornyhead Chub	0	0.00	38	6.09	0	0.00
Golden Shiner	0	0.00	0	0.00	52	0.85
Common Shiner	2	0.17	80	12.82	4	0.07
Blackchin Shiner	0	0.00	0	0.00	1	0.02
Bluntnose Minnow	3	0.26	7	1.12	14	0.23
Fathead Minnow	2	0.17	0	0.00	33	0.54
Blacknose Dace	306	26.45	73	11.70	0	0.00
Longnose Dace	0	0.00	84	13.46	0	0.00
Creek Chub	431	37.25	76	12.18	36	0.59
Pearl Dace	4	0.35	11	1.76	35	0.57
Central Stoneroller	0	0.00	20	3.21	0	0.00
Brown Bullhead	0	0.00	1	0.16	38	0.62
Banded Killifish	0	0.00	0	0.00	5	0.08
Brook Stickleback	90	7.78	42	6.73	73	1.20
Trout-perch	2	0.17	0	0.00	0	0.00
Rock Bass	3	0.26	11	1.76	122	2.00
Pumpkinseed	7	0.61	6	0.96	614	10.08
Bluegill	0	0.00	0	0.00	261	4.29
Smallmouth Bass	0	0.00	0	0.00	2	0.03
Largemouth Bass	35	3.03	40	6.41	1118	18.36
Black Crappie	0	0.00	0	0.00	9	0.15
Yellow Perch	44	3.80	52	8.33	832	13.66
Walleye	0	0.00	0	0.00	4	0.07
Iowa Darter	0	0.00	1	0.16	1	0.02
Johnny Darter	1	0.09	0	0.00	0	0.00
Logperch	0	0.00	5	0.80	45	0.74
Brook Silverside	0	0.00	0	0.00	1	0.02
Total No. of Species	**19**		**21**		**26**	
Total No. of Sites	**17**		**7**		**46**	

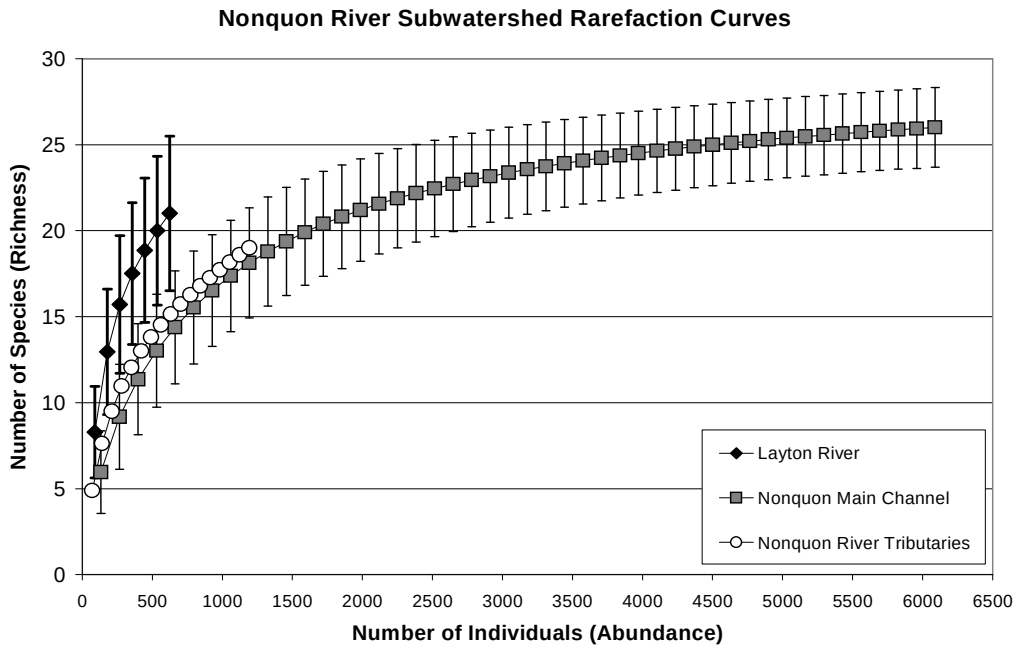

Figure 16: Species rarefaction curves with 95% confidence intervals calculated for Layton River (dark diamonds), Nonquon River main channel (squares) and Nonquon River tributaries (open circles). Rarefaction-based estimates of species richness are based on a standard sample size of 624 individuals.

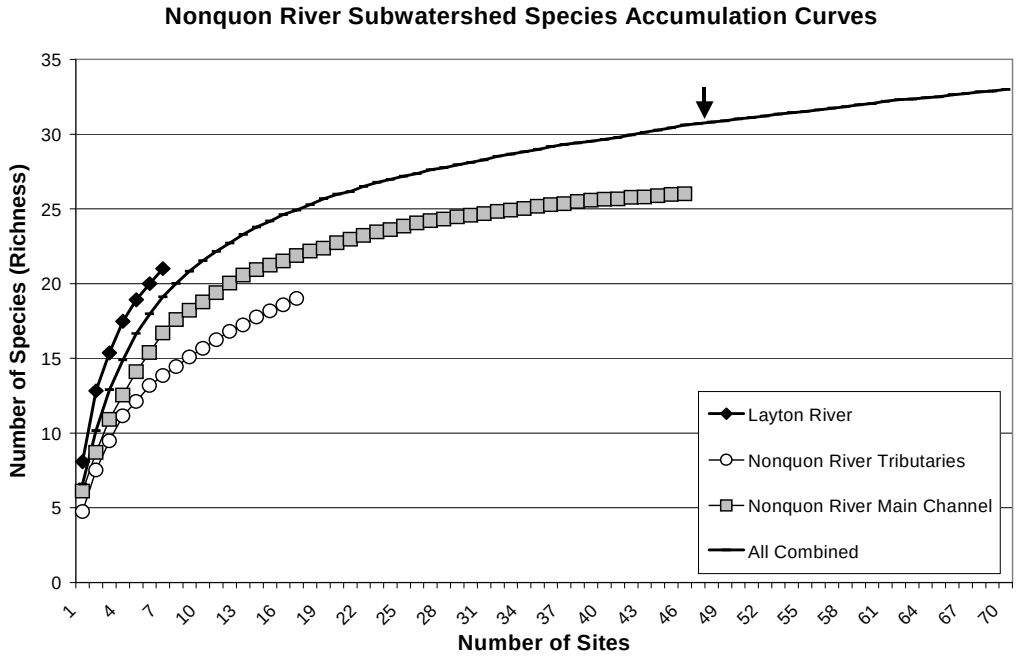

Figure 17: Species accumulation curves for all locations sampled from 2003-2005. Layton River (dark diamonds), Nonquon River tributaries (open circles), Nonquon River main channel (squares), and the combined sampling effort (line). The arrow indicates the effort required to detect 95% of the species captured.

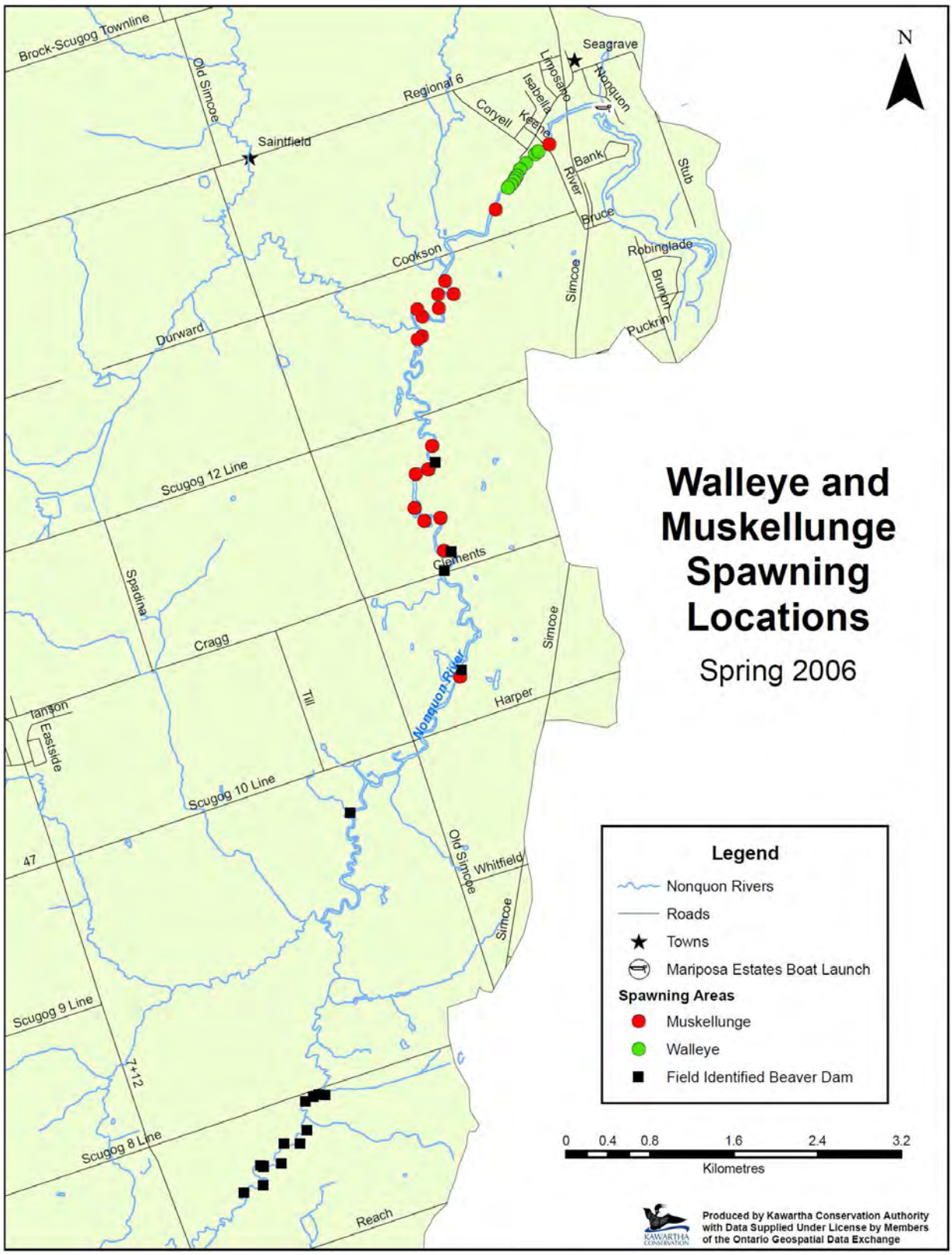

Figure 18: Observation sites of walleye and muskellunge during the spring spawning survey. Locations of beaver dams identified during field investigations are also documented.

Table 29: Summary of walleye spawning survey data collected in 2006.

DATE	No. of BOATS	START TIME	END TIME	AIR TEMP (°C)	WATER TEMP (°C)	WATER CLARITY	FLOW	NUMBER OBSERVED	OTHER FISHES	COMMENTS
Apr-09	1	12:00	17:30	8.6-10.1	4.5-6.7	clear	high	10	7 muskellunge white sucker	All walleye were 30cm or less, incredible schools of white sucker
Apr-18	1	21:33	0:07	14.7-13.4	10.7-5.5	poor	medium	0	common carp, bluegill, white sucker and bullhead	Thursday night walleye observed spawning near Valentia, schools of white sucker still present
Apr-20	2	20:52	22:20	16.0-10.5	18.0-16.1	very poor	medium	2	common carp, bluegill, pumpkinseed, white sucker, largemouth bass, bullhead, and muskellunge	Turbid water with a lot of algae and schools of baitfish observed
Apr-26	1	20:52	22:33	10.0-3.9	11.0-10.3	clear	high	1	muskellunge (large ones), bullhead, bluegill, rockbass, white sucker and largemouth bass	Schools of sucker completely gone, low numbers of all fishes observed

Table 30: Summary of muskellunge spawning survey data collected in 2006.

DATE	LOCATION	START TIME	END TIME	AIR TEMP (°C)	WATER TEMP (°C)	WATER CLARITY	FLOW	NUMBER OBSERVED	PAIRING (Y/N)	COMMENTS
Apr-18	From Reach Street downstream to marshy area	12:15	14:00	13.0-17.0	9.0-11.0	clear	low	0	n/a	
Apr-20	From Scugog Line 12 to Line 10 (Old Simcoe)	11:17	16:32	12.0-22.0	11.0-17.0	clear	medium	9	Y	Lots of algae visible
Apr-27	From Scugog Line 8 upstream to marshy area	12:20	14:50	11.0-17.0	13.0-15.0	clear	low	0	n/a	Where industrial area may connect to marsh the water depth is ~35cm for 830m
May-05	From Scugog Line 10 (Old Simcoe) past the Field Centre to dam shown between Line 10 and Line 8	11:02	12:30	15.0-15.0	13.0-16.0	poor	medium	0	n/a	
May-09	From Scugog Line 12 to Line 10 (Old Simcoe)	10:20	13:35	22.0-25.0	15.0-17.0	clear	low	0	n/a	Lots of filamentous algae

LIST of ACRONYMS

BIA – Business Improvement Association
BMP – Best Management Practice
BOD – Biological Oxygen Demand
CA – Conservation Authority
CFWIP – Community Fish and Wildlife Improvement Program
CLTIP – Conservation Lands Tax Incentive Program
Cm – Centimetres
CSSP – Community Stream Steward Program
DAAC – Durham Agricultural Advisory Committee
DEAC – Durham Environmental Advisory Committee
DFO – Fisheries and Oceans Canada
DLSC – Durham Land Stewardship Council
EC – Environment Canada
EFP – Environmental Farm Plan
ELC – Ecological Land Classification
EPT – Ephemeroptera, Plecoptera, Trichoptera
FMZ – Fisheries Management Zone
GC – Greencover Canada
HBI – Hilsenhoff Biotic Index
KRCA – Kawartha Region Conservation Authority
KWW – Kawartha Water Watch
LSEMP – Lake Scugog Environmental Management Plan
M – Metres
MAF – Mean Annual Flow
MFTIP - Managed Forest Tax Incentive Program
Mm – Millimetres
NEEC – Nonquon Environmental Education Centre
NITA – Nonquon Industrial Tributary Area
NRFMP – Nonquon River Fisheries Management Plan
NRSS – Nonquon River Subwatershed Study
OFA – Ontario Federation of Agriculture
OFAH – Ontario Federation of Anglers and Hunters
OMAFRA – Ontario Ministry of Agriculture, Food and Rural Affairs
OMMAH – Ontario Ministry of Municipal Affairs and Housing
OMNR, MNR – Ontario Ministry of Natural Resources
OMOE, MOE – Ontario Ministry of the Environment
OMPIR – Ontario Ministry of Public Infrastructure Renewal
ORMCP – Oak Ridges Moraine Conservation Plan
OSAP – Ontario Stream Assessment Protocol
PGMN – Provincial Groundwater Monitoring Network
PPS – Provincial Policy Statement
PWQMN – Provincial Water Quality Monitoring Network
SLS – Scugog Lake Stewards
TSW – Trent Severn Waterway
WATER – Water and Terrain Environmental Restoration
WBFiMP – Watershed Based Fisheries Management Plan Guidelines
WPCP – Water Pollution Control Plant

GLOSSARY

Abundance: The number of individuals in a population or in a specific area as expressed in number of fish.

Active sampling: Sampling methods in which the gear must be moved through the water and the fish are actively pursued (e.g., seine nets, electrofishing).

Adaptive management: A management plan that acknowledges the uncertainty of a managed system and therefore integrates design, management, and monitoring in order to allow managers to adapt and to learn.

Adopt-A-Stream: The Adopt-A-Stream program helps the public care for a local stream or river; encourages new community stewardship projects; facilitates communication between community groups and provides up to date information resources. More information is available at: http://www.ontariostreams.on.ca/adopt-a-stream.html

Algal blooms: An episode of excessive nutrient content in a river, stream or lake, which causes a proliferation of living algae. The end result is a depletion of much needed oxygen in the water. Excessive algae blooms can lead to the death of the fish and aquatic organisms of the given waterbody through oxygen deprivation called a "fish kill".

Aquifer: An underground bed or layer of sand, earth, gravel, or porous stone that contains water or permits its passage.

Assemblages: Groups of interacting individuals or populations in a given waterbody. For example, fish assemblage or a benthic macroinvertebrate assemblage.

Asymptote: A line that is considered to be the limit to a curve. As the curve approaches the asymptote, the distance separating the curve and the asymptote continues to decrease, but the curve never actually intersects the asymptote.

Backpack electrofishing: An active fish sampling technique that uses electrical currents and fields to control fish movement and/or immobilize fish allowing capture.

Bank stability: The ability of a stream bank to resist change.

Baseflow: A stream is at baseflow level when all of the water input is from groundwater sources.

Benthic macroinvertebrates: The name used to describe stream dwelling organisms, with no backbones, living in the substrate. They are small in size but large enough to be seen by the unaided eye.

Biodiversity: The diversity, or variety, of plants, animals and other living things in a particular area or region. It encompasses habitat diversity, species diversity and genetic diversity.

Biomonitoring: Use of a biological entity as a detector and its response as a measure to determine environmental conditions. Toxicity tests and biological surveys are common biological monitoring methods.

Biotic processes: Relating to life and living processes such as nutrient cycling, predator-prey relationships, migration, etc.

Buffer strips: Strips of grass or other close-growing vegetation that separates a waterway (ditch, stream, creek) from an intensive land use area (subdivision, croplands).

Channel morphology: Physical attributes of a water system, and the methods for measuring those attributes.

Check Your Watershed Day: A volunteer based event in which groups of individuals sample a watercourse within a specific watershed at roadside stream-crossings.

Climate: The average weather (usually taken over a 30-year time period) for a particular region and time period. Climatic elements include precipitation, temperature, humidity, sunshine and wind velocity and phenomena such as fog, frost, and hail storms.

Coldwater: A stream can be classified as cold water if its temperature is regularly $< 18^{o}C$.

Coolwater: A stream can be classified as cool water if its temperature is regularly between 18 and $25^{o}C$.

Communities: A group of interacting individuals or populations. Sometimes, a particular subgrouping may be specified, such as the fish community in a lake or the soil arthropod community in a forest.

Community Fish and Wildlife Involvement Program: This program supports local community groups in their efforts to improve fish and wildlife habitat. Supported projects include: spawning bed creation, habitat restoration, wildlife census, streambank fencing and stabilization, fish culture and stocking, schoolyard renaturalization, building nesting platforms, developing educational trails, or reintroduction of lost species. More information is available at: http://www.mnr.gov.on.ca/MNR/fishing/cfwip.html

Community Stream Steward Program: This program is a multi-partner initiative that is focused on creating a sense of community and individual awareness of the need in restoring and preserving coldwater streams. More information is available at: http://www.ofah.org/Stream/

Conservation Easements: Under the Conservation Lands Act of Ontario, municipalities, conservation authorities and non-governmental not-for-profit natural heritage organizations

are empowered to acquire and hold conservation easements that protect natural heritage sites. This is voluntary legal agreement with the property owner, an appraisal of the property is completed and a tax receipt is provided for the value of the donation.

Conservation Lands Tax Incentive Program (CLTIP): Lands identified by the Ministry of Natural Resources as Provincially Significant are eligible for this program. These are a small subset of lands found in a natural state in Ontario including provincially significant wetland; provincially significant area of natural and scientific interest (ANSI); habitat of endangered species; land designated as escarpment natural area in the Niagara Escarpment Plan; and, community conservation land. The conservation land must be at least 1/5 of a hectare (1/2 acre) in size. http://www.mnr.gov.on.ca/MNR/cltip/

Cultural value: Refers to the aesthetic, historic, scientific or social value of items or places and are importance to past, present or future generations.

Discharge: An area where water leaves the underground, saturated zone and is exposed to the surface.

Dissolved oxygen (DO): The oxygen dissolved in water. Dissolved oxygen is necessary for the life of fish and other aquatic organisms.

Drought: A deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area. A regional water shortage caused by a prolonged period of below-average precipitation, above-average temperatures, or a combination of the two.

Ecological Land Classification: A tool developed by the OMNR to describe ecological communities in southern Ontario.

Ecosystem: Any complex of living organisms interacting with nonliving chemical and physical components that form and function as a natural environmental unit.

Ecosystem approach: Natural resource planning and management activities and methods used to establish and maintain sustainable environments. It involves recognizing that all ecosystems (living and non-living components) are interdependent upon one another, and that changes to one ecosystem can impact other ecosystems.

Environmental Farm Plan: A voluntary program that aids farmers in assessing a variety of environmental concerns on their farm. The process supports individual farm planning and decision-making in the short and long term, and harmonizes productivity, business objectives and the environment. More information is available at: www.omafra.gov.on.ca/english/environment/efp/efp.htm

Evapotranspiration: The total water loss from the soil, including that by direct evaporation and that by transpiration from the surfaces of plants.

Fauna: A synonym for animals.

Feeding habitat: Areas utilized by fish for feeding. Feeding habitats may change for each species during the course of a year as food sources become available.

Forage Fish: Small fish which breed prolifically and serve as food for larger, predatory fish.

Flora: A synonym for plants.

Game fishes: Also called "sport fishes." Species of fish sought by recreational fisherman (trout, bass, salmon, etc).

Gradient: A gradual change in stream elevation over a specific distance.

Greencover Canada: The Greencover Canada program is an initiative to help improve grassland-management practices, protect water quality, reduce greenhouse-gas emissions, and enhance biodiversity and wildlife habitat. It is a national program that focuses on five components: land conversion, critical areas, technical assistance and regional technical Assistance, watershed evaluation of best management practices and shelterbelts. More information about this program is available at: http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181580137261&lang=e

Groundwater: (1) Water located underground, in the substrate of the earth that is recharged by infiltration and enters streams through seepage and springs. (2) Subsurface water in a zone of saturation, standing in or passing through the soil and the underlying strata.

Habitat: The environment in which an organism lives.

Headwaters: Upper reaches of tributaries in a drainage basin.

High water table: The highest meeting point between the groundwater and the unsaturated layer above it.

Hilsonhoff's Biotic Index: A rating based on the varying levels of organic pollution tolerance of benthic macroinvertebrates.

Hoop net: A funnel-shaped net mounted on metal hoops that have a lead and two wings that guide the fish to the mouth of the trap.

Hydrology: The scientific study of the waters of the earth, especially with relation to the effects of precipitation and evaporation upon the occurrence and character of water in streams, lakes, and on or below the land surface.

Hydrologic cycle: Cycle of water movement from the atmosphere to the earth via precipitation through surface and groundwater to the oceans and return to the atmosphere via evaporation from water bodies and transpiration by plants.

In-stream barriers: Any structure spanning the entire width of a watercourse that blocks upstream movement of fish species (e.g., dam or weir).

Invasive species: A species that has been introduced by humans into an area in which it does not naturally occur, causing negative environmental effects.

Macrophytes: Large aquatic plants. Undesirable aquatic plants are often referred to as 'weeds'.

Managed Forest Tax Incentive Program (MFTIP): This program is designed to encourage landowner participation in natural resource stewardship on private forestland in Ontario. Eligibility requirements can be found online at: http://www.mnr.gov.on.ca/MNR/forests/mftip/pdf/MFTIP_Guide_06.pdf

Native species: A species that naturally occurs in a specific watercourse as a result of post-glacial dispersal.

Naturalized species: A species that does not naturally occur in a specific watercourse but has been introduced to the area by humans and now is in relative balance with the rest of the ecosystem (ie. exhibits population fluctuations, etc.)

Nitrates: The chemical form of nitrogen. A plant nutrient and inorganic fertilizer that enters water supply sources from septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills and garbage dumps.

Non-point source: Diffuse pollution sources (e.g. without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, and city streets.

Nursery habitat: Portions of a waterbody or watercourse used by early life stages of fish species, fulfilling life requirements for adequate food and protection from predators.

Oak Ridges Moraine: One of the most significant landforms in southern Ontario. It contains the headwaters of 65 river systems and has a wide diversity of streams, woodlands, wetlands, kettle lakes, kettle bogs and significant fauna and flora.

Off-line ponds: small, often man-made waterbodies that are not connected to a central watercourse (stream, river or lake).

On-line ponds: small, often man-made waterbodies that are connected to watercourses.

Organic compounds: Animal or plant-produced substances containing mainly carbon, hydrogen, nitrogen, and oxygen.

Organic pollution: The influx of organic compounds into an environment. Organic pollution often originates from sewage plants (raw or treated), agricultural and urban runoff, septic systems and industrial effluents. Microorganisms living and feeding on organic compounds decompose the material, using up oxygen quicker then it can be replenished.

Stream biota is impacted as pollution sensitive species become less abundant, and in severe cases large die-offs (e.g., fish kills) can occur.

pH: A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a scale of 0 to 14 with 7 representing a neutral state, 0 representing the most acidic and 14 the most basic.

Passive sampling: Any sampling device that is stationary and allows fish to trap themselves (e.g., hoop net); many operate on the 'funnel' principle such that fish can enter the trap but not escape.

Pathogens: An organism that causes disease in another organism.

Perched culvert: A culvert under a road crossing that is elevated considerably from the stream bed, blocking the passage of fish from one side of the crossing to the other.

Phosphates: General term used to describe phosphorus-containing substances. Phosphates constitute an important plant nutrient.

Physiography: The study or description of landforms.

Pleistocene Epoch: A geological time period extending from 2 million years to 10,000 years before present, characterized by several glacial ages.

Point source pollution: Pollution that enters waterways from a single, identifiable location or source, typically from discharge pipes.

Pollution-sensitive: Refers to animals that are intolerant of organic pollution. For example, the presence of pollution sensitive macroinvertebrates indicates that the body of water is healthy.

Pollution-tolerant: Refers to animals that can tolerate moderate to high levels of organic pollution. For example, the excessive presence of pollution tolerant macroinvertebrates indicates poor water quality.

Provincial Groundwater Monitoring Network: A partnership program between the province of Ontario and conservation authorities to collect and manage ambient (baseline) groundwater level and quality information from key aquifers located across Ontario.

Provincial Water Quality Monitoring Network: Ontario's provincial water quality monitoring network collects surface water quality information from streams at locations across Ontario in partnership with conservation authorities. The standard set of water quality indicators monitored at each station includes chloride, nutrients, suspended solids, trace metals and other general chemistry parameters. Other substances such as pesticides and other contaminants are monitored in detailed water quality surveys in priority watersheds.

Provincially Significant Wetland: A wetland area identified as provincially significant by the OMNR. Many different criteria exist for labelling a wetland as provincially significant such as wetland size, species richness etc.

Rarefaction: Refers to a technique to standardize and compares species richness computed from samples of different sizes. Rarefaction allows the calculation of the species richness for a given number of sampled individuals and allows the construction of a rarefaction curve. This curve is a plot of the number of species as a function of the number of individuals sampled.

Recharge: The downward movement of surface precipitation (e.g. rain, snow melt) to the water table and underlying saturated zone.

Refuge habitat: An area where an animal can avoid stresses, such as predation, high temperatures, low dissolved oxygen etc.

Resident habitat: An area in a stream where an animal lives for a prolonged time period or the majority of its life.

Riparian: Areas immediately adjacent to watercourses and the surrounding vegetation on the banks of rivers and streams.

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

Runoff: The portion of rainfall, melted snow or irrigation water that flows across the surface and eventually returns to streams. Runoff can pick up pollutants from the air or the land and carry them to the receiving waters.

Scugog WATER Fund: The goal of the Scugog WATER Fund is to address the major issues affecting Lake Scugog including: extensive erosion on lakeshores and stream banks, leaking septic systems around the lake, agricultural runoff, manure storage, milk house waste water, cropland erosion, extensive fertilizer and pesticide use and livestock access to watercourses. The program provides funding for landowner to mitigate the above-mentioned issues. More information is available at: http://www.kawarthaconservation.com

Seeps: Springs or wet areas where water enters the stream from a groundwater source.

Seine net: An active sampling method. Bag seines consist of a net extended between two poles. In the centre of the seine is a bag consisting of small mesh where the fish catch accumulates. The bag is flanked on both sides by mesh net wings that sweeps or directs the catch into the bag. Each wing is connected to a pole at either end of the bag seine. The poles are held by two persons, one pulls the bag seine quickly out into the water, arcing out from the shoreline and then joining back to the shoreline and closing the net up by crossing the ends of the net together, closing up the bottom so fish cannot escape, and pulling the bag end of the seine into the shore to be processed.

Simpson's Diversity Index: The index is a measure of diversity that represents the probability that two individuals randomly selected from a sample will belong to different species

Spawning habitat: An area within a watercourse where deposition and fertilization of eggs takes place.

Species accumulation curve: A statistical analysis for determining the appropriate number of sample sites for a given study. It is typically represented by plotting a graph of the number of species against the number of study sites or number of cumulative individuals caught. A species accumulation curve rises rapidly, and then starts to flatten out. If all of the species present have been sampled, the line would level off. If the line is still rising, it is an indicator that more sampling may yield more species not yet represented.

Species richness: A measures of the absolute number of different species in a community without reference to the number of individuals in each species.

Stakeholder: An individual or organization that has an interest in the outcome of a particular product, service or decision, or any individual or organization that is impacted by a decision.

Standardized: The procedure of maintaining methods and equipment as constant as possible.

Stewardship: The integration and application of environmental values in order to improve quality of life and preserve valuable natural resources for present and future generations.

Substrate: (1) The substance forming the bottom of the stream or lake bed; a general term for any benthic habitat. (2) The base on which an organism lives, or other solid surface to which animals or plants attach, or on which they move.

Transient habitat: An area within a watercourse that act as fish habitat in which a fish passes through during some portion of its life.

Trees Ontario: Trees Ontario Foundation has undertaken the task of revitalizing Ontario's tree-planting efforts on private land through the development of partnerships between all organizations with an interest in replenishing Ontario's private land forests. More information is available at: http://www.treesontario.on.ca

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

Turbidity: A measure of how "murky" the water column is. High turbidity values indicate a high amount of suspended sediments in the watercourse.

Warmwater: A stream can be classified as warm water if its temperature is regularly $> 25^{o}C$.

Water balance: A record of outflow from, inflow to, and storage in a hydrologic unit such as an aquifer or drainage basin.

Water budget: The balance of all water moving into and out of a specified area within a specified period of time.

Water quality: An integrated index of chemical, physical and microbiological characteristics of natural water that is a function of natural processes and anthropogenic impacts.

Water quantity: An amount of water (e.g. flow, velocity, discharge, water levels).

Watercourse: A natural or artificial means in which water flows.

Watershed: (1) A region or area drained by surface and groundwater flow in rivers, streams, or other surface channels. A smaller watershed can be wholly contained within a larger watershed. (2) The divide between two catchment areas.

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

Winterkill: The sudden mortalities of fishes which occur in winter, usually as a direct result of suffocation (lake of oxygen exchange between air and water).

Yellow Fish Road: A nation-wide environmental education program designed and managed by Trout Unlimited Canada. The goal of the Yellow Fish Road program is to help Canadians understand that stormwater drains are the doorways to our rivers, lakes and streams. Preventing pollutants from entering our stormwater drains is critical to protecting and improving water quality and aquatic habitat. More information is available at: http://www.yellowfishroad.org/about.html

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APPENDIX A: LEGISLATION SUMMARIES

FISHERIES ACT
http://www.e-laws.gov.on.ca:81/ISYSquery/IRLA108.tmp/10/doc

The federal *Fisheries Act* assigns the Minister of Fisheries and Oceans the authority to protect fish and fish habitat from destructive activities. Any works that occur in or near water may require authorization under the *Fisheries Act*. Section 35(1) of the Act states, no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat while Subsection 35(2) explains how a contravention of Subsection 35(1) can be authorized by the federal government, provided certain acceptable conditions have been met. The issuance of an authorization to harmfully alter, disrupt, or destroy fish habitat is a regulatory trigger for an environmental assessment under the *Canadian Environmental Assessment Act*. It should also be noted that Fisheries and Oceans Canada may refuse to authorize certain works where the impacts to fish habitat are unacceptable or cannot be adequately compensated through a compensation plan. In addition to Section 35, *Fisheries Act* Sections 20, 21, 22, 27, 30, 32, 36 and 37 set out general habitat and pollution provisions which are binding on all levels of government and the public in areas such as:

- need for safe fish passage around migration barriers
- recovery of costs for obstruction to fish passage
- requirements for sufficient water flows
- protection of fish in or near fish-ways
- fish guards and screen
- destruction of fish
- destruction of habitat
- pollution of fish habitat
- obligations of proponents

Section 2 of the *Fisheries Act* defines fish to include:

> "parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals".

Section 34(1) of *Fisheries Act* defines fish habitat as:

> "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes".

NAVIGABLE WATERS PROTECTION ACT
http://laws.justice.gc.ca/en/ShowFullDoc/cs/N-22///en

The *Navigable Waters Protection Act* is a federal law that protects the rights of the public to navigation in Canadian waters. This is accomplished by prohibiting any works in, on, over, under, through or across any navigable waters without the authorisation of the Minister of Fisheries and Oceans Canada. Navigable Waters is defined as any body of water capable, in its natural state, of being navigated by any type of floating vessel for the purpose of transportation, recreation or commerce and includes a canal and any other body of water created or altered for the benefit of the public, as a result of the waterway assigned for public use.

SPECIES AT RISK ACT
http://laws.justice.gc.ca/en/S-15.3/index.html

The purpose of the *Species At Risk Act* is to ensure that native Canadian species and subspecies as well as distinct populations are prevented from becoming extirpated or extinct. It also encourages management to prevent further species from becoming at risk, and promotes the recovery of those who are already listed as endangered or threatened. The Act provides for the legal protection of wildlife as well as the conservation of biodiversity.

CANADIAN ENVIRONMENTAL ASSESSMENT ACT
http://laws.justice.gc.ca/en/C-15.2/

The *Canadian Environmental Assessment Act* is administered by the Canadian Environmental Assessment Agency (CEAA), which is a federal agency that reports directly to the Minister of the Environment. There is a long list of triggers for a federal environmental assessment, as described in the Inclusion List for CEAA environmental assessments. Among those triggers are the applications for authorization under the *Fisheries Act* to kill fish by means other than fishing (Section 32) or to harmfully alter, disrupt or destroy fish habitat (Subsection 35(2) of the Act).

LAKES AND RIVERS IMPROVEMENT ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90l03_e.htm

The *Lakes and Rivers Improvement Act* gives the Ministry of Natural Resources the mandate to manage water related activities, particularly in areas outside the jurisdiction of Conservation Authorities. The purpose of the Act is to preserve public rights in or over water; protect the interest of riparian owners; manage fish, wildlife and other natural resources, which depend on such waters; preserve natural amenities; and ensure the suitability of the location and nature of improvements. Depending on the type of work to be done a permit may be required and approval from other agencies may also be necessary. For works not requiring a permit, Best Management Practices are outlined as well as supporting documentation to aid in completing the project in an environmentally sound manner.

FISH AND WILDLIFE CONSERVATION ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_97f41_e.htm

The *Fish and Wildlife Conservation Act* allows for the sound management of Ontario's fish and wildlife species. The act serves to protect and manage a broad range of both game species and specially protected species. It covers aspects such as hunting, trapping, fishing and other related activities; life fish and wildlife (wildlife in captivity, release of wildlife, aquiculture, etc.); sale, purchase and transport of wildlife; licenses and other authority; and enforcement. The Act applies to all species named within the Act, and also provides for the protection of all life stages (eggs, fry etc), as well as hybrids, subspecies and animal parts. The new *Fish and Wildlife Conservation Act* replaced the *Game and Fish Act* on January 1, 1999.

PUBLIC LANDS ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90p43_e.htm

The *Public Lands Act* is a provincial legislative tool for controlling works done on public lands (crown lands) or shore lands, as well as to protect public lands from being adversely impacted by activities undertaken on adjacent, privately owned lands. The types of works permitted are controlled by the issuing of work permits which ensure that the activities are completed in an environmentally sound manner. The types of activities that require work permits on or near public lands include: construction of a building; construction of a trail, water crossing or road; dredging of shore lands; filling of shore lands; removal of aquatic vegetation on shore lands (located in the areas as set out in Schedule 1 of the Act); removal of more then 100 square meters of aquatic vegetation on shore lands (located in the areas as set out in Schedule 2 of the Act); or construction or placement of a structure or combination of structures that occupies more then 15 square meters of shore lands. Districts that have a Conservation Authority with a signed Level I, II, or III agreement with the Department of Fisheries and Oceans (DFO) review proposed work permits that may cause Harmful Alteration, Disruption or Destruction (HADD) of fish habitat. Once CA/DFO review the permit, advice or authorization is provided and the MNR will issue the permit with the appropriate conditions. In areas with no CA's or CA's without signed agreements, DFO will review the permits and authorize the work permits.

AGGREGATE RESOURCES ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90a08_e.htm

Aggregate resources include any combination of sand, gravel, or crushed stone in a natural or processed state. Aggregates are used in the construction of highways, dams and airports, as well as residential, industrial and institutional buildings. The term 'aggregate' is defined by the Act as: gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, and rock.

The purpose of this Act is,

(a) to provide for the management of the aggregate resources of Ontario;

(b) to control and regulate aggregate operations on Crown and private lands;
(c) to require the rehabilitation of land from which aggregate has been excavated; and
(d) to minimize adverse impact on the environment in respect of aggregate operations

ONTARIO PLANNING AND DEVELOPMENT ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_94o23_e.htm

The *Planning and Development Act* guides the building and development of private lands. It serves to promote the sustainable economic development in a healthy natural environment within a provincial policy framework. The Act takes into public interests such as the protection of the provinces natural resources, and the preparation of official plans to guide future developments. Potential risks to human life and property is also reduced by directing development away from areas that pose a risk and by mitigating any hazards to development. The public is notified of proposals and allowed to comment on the proposal and to appeal decisions made by the Ontario Municipal Board (OMB) if necessary.

OAK RIDGES MORAINE CONSERVATION ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_01o31_e.htm

The *Oak Ridges Moraine Conservation Act*, 2001, administered by the Ministry of Municipal Affairs and Housing, is intended to conserve the Oak Ridges Moraine by enabling the designation of the Oak Ridges Moraine Area and the establishment of the Oak Ridges Moraine Conservation Plan. The plan is designed to protect the ecological and hydrological integrity of the Oak Ridges Moraine while providing for land and resource uses and development that are compatible with maintaining the ecological well-being of the moraine. The *Act* states that decisions shall conform with the Oak Ridges Moraine Conservation Plan.

GREENBELT ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_05g01_e.htm

The *Greenbelt Act* enables the creation of a Greenbelt Plan to protect about 1.8 million acres of environmentally sensitive and agricultural land in the Golden Horseshoe from urban development and sprawl. It includes and builds on about 800,000 acres of land within the Niagara Escarpment Plan and the Oak Ridges Moraine Conservation Plan. The legislation authorizes the government to designate a Greenbelt Area and establish a Greenbelt Plan. It sets out the main elements and objectives for the Greenbelt, which are addressed in the Plan. It also requires planning decisions to conform to the Greenbelt Plan.

Pursuant to the Greenbelt Act, the Greenbelt Council was appointed by the minister in June 2005. The council will provide advice on the administration of the Greenbelt and will guide the government on such matters as the implementation of the Greenbelt Plan, performance measures and the 10-year review of the plan.

PLANNING ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90p13_e.htm

The *Planning Act* guides land use development through a provincial policy-led planning system to:

- promote sustainable economic development, in a healthy natural environment;
- provide for planning processes that are fair, open, accessible, timely and efficient;
- integrate matters of provincial interest in provincial and municipal planning decisions; and,
- encourage co-operation and co-ordination among various interests.

The Provincial Policy Statement is issued under the authority of Section 3 of the *Planning Act* and came into effect on March 1, 2005. It applies to all applications, matters or proceedings commenced on or after March 1, 2005. In respect of the exercise of any authority that affects a planning matter, Section 3 of the *Planning Act* requires that decisions affecting planning matters "shall be consistent with" policy statements issued under the Act. The Provincial Policy Statement provides for appropriate development while protecting resources of provincial interest, public health and safety, and the quality of the natural environment. The Provincial Policy Statement supports improved land use planning and management, which contributes to a more effective and efficient land use planning system.

DRAINAGE ACT
http://www.canlii.org/on/laws/sta/d-17/20060614/whole.html

Drainage legislation has been in effect in Ontario for over 150 years. The *Drainage Act* is the current statute that allows landowners to resolve drainage issues and balances the rights of landowners who live along watercourses and those that do not. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) administer the Act, however the local municipalities are responsible and liable for the maintenance of the drains once they are created. The costs associated with the maintenance of the drains are shared amongst the landowners within the watershed. Any work on drains that are not classified as municipal drains must first be approved by the local Conservation Authority who will determine the necessary steps to take before any work is begun.

NUTRIENT MANAGEMENT ACT
http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030267_e.htm

The *Nutrient Management Act* passed on June 27, 2002. It addresses land-applied materials containing nutrients. This includes provisions for the development of strong new standards for all land-applied materials containing nutrients, a proposal to ban the land application of untreated septage over a five-year period, and proposed strong new requirements such as: the review and approval of nutrient management plans, certification of land applicators and a new registry system for all land applications.

The Act provides a comprehensive nutrient management framework for Ontario's agricultural industry, municipalities and other generators of materials containing nutrients, including clear environmental protection guidelines. It builds on the existing system by giving current best management practices the force of law, and creating comprehensive, enforceable, province-wide standards to regulate the management of all land- applied materials containing nutrients

CLEAN WATER ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_06c22_e.htm

The *Clean Water Act* received Royal Assent on October 19, 2006. The purpose of this Act is to protect existing and future sources of drinking water. The intent of the legislation is to ensure communities are able to protect their municipal drinking water supplies through developing collaborative, locally driven, science-based protection plans. Communities will identify potential risks to local water sources and take action to reduce or eliminate these risks. Municipalities, conservation authorities, property owners, farmers, industry, community groups and the public will all work together to meet common goals.

PESTICIDES ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90p11_e.htm

The *Pesticides Act* was created to provide environmental protection from harmful pesticide applications. Under the Act, no person, whether acting or not acting under the authority of a licence or permit under this Act or an exemption under the regulations, shall discharge or cause or permit the discharge of a pesticide or of any substance or thing containing a pesticide into the environment that,

(a) causes or is likely to cause impairment of the quality of the environment for any use that can be made of it greater than the impairment, if any, for such use that would necessarily result from the proper use of the pesticide;

(b) causes or is likely to cause injury or damage to property or to plant or animal life greater than the injury or damage, if any, that would necessarily result from the proper use of the pesticide;

(c) causes or is likely to cause harm or material discomfort to any person greater than the harm or material discomfort, if any, that would necessarily result from the proper use of the pesticide;

(d) adversely affects or is likely to affect adversely the health of any person to a greater degree than the adverse effect, if any, that would necessarily result from the proper use of the pesticide;

(e) impairs or is likely to impair the safety of any person to a greater degree than the impairment, if any, of the safety of any person that would necessarily result from the proper use of the pesticide; or

(f) renders or is likely to render directly or indirectly any property or plant or animal life unfit for use by humans to a degree greater than the unfitness, if any, that would necessarily result from the proper use of the pesticide.

ENVIRONMENTAL PROTECTION ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e19_e.htm

The purpose of this Act is to provide for the protection and conservation of the natural environment. The *Canadian Environmental Protection Act* (CEPA), 1999, gives Environment Canada the power to regulate substances that have been declared toxic as defined in the Act. To be determined toxic under CEPA 1999, substances must enter the environment in amounts that have or may have an immediate or long-term harmful effect on the environment or human health. The Act takes a risk-based approach to decision-making that considers the entry of substances into the environment, exposure conditions and inherent toxicity. This is accomplished by recognizing the need to virtually eliminate the most persistent and bioaccumulative toxic substances and the need to control and manage pollutants and wastes, if their release into the environment cannot be prevented.

ONTARIO WATER RESOURCES ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90o40_e.htm

The purpose of this Act is to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, in order to promote Ontario's long-term environmental, social and economic well-being. The *Ontario Water Resources Act* provides for the protection of surface and ground water related to adverse discharges. The Act regulates the taking of water from wells or surface water sources and the treatment and disposal of sewage.

ENVIRONMENTAL ASSESSMENT ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e18_e.htm

The *Environmental Assessment Act* protects the environment by assessing the potential effects of development on the surrounding land before any of the construction work begins. This act applies to most public and some private lands. This process allows input from federal, provincial and municipal government, as well as stakeholders and the public. The three major process are: individual environmental assessments (EAs), class EAs, and electricity generation and transmission. The individual environmental assessments typically include large and complex projects, such as landfills. The proponent must create a Terms of Reference which helps to guide the EA. Individual EAs typically cause the majority of delays in approving waste facilities and transportation projects, however they account for less than five percent of all EAs. Class EAs are based on which type or class of environmental disturbance the project falls into. For example, municipal roads, water and sewer, forest management, highways and GO Transit each have their own EA process.

PLACES TO GROW ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_05p13_e.htm

Places to Grow is the Ontario government's program to manage growth and development in Ontario in a way that supports economic prosperity, protects the environment and helps communities achieve a high quality of life.

The purposes of the Act are,

(a) to enable decisions about growth to be made in ways that sustain a robust economy, build strong communities and promote a healthy environment and a culture of conservation;

(b) to promote a rational and balanced approach to decisions about growth that builds on community priorities, strengths and opportunities and makes efficient use of infrastructure;

(c) to enable planning for growth in a manner that reflects a broad geographical perspective and is integrated across natural and municipal boundaries;

(d) to ensure that a long-term vision and long-term goals guide decision-making about growth and provide for the co-ordination of growth policies among all levels of government.

CONSERVATION AUTHORITIES ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90c27_e.htm

The *Conservation Authorities Act* is the legislative tool guiding the creation, operations, and mandate of Conservation Authorities in Ontario. Conservation Authorities are mandated to ensure the conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs. This is achieved on a watershed basis by protecting and restoring rivers, lakes, wetlands, woodlands and natural habitats. CAs also work closely with municipalities to ensure that development takes place in a manner that ensures the protection and safety of human life and property from natural hazards such as flooding and erosion.

MUNICIPAL ACT
http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_01m25_e.htm

The *Municipal Act* allows municipalities to deal with local issues and to act on changes to local economic, environmental or social aspects as they arise without going through lengthy legislative changes. The Act uses three new concepts: Natural person powers, spheres of jurisdiction, and governmental powers. Natural person-powers gives the municipality powers over normal corporate administrative operations such as the hiring of staff and the acquiring of lands and equipment as necessary. Spheres of jurisdiction grants authority to 10 service delivery areas. This allows new activities to take place, again without the need for legislative change. The government powers consolidates many of the governmental powers that were scattered throughout the previous statute. With the increased flexibility of the Act, explicit

limitations also needed to be laid out. The Act also requires the municipality to be more accountable, and also to provide a review every five years, with the first review due in 2007.

APPENDIX B: GUIDING DOCUMENTS

POLICY FOR THE MANAGEMENT OF FISH HABITAT (DFO 1986)

The purpose of this document is to provide Canadians with Fisheries and Oceans Canada's policy objectives, goals and strategies for the management of fish habitats supporting Canada's freshwater and marine fisheries. In particular, the policy focuses on a guiding principle of "no net loss" of the productive capacity of fish habitat through the conservation, restoration and enhancement of fish habitat. In Ontario, Fisheries and Oceans Canada (DFO) works both independently and in parternship with other agencies (conservation authorities, Parks Canada, Ontario Ministry of Natural Resources, Ministry of Transportation of Ontario) to review works in and around water. Where fisheries objectives have been identified through fishery management plans, DFO strives to support locally identified fishery management objectives within the larger framework of integrated multi-faceted aquatic resource management.

LINDSAY DISTRICT FISHERIES MANAGEMENT PLAN 1989-2000 (OMNR 1989)

Now expired, the purpose of the fisheries management plan was to identify how the fisheries resources will be managed to the year 2000 and to identify specific short-term (5-year) management actions, which are required to meet specific fisheries objectives in the Lindsay District. Fish habitat protection and restoration were identified as being an important component of the management program, as development pressures are expected to increase.

This report provided information on the fisheries resource, current use and projected use, present management practices, issues and problems, general fisheries management objectives, strategies and tactics to manage noted issues and problems within the Lindsay District, as well as an implementation schedule. This document was produced with public consultation and input, and can be used by fisheries managers and the public. It is a useful document to generate background information for the creation of fisheries management plans for this watershed.

STRATEGIC PLAN FOR ONTARIO FISHERIES II: AN AQUATIC ECOSYSTEM APPROACH TO MANAGING FISHERIES (OMNR 1992)

Developed in 1976, the original Strategic Plan for Ontario Fisheries (SPOF I) provided a long-term plan for managing Ontario's fisheries resources. SPOF I was a beginning, and led to substantial gains. In 1989, the Ministry of Natural Resources, in consultation with the public, designed a new Strategic Plan for Ontario Fisheries (SPOF II) for the 1990s and beyond. This consultative approach to the development of SPOF II allowed for the contribution of many diverse groups. SPOF II identified the ecological, economic, and social values we place on our fisheries, and mapped out a course of action to sustain aquatic ecosystems for the future.

SPOF II identified the following strategic management actions to address the issues that currently face fisheries managers:

- Ensure benefits are sustained by protecting and rehabilitating aquatic ecosystems
- Inform and involve the public in decision making and program delivery to foster stewardship
- Ensure resources are appropriately valued.
- Ensure effective program management and coordination among agencies.
- Acquire and communicate essential knowledge for timely and effective resource management decision-making.
- Enforce firmly and effectively.

A NEW ECOLOGICAL FRAMEWORK FOR RECREATIONAL FISHERIES MANAGEMENT IN ONTARIO (OMNR 2005a)

For recreational fishing purposes, Ontario has been divided into 20 Fisheries Management Zones. These zones are based on ecological and social factors such as climate zones, watersheds, fishing pressure and road networks. Recreational fisheries management has traditionally been based on individual lakes; however the new management framework manages the fisheries based at a broader landscape level.
The Nonquon River watershed, which was previously in Division 6, is now part of Fisheries Management Zone 17.

The objectives for this initiative:

- Fishing regulations that are more userfriendly
- A management approach that focuses on the state of the resource in ecological zones, not just individual lakes
- More public involvement through an enhanced stewardship approach

WATERSHED-BASED FISHERIES MANAGEMENT PLAN GUIDELINES (Koenig 2005)

The Watershed-based Fisheries Management Plan Guidelines (WBFiMP) document serves as a guideline for fisheries management plans. It gives further detail on the steps necessary to prepare a WBFiMP which are: establish the need for a WBFiMP; developing a management team; establish principles of operation; establish scientific, management & regulatory principles; define key elements of the plan; public process, baseline information, resolve issues, set direction, prepare draft plan; review drafts and attain endorsement; implement and monitor. It also includes a number of examples that could be, or have been used in fisheries management plans as well as a large list of references to aid in researching everything from Aboriginal Issues to Wetlands. It also contains copies of timelines, presentations, and questionnaires that can be used as examples when creating these documents.

PROTECTING WHAT SUSTAINS US: ONTARIO'S BIODIVERSITY STRATEGY (OMNR 2005b)

This document provides information why Ontario's Biodiversity needs to be protected, and the important economic, cultural and social benefits it provides us. Species diversity has continued to decline, with many new species becoming endangered, extirpated or extinct. The reasons many species are in decline are due to the impact of human activities. This document outlines a plan that all Ontarians can, and should, follow in order to help protect our biodiversity. This includes a vision for our future, goals, and biodiversity principles. It also outlines the threats to biodiversity, opportunities (for increased public awareness and participation). In order to protect our biodiversity, the strategy includes the following directions: engage Ontarians, promote stewardship, work together, integrate biodiversity conservation into land use planning, prevention, and improve understanding. A report on the "State of Ontario's Biodiversity" is to be completed by 2010, and every five years there after.

OAK RIDGES MORAINE CONSERVATION PLAN (OMMAH 2002)

The Oak Ridges Moraine Conservation Plan derives its authority from the Oak Ridges Moraine Conservation Act (2001), which authorizes the Lieutenant Governor in Council to designate an area of land as the Oak Ridges Moraine Area.

The objectives of the Oak Ridges Moraine Conservation Plan are,

- protecting the ecological and hydrological integrity of the Oak Ridges Moraine Area;
- ensuring that only land and resource uses that maintain, improve or restore the ecological and hydrological functions of the Oak Ridges Moraine Area are permitted;
- maintaining, improving or restoring all the elements that contribute to the ecological and hydrological functions of the Oak Ridges Moraine Area, including the quality and quantity of its water and its other resources;
- ensuring that the Oak Ridges Moraine Area is maintained as a continuous natural landform and environment for the benefit of present and future generations;
- providing for land and resource uses and development that are compatible with the other objectives of the Plan;
- providing for continued development within existing urban settlement areas and recognizing existing rural settlements;
- providing for a continuous recreational trail through the Oak Ridges Moraine Area that is accessible to all including persons with disabilities;
- providing for other public recreational access to the Oak Ridges Moraine Area;

GREENBELT PLAN (OMMAH 2005a)

The Greenbelt Plan derives its authority from the Greenbelt Act (2005), which authorizes the Lieutenant Governor in Council to designate an area of land as the Greenbelt Area.

The objectives of the Greenbelt Plan are,

- to establish a network of countryside and open space areas which supports the Oak Ridges Moraine and the Niagara Escarpment;
- to sustain the countryside, rural and small towns and contribute to the economic viability of farming communities;
- to preserve agricultural land as a continuing commercial source of food and employment;
- to recognize the critical importance of the agriculture sector to the regional economy;
- to provide protection to the land base needed to maintain, restore and improve the ecological and hydrological functions of the Greenbelt Area;
- to promote connections between lakes and the Oak Ridges Moraine and Niagara Escarpment;
- to provide open space and recreational, tourism and cultural heritage opportunities to support the social needs of a rapidly expanding and increasingly urbanized population;
- to promote linkages between ecosystems and provincial parks or public lands;
- to control urbanization of the lands to which the Greenbelt Plan applies;
- to ensure that the development of transportation and infrastructure proceeds in an environmentally sensitive manner;
- to promote sustainable resource use.

PROVINCIAL POLICY STATEMENT (OMMAH 2005b)

The Provincial Policy Statement provides direction in matters regarding land use planning and development. It is issued under Section 3 of the Planning Act and came into effect on March 1, 2005. The Provincial Policy Statement is the foundation for land use planning which regulates the use and development of land in Ontario while striving to improve the quality of life for the people of Ontario. The Policy works to divert growth and expansion away from significant or sensitive areas, as well as areas which may pose a risk to human health, yet still promotes and sustains growth and ensures development meets both current and future needs. Healthy communities are promoted by ensuring that development limits the impacts on the air, water and other surrounding resources.

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE (OMPIR 2006)

The Growth Plan for the Great Golden Horseshoe derives its authority from the Places to Grow Act (2005) which authorizes the Lieutenant Governor in Council to designate any area of land within Ontario as a growth plan area.

The guiding principles of the Growth Plan are to:

- build compact, vibrant and complete communities;
- plan and manage growth to support a strong and competitive economy;
- protect, conserve, enhance and wisely use the valuable natural resources of land, air and water for current and future generations;

- optimize the use of existing and new infrastructure to support growth in a compact, efficient form;
- provide for different approaches to managing growth that recognize the diversity of communities in the Greater Golden Horseshoe;
- promote collaboration among all sectors – government, private and non-profit – and residents to achieve the vision.

MUNICIPAL OFFICIAL PLANS

The Regional Municipality of Durham Official Plan (2006) and the City of Kawartha Lakes Official Plan (2006 DRAFT) regulate land use in the Nonquon River watershed under the authority of the Planning Act. An Official Plan describes the local or county or regional council's policies on how land in the community should be used and helps ensure that future planning and development will meet the specific needs of the community.

BEST MANAGEMENT PRACTICES (OMAFRA)

Best Management Practices (BMPs) are a suite of agricultural management strategies that can provide a practical, affordable approach to conserving a farm's soil and water resources without sacrificing productivity. Many cost-sharing opportunities exist for agricultural producers through the development of an Environmental Farm Plan (EFP). The EFP is a voluntary program that aids farmers in assessing a variety of environmental concerns in up to 23 areas on their farm. The EFP process supports individual farm planning and decision-making in the short and long term, and harmonizes productivity, business objectives and the environment. OMAFRA has published a series of BMPs to present a range of circumstances and options to address a particular environmental concern. The BMPs that are currently available include:

- Farm Forestry and Habitat Management
- Field Crop Production
- Soil Management
- Water Management
- Irrigation Management
- Integrated Pest Management
- Fish and Wildlife Habitat Management
- No-Till: Making It Work
- Water Wells
- Keeping Your Well Water Safe to Drink
- Pesticide Storage, Handling and Application
- Nutrient Management Planning (revised edition 2006)
- Buffer Strips
- Manure Management
- Greenhouse Gas Reduction in Livestock Production Systems
- Agroforestry Series Volume 1 - Woodlot Management
- Streamside Grazing

APPENDIX C: QUESTIONNAIRES

Table A1: Summary public tally sheet from questionnaires.

Interest in the Nonquon River comes from the following perspective(s)	
Angler	27.2%
Naturalist	18.5%
Pleasure boat	18.5%
Canoe / kayak	14.8%
Residential Landowner	12.3%
Other	4.9%
Hunter	1.2%
Business Owner	1.2%
Agricultural Landowner	1.2%
Industrial Landowner	0.0%

Reason for interest in NRFMP	
Water Quality	29.0%
Loss of Aquatic Habitat	15.9%
For Good Fishing	15.0%
Notice Fish Declines (walleye 9, bullhead 1, LM bass 1)	12.1%
Influence of NRFMP to Current Use	12.1%
Respect for Multiple Uses	7.5%
Notice Fish Increases (crappie 2, carp 2, panfish 1)	5.6%
Other	2.8%

Importance of Potential Actions (total score)	
Restore/ protect Native Fish	46
Increase public awareness	38
Increase sport fish opportunities	29
Dam removal	17
Increase public access	3

How frequently anglers fish the Nonquon River	
Occasionaly	52%
Once a week	35%
Once a month	13%
Once a day	0%

The importance of fish in the Nonquon River (total score)	
Indicator of Water Health	58
Provide Educational Opportunities	46
Natural Heritage Aspect	45
One of Many Important Resources	36
Important Only for Angling	29

Importance of impacts on fish communities in watershed (total score)	
Water quality	58
Contaminants	58
Land use impacts	54
Over harvest	50
Nutrient loading	49
Habitat Altered	45
Loss of wetlands	45
Invasive Species	45
Lack of Enforcement	43
Species at risk	39
Loss of native species	36
Water level fluctuations	35
Loss of forest	31
Water taking	27
Comments	0

Species in most need of management	
Walleye	48.3%
Bass	24.1%
Muskie	10.3%
All species	6.9%
Carp (reduce)	3%
Panfish	3%
Baitfish	3%

APPENDIX D: MANAGEMENT ZONE CHARACTERISTICS

Table A2: Geology, physiography, Ecological Land Classification and fishes present for each management zone in the Nonquon River watershed. Area values are in km^2.

	MANAGEMENT ZONE #1: Nonquon River Headwaters (44.75km²)		MANAGEMENT ZONE #2: Greenbank (42.52km²)		MANAGEMENT ZONE #3: Port Perry (10.63km²)		MANAGEMENT ZONE #4: Nonquon River Main Channel (30.57km²)		MANAGEMENT ZONE #5: Layton River Subwatershed (59.34km²)	
GEOLOGY										
Type	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**
Glaciolacustrine Deposit	13.45	30.06	20.36	47.88	7.31	68.77	14.25	46.61	2.43	4.10
Glaciofluvial Ice - Contact Deposits	28.57	63.84	2.12	5.00	0.00	0.00	0	0.00	0.15	0.25
Organic Deposits	0.00	0.00	0.58	1.40	3.31	31.14	2.81	9.19	0.06	0.10
Till	2.73	6.10	19.44	45.72	0.00	0.00	13.39	43.80	56.7	95.55
PHYSIOGRAPHY										
Type	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**
Peat and Muck	0.00	0.00	1.19	2.80	3.8	35.75	5.37	17.57	10.64	17.93
Till Plain (Drumlinized)	6.60	14.75	33.15	77.96	0.00	0.00	20.76	67.91	45.29	76.32
Sand Plain	14.01	31.31	1.44	3.39	6.04	56.82	2.91	9.52	0.00	0.00
Clay Plain	5.42	12.11	0.00	0.00	0.23	2.16	0.00	0.00	0.00	0.00
Kame Moraine	18.43	41.18	0.19	0.45	0.00	0.00	0.00	0.00	0.00	0.00
Drumlin	0.19	0.42	6.54	15.38	0.56	5.27	0.99	3.24	1.06	1.79
Esker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.16	3.64
Water	0.09	0.20	0.00	0.00	0.00	0.00	0.48	1.57	0.17	0.29
ECOLOGICAL LAND CLASSIFICATION										
Type	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**	**Area**	**Percentage**
Aggregate	0.36	0.80	0.12	0.28	0	0.00	0.00	0.01	0.01	0.02
Agriculture	25.87	57.81	32.42	76.25	3.37	31.70	14.66	47.96	35.87	60.45
Forest	8.92	19.93	5.08	11.95	0.61	5.74	2.84	9.29	10.97	18.49
Manicured Open Space	0.33	0.74	0.14	0.33	0.02	0.19	0.26	0.85	0.21	0.35
Meadow	5.09	11.37	4.01	9.43	0.6	5.64	1.78	5.82	2.89	4.87
Rural Development	2.60	5.81	2.22	5.22	1.22	11.48	2.66	8.70	2.64	4.45
Wetland	1.95	4.36	7.73	18.18	4.92	46.28	7.91	25.88	7.23	12.18
Water	0.25	0.56	0.14	0.33	0.56	5.27	0.85	2.78	0.29	0.49
Other	0.00	0.00	0.00	0.00	0.01	0.09	0.03	0.10	0.00	0.00
FISHES										
	Common Name	**Thermal Class**	**Common Name**	**Thermal Class**	**Common Name**	**Thermal Class**	**Common Name**	**Thermal Class**	**Common Name**	**Thermal Class**
	brook trout	cold	central mudminnow	cool/warm	central mudminnow	cool/warm	central mudminnow	cool/warm	central mudminnow	cool/warm
	central mudminnow	cool/warm	Northern redbelly dace	cool/warm	white sucker	cool	white sucker	cool	white sucker	cool
	white sucker	cool	common shiner	cool	Northern redbelly dace	cool/warm	brassy minnow	cool	Northern redbelly dace	cool/warm
	Northern redbelly dace	cool/warm	brassy minnow	cool	finescale dace	cool	golden shiner	cool	finescale dace	cool
	finescale dace	cool	fathead minnow	warm	brassy minnow	cool	common shiner	cool	brassy minnow	cool
	common shiner	cool	blacknose dace	cool	golden shiner	cool	blackchin shiner	cool/warm	horneyhead chub	cool
	bluntnose minnow	warm	creek chub	cool	common shiner	cool	bluntnose minnow	warm	common shiner	cool
	blacknose dace	cool	brook stickleback	cool	bluntnose minnow	warm	blacknose dace	cool	bluntnose minnow	warm
	creek chub	cool	pumpkinseed	warm	fathead minnow	warm	creek chub	cool	fathead minnow	warm
	pearl dace	cold/cool	yellow perch	cool	creek chub	cool	pearl dace	cold/cool	blacknose dace	cool
	brook stickleback	cool	lowa darter	cool	pearl dace	cold/cool	brown bullhead	warm	longnose dace	cool
	pumpkinseed	warm			brown bullhead	warm	banded killifish	cool	creek chub	cool
	yellow perch	cool			banded killifish	cool	brook stickleback	cool	pearl dace	cold/cool
	Johnny darter	cool			brook stickleback	cool	trout perch	cold	central stoneroller	cool/warm
					rockbass	cool	rockbass	cool	brown bullhead	warm
					pumpkinseed	warm	pumpkinseed	warm	brook stickleback	cool
					bluegill	warm	bluegill	warm	rockbass	cool
					largemouth bass	warm	smallmouth bass	warm	pumpkinseed	warm
					yellow perch	cool	largemouth bass	warm	largemouth bass	warm
							black crappie	cool	yellow perch	cool
							yellow perch	cool	lowa darter	cool
							walleye	cool	logperch	cool/warm
							lowa darter	cool		
							Johnny darter	cool		
							brook silverside	cool/warm		

NOTE: Highlighted fishes are unique to the zone

APPENDIX E: BENTHIC MACROINVERTEBRATE INDEX VALUES

Table A3: Hilsenhoff Biotic Index (Hilsenhoff 1988) and Pollution Tolerance Index Rating Values (KRCA 1999).

INVERTEBRATE TAXON	COMMON NAME	HILSENHOFF INDEX VALUE	POLUTION TOLERANCE INDEX
Acarina	Water Mites	6	Tolerant
Oligochaeta	Segmented Worms	8	Tolerant
Hirudinea	Leeches	8	Tolerant
Amphipoda	Scuds	6	Moderate
Isopoda	Aquatic Sowbugs	8	Moderate
Chironomidae	Blood Worms	7	Tolerant
Simuliidae	Black Flies	6	Tolerant
Tipulidae	Craneflies	3	Moderate
Other Diptera	Other Flies	5	Other
Ephemeroptera	Mayflies	5	Sensitive
Plecoptera	Stoneflies	1	Sensitive
Hemiptera	True Bugs	5	Other
Coleoptera	Beetles	4	Moderate
Megaloptera	Helgrammites	4	Sensitive
Anisoptera	Dragonflies	5	Moderate
Zygoptera	Damselflies	7	Moderate
Trichoptera	Caddisflies	4	Sensitive
Gastropoda	Snails	8	Moderate
Pelecypoda	Clams	6	Moderate
Ostracoda	Seed Shrimp	7	Other
Decapoda	Crayfish	6	Moderate
Coelenterata	Hydras	5	Other
Platyhelminthes	Flatworms	6	Sensitive
Nematodes	Roundworms	9	Other
Cladocera	Water Fleas	8	Other
Lepidoptera	Aquatic Moths	5	Other
Ceratopogonidae	No-see-ums	6	Other
Culicidae	Mosquitos	8	Other
Tabanidae	Horse and Deer Flies	5	Other

Table A4: Summary of benthic macroinvertebrate analyses based on data collected from each OSAP site sampled. Percent of combined Ephemeroptera, Plecoptera and Trichoptera taxa, and individual percents for Chironomidae, Oligochaeta, Amphipoda and other taxon are shown. The calculated values of the ratio of EPT to Chironomids, Hilsenhoff Biotic Index, and Pollution Tolerance Index presented as percent tolerant, moderate and sensitive taxa.

Site Code	% EPT	% Chironomidae	% Oligochaeta	% Amphipoda	% Others	EPT: Chrironomid	Hilsenhoff Biotic Index	% Tolerant	% Moderate	% Sensitive	Simpsons Diversity Index
NQN0203	30.84	26.87	0.44	0.00	41.85	1.15	5.13	54.19	11.89	30.84	0.83
NQN0403	7.20	29.60	2.40	29.60	31.20	0.24	5.05	48.00	43.20	8.80	0.79
NQN0503	33.00	0.50	17.00	1.50	48.00	66.00	4.89	31.50	28.50	39.50	0.88
NQN0603	4.39	85.96	4.82	0.44	4.39	0.05	6.84	92.54	3.07	4.39	0.26
NQN0703	2.49	14.43	74.63	0.00	8.46	0.17	7.59	91.54	5.97	2.49	0.42
NQN0803	14.36	29.70	32.67	0.00	23.27	0.48	6.50	64.85	20.79	14.36	0.77
NQN0903	17.09	26.58	2.53	0.00	53.80	0.64	5.25	36.71	44.94	17.09	0.85
NQN1003	19.71	22.60	0.96	0.00	56.73	0.87	5.47	62.98	15.38	19.71	0.83
NQN1103	41.98	23.58	0.47	2.83	31.13	1.78	5.09	33.02	24.53	42.45	0.81
NQN1203	5.08	18.64	50.85	2.82	22.60	0.27	6.89	78.53	15.82	5.65	0.69
NQN1303	19.25	27.20	0.00	0.00	53.56	0.71	5.71	77.82	0.00	19.25	0.69
NQN1503	43.26	24.72	1.69	0.56	29.78	1.75	4.84	34.83	21.91	43.26	0.73
NQN1803	36.67	36.19	0.48	2.38	24.29	1.01	5.34	43.81	19.52	36.67	0.75
NQN2003	37.44	39.73	1.83	0.91	20.09	0.94	5.01	45.66	16.44	37.44	0.77
NQN2103	30.87	58.70	0.43	0.87	9.13	0.53	5.82	62.17	6.09	30.87	0.56
NQN2403	24.32	50.97	0.77	0.77	23.17	0.48	6.34	52.90	22.39	24.71	0.69
NQN2503	0.00	17.65	81.86	0.00	0.49	0.00	7.82	99.51	0.49	0.00	0.30
NQN2603	37.44	27.59	0.00	19.21	15.76	1.36	4.41	33.50	28.08	37.44	0.81
NQN2703	28.44	23.85	6.42	5.50	35.78	1.19	5.25	36.24	34.86	28.90	0.80
NQN2803	36.36	14.09	17.27	1.36	30.91	2.58	6.20	32.73	30.91	36.36	0.83
NQN2903	2.97	10.40	2.48	53.47	30.69	0.29	5.72	22.28	74.75	2.97	0.67
NQN3003	0.00	14.71	7.84	11.76	65.69	0.00	5.90	35.29	63.73	0.00	0.85
NQN3103	1.37	26.48	20.09	5.48	46.58	0.05	7.18	48.86	49.77	1.37	0.81
NQN3203	35.32	4.09	2.23	5.58	52.79	8.64	4.93	11.90	48.70	35.32	0.78