Natural Environment Update for Huron County - Technical Document

Background Research for Natural Environment Planning

September 2019

This report was prepared by the Technical Team for the Natural Environment Update for Huron County Advisory Committee.

Executive Summary

The countryside of Huron County supports different land use activities with agriculture being prominent. At the property scale, many people find that natural areas such as woodlots, rivers, ponds, and meadows are the most attractive features of their property. In this working landscape, these features are also collectively valued by the community and broader society. It is important to have a coordinated approach for protecting and enhancing natural heritage features that is supported by agencies, stakeholders and landowners across the County.

Natural systems planning identifies spatially and functionally interconnected systems of natural features and landforms. It is an effective way to preserve biodiversity, which is an essential component of ecosystem health. The natural heritage system in Huron County is comprised of coastal and hinterland landforms, natural heritage features, and watercourses. The Natural Heritage Systems Study section describes the methodology used to identify natural heritage features in Huron County and evaluate the features based on their individual significance and within the context of the natural heritage system. According to 2006 aerial imagery, there is 20% natural cover in the County. Woodlands cover 16.6% of Huron County, wetlands 6.5%, meadows 1.8%, and thickets (areas with shrubs and small trees) 0.49%. The landscape model used to apply significance criteria to natural heritage patches in Huron County identified 98% of the natural cover as being significant. The remaining 2%, which includes many small patches that cover 0.4% of the County's land base, are also important components of the natural heritage system. The cover is not equally distributed throughout the County, and is highly fragmented. Connections between natural features should be enhanced where possible.

Aquatic resource information for watercourses in Huron County such as water quantity and quality, fish, and aquatic habitat were summarized from existing reports. Water chemistry parameters were used to summarize information about water quality, while other parameters (mainly flow, water temperature and clarity) were used to describe the aquatic habitat and to classify watercourses.

To describe the aquatic habitat in Huron County, the mapped watercourses were grouped into five systems. Most of the watercourses (44.3%) have permanent flow, warm or cool/cold water and have sensitive or significant species (classified as System 1). Sixteen percent of watercourses have permanent flow, warm water and support baitfish (System 2). Eleven percent of watercourses have intermittent flow, warm water, and are seasonally accessed by baitfish and other larger fish (System 3). Approximately 21.4% of watercourses within Huron County are closed (watercourses that have been tiled underground). Lastly, approximately 7% of watercourses have not been classified, in part due to access and to the ephemeral nature of these channels ('Unclassified' grouping).

Concentrations of nitrate, phosphorus and bacteria appear to be impairing some of the recreational uses of water in Huron County. There are differences in water chemistry and aquatic habitat amongst the rivers in Huron County. Further examination of the sources and conveyance of nutrients and bacteria in watercourses with different physical features and land use will inform stewardship efforts to improve the water for all users.

Species at Risk contribute to the overall biodiversity of the landscape and are important indicators of environmental health. Huron County is home to a number of rare species.

Acknowledgements

The Technical Team gratefully acknowledges the dedication, support and guidance of the Advisory Committee to complete the Technical Document. The representation of organizations on the Advisory Committee and the Technical Team are below.

Advisory Committee	Technical Team
• County of Huron • Huron County Planning Department • Representatives from the ABCA, MVCA, SVCA, UTRCA* • Christian Farmers of Ontario • Huron Federation of Agriculture • National Farmers Union • Ontario Ministry of Natural Resources and Forestry • Huron Stewardship Council • Huron-Perth Ontario Woodlot Association • Lower Maitland Stewardship Group • Nature Conservancy of Canada	• Huron County Planning Department • Representatives from the ABCA, MVCA, SVCA, UTRCA* • Ontario Ministry of Natural Resources and Forestry • Lake Huron Centre for Coastal Conservation • Huron Stewardship Council • Nature Conservancy of Canada

*Ausable Bayfield Conservation Authority = ABCA; Maitland Valley Conservation Authority = MVCA; Saugeen Valley Conservation Authority = SVCA; Upper Thames River Conservation Authority = UTRCA.

Several pre-project meetings were held between September 2010 and April 2011 with staff from the Conservation Authorities and County of Huron to discuss the Natural Environment Update for Huron County. Huron County Council approved the Terms of Reference developed by the Conservation Authorities at the November 2010 meeting of County Council. County funds were allocated to the project in the 2011 and 2012 budgets.

The Huron County Planning Department managed the overall project**.** The Upper Thames River Conservation Authority (UTRCA) managed the development of the Technical Document from January 2011 to October 2011. From November 2011 to December 2013, Maitland Valley Conservation Authority (MVCA) chaired the Technical Team with the support of Ausable Bayfield Conservation Authority (ABCA) and UTRCA.

The Technical Team would like to thank the peer reviewers, Katharina Walton and David Stephenson of Natural Resources Solutions Inc. (NRSI), for their very thoughtful and helpful review of this document.

This document has also been peer reviewed by the late Dr. Jane Bowles (University of Western Ontario) in spring of 2011. Sadly, Jane passed away in the summer of 2013. Jane's career-long contribution to conserving natural heritage in Huron County was immense, and we are grateful for her involvement in this project.

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1 Background

1.1 Introduction

The countryside of Huron County supports many land use activities, with agriculture and natural heritage features being prominent. In this working landscape, natural features are collectively valued by the community and by broader society. It is important for municipal land use planning to present an approach that is reflective of these broader community interests.

The County of Huron has a long history of protecting and enhancing its natural heritage features with incentive programs and land use planning tools. The Natural Environment section of the County of Huron Official Plan (2013) includes Community Policies and Actions to develop a comprehensive Natural Heritage Plan (section 6.3.2). The County's *Take Action for Sustainable Huron* report (Huron County 2011) promotes the protection of the County's natural heritage and connectivity. The Natural Environment Update for Huron County will be used to guide municipal land use planning, inform stewardship efforts, and support the Forest Conservation By-law. The Technical Document provides the scientific basis for the Natural Environment Update.

The Province of Ontario indicates that municipalities are required to develop and implement policies which are consistent with the Provincial Policy Statement (PPS; OMMAH 2014). Specifically, the PPS states:

> *"The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and groundwater features."*

The PPS also provides policies for the protection of natural heritage systems including natural features such as significant woodlands, wildlife habitat, wetlands, valleylands, fish habitat, and the habitat of endangered and threatened species (OMMAH 2014).

1.2 Study Area – Huron County

The County of Huron is located on the southeast shore of Lake Huron in Southern Ontario (Figure 1.1). The County of Huron includes nine lower-tier municipalities: Township of Ashfield-Colborne-Wawanosh, Township of North Huron, Municipality of Morris-Turnberry, Municipality of Huron East, Municipality of Central Huron, Municipality of Bluewater, Municipality of South Huron, the Town of Goderich, and Township of Howick. The nine municipalities together span an area approximately 3,400 km^2 (Figure 1.2).

Approximately 60,000 people live in Huron County. Huron is one of the most "rural" areas of the province, with no urban centres over 8,000 in population, and roughly 60% of the population being rural farm and non-farm (HBDC 2010). In 2006 agriculture employed 17% of the workforce; the highest of any sector of employment for Huron County (HBDC 2010).

Huron County is within the watersheds of four Conservation Authorities. Saugeen Valley Conservation Authority (SVCA), Maitland Valley Conservation Authority (MVCA), and Ausable Bayfield Conservation Authority (ABCA) all contain watersheds that drain to Lake Huron. The Upper Thames River Conservation Authority's (UTRCA) watershed drains to Lake St. Clair. Most of the County is contained within the boundaries of the ABCA and MVCA (Figure 1.2).

The northern part of Huron County lies within the Great Lakes-St. Lawrence Forest Region while the southern portion is in the Deciduous Forest Region (Rowe 1972). These regions characterize similar forest types that occur over broad geographic locations as a result of climate and physiography (Cadman *et al*. 2007).

About a third of Huron County contains the Stratford Till Plain, where soils have good natural fertility and are ideal for agriculture (Chapman and Putman 1984). The Horseshoe Moraines cut through the County in a north-south direction and have a more rugged topography that result in a higher area of natural cover. The Huron Slope landform lying west of the Horseshoe Moraines, although with less severe topography than the moraines, also has a higher percentage of natural cover than the Till Plain (Bowles *et al*. 2001). The physiography, surficial geology and economics are important influences that helped to shape the present land use pattern of the area.

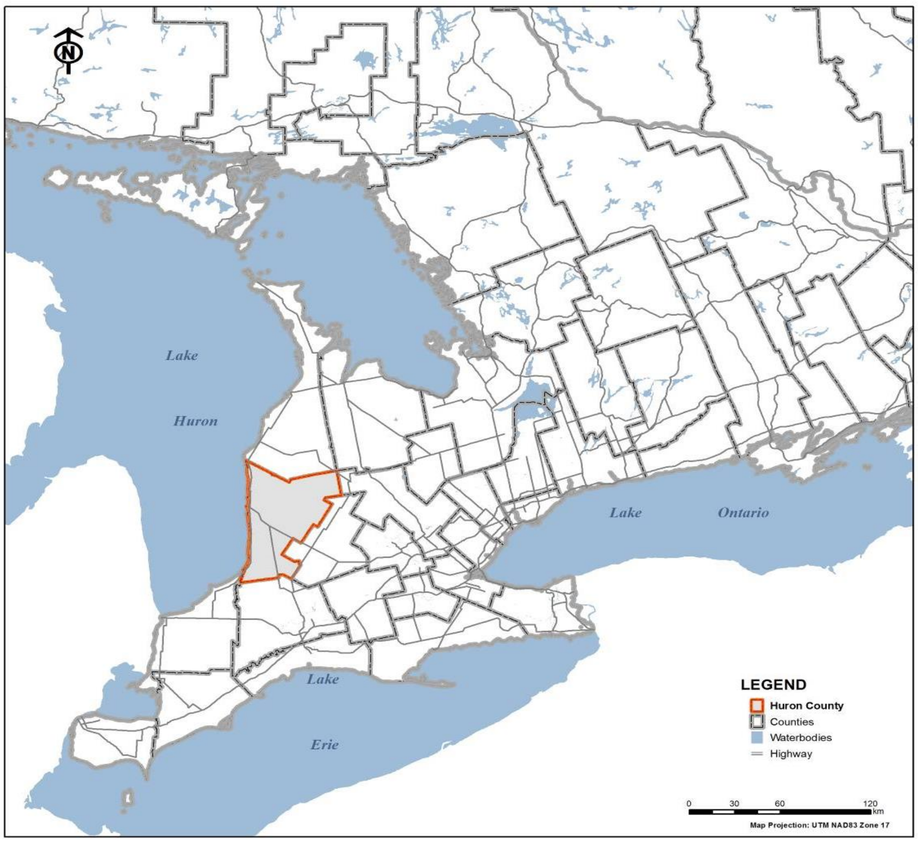

Figure 1.1 Location of Huron County within Southern Ontario.

1.3 History of Settlement

It was not until the 1820's that Europeans began to settle the Huron Tract in significant numbers. The relative remoteness discouraged industry and large cities, while rich soils encouraged agricultural development (DWSP 2011). Between 1850 and the early 1900s land clearing (for agriculture, settlements) dramatically reduced the natural areas in Huron County, which has contributed to degraded watercourses, flooding, drought, soil erosion, and the extirpation of species (DWSP 2011).

Agriculture is a significant economic driver in Huron County (HBDC 2010). Currently the County leads all other counties and regions in Ontario in total value of agricultural production (HBDC 2010). More recently, the allure of the Lake Huron shore, good roads, and ready access to Canadian and U.S. markets have expanded the tourism industry and encouraged industrial development (DWSP 2011).

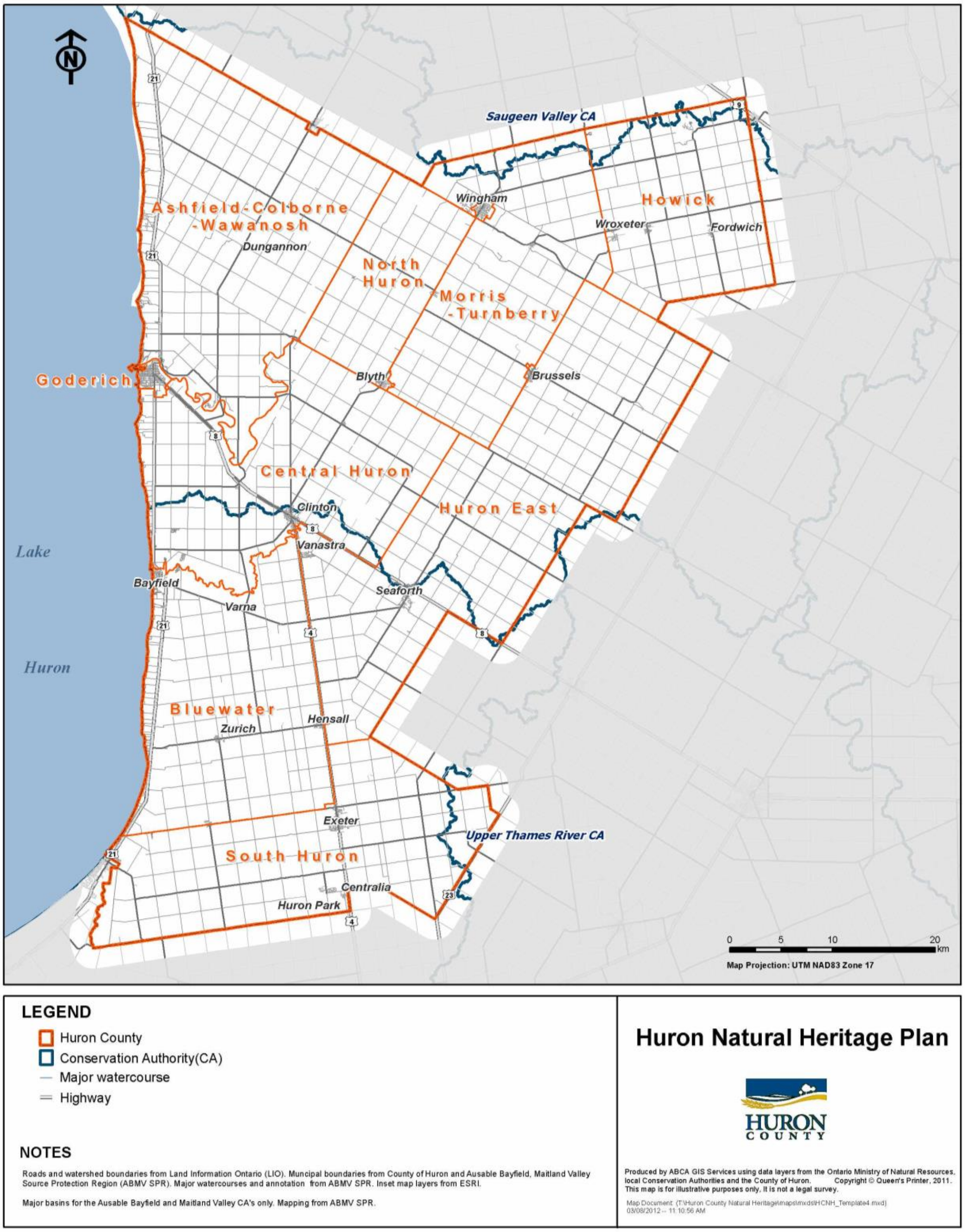

Figure 1.2. Municipalities within the County of Huron

1.4 Natural Heritage System in Huron County

Natural areas cover approximately 20% of the County's landscape. The benefits of a healthy natural environment include clean air and water, improved soil quality, habitat for plants and wildlife, resiliency to extreme weather events (such as flooding), protection of groundwater, opportunities for recreation and education, improved physical and mental health, a beautiful landscape, and sustainable economy (e.g. timber harvest, maple syrup production, etc.) (Olewiler 2004; Luinstra 2010). The abundance, size, shape, and proximity to other natural areas all contribute to the resilience of the landscape to threats.

There are a number of factors that threaten the health of the natural environment in Huron County. Some of these factors include fragmentation, loss of habitat, development pressure, unpredictable and extreme weather events, pollution, and the proliferation of invasive species, pests, and disease.

The protection of *individual* natural heritage features is unlikely to ensure the survival of species or ecosystems, as it does not take into account how well the remaining natural features function or how effective they are in providing environmental benefits (Humke *et al.* 1975). As well, there is a danger in cumulative loss by assessing habitat patches only at a site scale, since their importance within the broader landscape is unknown.

A natural heritage system is a system of connected, or to be connected, natural areas that provide ecological functions over a longer period of time and enable movement of species (OMNR 2010). An ecologically-based delineation of natural systems incorporates features, functions and linkages as component parts of the system. The dynamic nature of the ecological systems makes it impossible to consider one area in isolation without considering the larger landscape. Terrestrial and aquatic ecosystems are variable in time and space. A systems-based approach has regard for this variability.

1.5 Technical Document Goals and Products

The Technical Document includes: background information of land use and natural features in Huron County (Background; Chapter 1), the mapping methodology and scientific framework used to identify and evaluate the County's natural systems (Natural Heritage Systems Study; Chapter 2), analyses of water quality and watercourse sensitivity in Huron County (Aquatic Resources Study; Chapter 3), information about rare species in the County (Rare Species; Chapter 4), and conclusions and technical recommendations based on the findings of the previous three chapters (Conclusions and Recommendations; Chapter 5).

The information collected and generated from the Technical Document will be used to:

- Provide an increased understanding of the location, significance and interaction of the County's natural heritage features.
- Ensure the County planning documents are consistent with the provincial direction for protecting natural heritage features.
- Develop priorities for land stewardship programs using a stakeholder engagement approach.
- Support sustainable economic development.

Products of the Technical Document include:

- Accurate, detailed and comprehensive natural heritage systems mapping based on 2015 air photography (Appendix B).
- Metadata associated with each Geographic Information Systems (GIS) layer.
- A methodology for determining significance of natural features at the County level.
- A description of aquatic features in Huron County.
- A description of rare species in Huron County.
- Recommendations for protecting and enhancing natural heritage features.

1.6 References

Bowles, J.M., T.D. Schwan, D. Kenny, N. Gaetz, and R. Steele. 2001. Maitland Valley Conservation Authority Forest Resource Assessment. 70 pp.

Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier (eds.). 2007. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario. 3rd ed. Ontario Geological Survey. 270p.

Drinking Water Source Protection (DWSP). 2011. Ausable Bayfield Maitland Valley Source Protection Region. Maitland Valley Source Protection Area Assessment Report. 290 pp.

Humke, J.W., B.S. Tindall, R.E. Jenkins, H.L. Wietung, and M.S. Lukowski. 1975. The Preservation of Natural Diversity: A Survey and Recommendations. The (US) Nature Conservancy.

Huron Business Development Corporation (HBDC). 2010. The State of the Huron County Economy 2010. Huron Business Development Corporation and Avon Maitland District School Board. 45 pp.

County of Huron. 2013. Huron County Official Plan. Consolidated June 3, 2013. County of Huron, Planning and Development Department.

Huron County. 2011. Take Action for Sustainable Huron. 55 pp.

Luinstra, B. 2010. Climate Trends in the Maitland Valley Conservation Authority Jurisdiction. Luinstra Earth Sciences. 131 pp.

Olewiler, N. 2004. The Value of Natural Capital in Settled Areas of Canada. Ducks Unlimited Canada and the Nature Conservancy of Canada. 36 pp.

Ontario Ministry of Municipal Affairs and Housing (OMMAH). 2014. Provincial Policy Statement, 2014. 50pp.

Ontario Ministry of Natural Resources (OMNR). 2010. Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement. 2nd edition. 233 pp.

Rowe, J.S. 1972. Forest Regions of Canada. Canadian Forestry Service Pub. #1300. Department of Environment, Ottawa. 172 pp.

Chapter 2

Natural Heritage Systems Study


Photo by Jory Mullen

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2 Natural Heritage Systems Study

2.1 Introduction

The Provincial Policy Statement (OMMAH 2014) defines natural heritage system (in part) as: *… a system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural heritage processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems.*

The Natural Environment Update for Huron County strives to maintain and enhance the ecological integrity of the landscape by using a natural heritage systems planning approach in Huron County. In the Technical Document, the Natural Heritage Systems Study (NHSS) identifies and evaluates Huron's natural heritage features, and defines the natural heritage system. According to Ontario Nature (2014), natural heritage systems planning is 'about maintaining, restoring, and enhancing ecologically sustainable and resilient landscapes'. It is an important mechanism for preserving the natural environment, as it recognizes the inadequacy of protecting a particular woodland, river, wetland, meadow, or other natural feature, in isolation. Instead, natural systems planning identifies spatially and functionally interconnected systems of natural features and landforms. It is an effective way to preserve biodiversity, which is an essential component of ecosystem health.

The natural heritage system in Huron County is comprised of coastal and hinterland landforms, natural heritage features, and watercourses (Figure 2.1). Natural features in Huron County were identified and evaluated based on their individual significance and within the context of the natural heritage system (Appendix A). In defining a natural heritage system, linkages that are ecologically functional should be incorporated (OMNR 2010). Landforms, watercourses, and other vegetated corridors such as hedgerows, provide important links between natural features, support natural heritage processes, and are significant components of the natural heritage system (Appendix B). Section 2.4 describes the methodology for mapping landforms, natural features, and watercourses in Huron County.

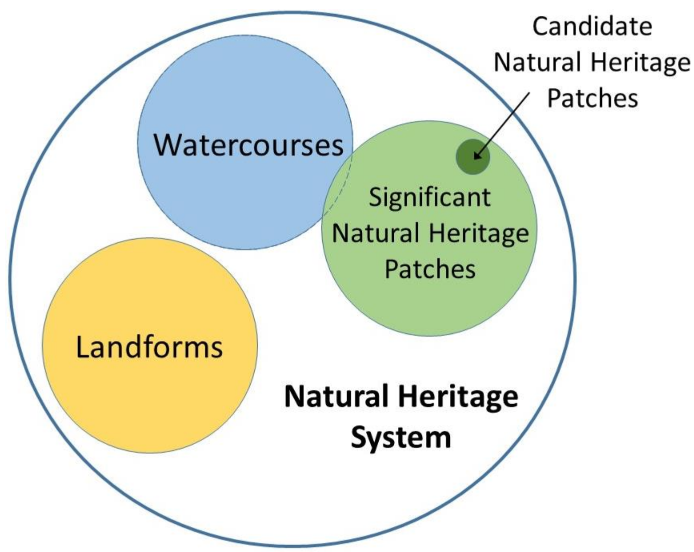

Figure 2.1 Diagram depicting the components of the natural heritage system in Huron County. Significant natural heritage patches cover 98% of the natural area in the County, candidate patches cover 2%. Major watercourses are part of the natural heritage patches (Table 2.3), which is why watercourses and natural heritage patches intersect in this diagram.

Three main types of criteria were developed to determine the significance of the mapped natural features (section 2.3; Figure 2.2). Significance criteria for landforms, vegetation groups, and natural heritage patches were drawn from technical guidelines such as the Natural Heritage Reference Manual (NHRM; OMNR 2010), and peer-reviewed scientific literature. Where there was a lack of definitive guidelines, cut-offs were determined by statistical analysis and the use of percentiles (see section 2.3.2.3 (thicket size) and 2.3.3.5 (diversity of vegetation communities)). The NHRM (OMNR 2010) was prepared by the Ontario government, led by the Ministry of Natural Resources and Forestry. The manual provides technical guidance for implementing natural heritage policies under the Provincial Policy Statement (PPS; OMMAH 2014).

Many studies have shown it is important to use multiple criteria to assess the characteristics of natural features since the external characteristics or setting of a feature may not always reflect its internal quality (Carter 2000, Bowles 1997, Bowles *et al.* 2000). This emphasizes the value of examining all vegetation communities at both the landscape and site level so important characteristics are not overlooked.

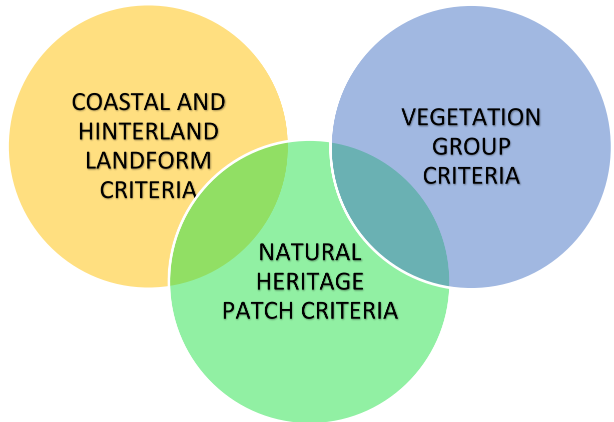

Figure 2.2 The relationship between the significance criteria for natural features and landforms in Huron County.

2.1.1 Mapping Limitations

The base mapping layer was originally based on spring colour 2006 aerial photography (ortho-imagery). At the time when the study began (January 2011), the 2006 aerial imagery was the most up to date imagery available; however, in 2017 the mapping was updated to reflect the 2015 aerial photography. The Natural Heritage Systems Study maps only the boundaries of the natural features in existence in 2015 as seen on the 2015 ortho-imagery. Base mapping layers are manually interpreted through an on-screen process. The 'vegetation community' information is derived from the colours and patterns seen on the photography (see mapping methods, section 2.4, for more details). Misinterpretation of certain features may occur. As well, the mapping layer is only accurate to the date and season when the air photo was taken.

Although the boundary of some natural heritage features will change, it is important to use a base layer from a single point in time that is consistent across the County so that it can be used for future comparisons.

Another limitation with mapping features that are developed and maintained by dynamic processes (e.g., succession of meadows) is that they are more likely to change over a shorter period of time than features that are more stable (e.g., mature woodlands).

For many ecosystem functions it is not possible or appropriate to delineate clear spatial boundaries between natural heritage features. Often these boundaries are dynamic in both space and time, depending on seasonal patterns of rainfall and/or land use. Dynamic processes include geomorphology (e.g., bluff development), natural disturbances such as fire, wind erosion, flooding, plant succession (e.g., meadow to thicket to woodland), and anthropogenic disturbances (e.g., cattle grazing, drainage changes, deforestation, etc.).

Not every decision the Technical Team made about the criteria in the NHSS was straightforward, and there were several limitations based on the nature of natural heritage mapping. One example is related to the integration of Species at Risk (SAR) observations into the significant patch criteria. Neither bird nor fish SAR observations were included in the model. How do you take into account bird observations along roadways or in agricultural fields? Are all these areas significant? The methodological decisions of the Technical Document are the result of detailed research and discussion by the Technical Team, using the best science available.

2.1.1.1 Aquatic features in Huron County

The Technical Document includes an Aquatic Resources Study which provides comprehensive information about water quality and watercourse sensitivity in Huron County. This information can help improve watershed health by informing priorities for stewardship in Huron County.

Users of this document may notice a gap in linking the Aquatic Resources Study findings to the Natural Heritage Systems Study. This is a methodological shortcoming in other Ontario natural heritage studies as well (County of Frontenac 2012; Middlesex County 2014). The authors of the Technical Document recognize that the interaction between land and water is dynamic. The nature of this relationship changes from season to season and year to year due to factors such as change in land use practices and weather variability. Given the nature of this relationship, there are methodological challenges in establishing the model. Nevertheless, aquatic systems are recognized as an essential component of environmental health.

The criteria used to incorporate aquatic information into the landscape model were limited - the complexity of the system makes it inherently difficult to capture all relationships. In the model, major and minor watercourses were identified (Table 2.10), and vegetation communities adjacent to a watercourse were significant for their riparian functions. The criteria for major and minor watercourses do not include any criteria for ephemeral channels, which play an important role from a watershed health perspective. Ephemeral channels are influenced by soil type, slope, and land use practices. Recent studies have found the flow of water through agricultural fields and ephemeral streams can have a significant impact on water quality (Upsdell and Veliz 2013).

Even though the NHSS does not include criteria to incorporate the aquatic system more completely into the *landscape model* (Appendix A), which determines the significance of natural heritage features, watercourses in Huron County are important components of the *natural heritage system* (Appendix B). It should be noted that fish habitat is a natural heritage feature identified under Section 2.1 of the PPS (OMMAH 2014), so all potential fish habitat (i.e., open watercourses) should be identified. Future updates of the NHSS landscape model should attempt to integrate a more comprehensive set of aquatics criteria.

2.1.1.2 Other significant natural features

The Provincial Policy Statement (PPS; OMMAH 2014) identifies the significant natural features that are to be maintained restored, or where possible, improved. S*ignificant wildlife habitat* is one of these features (PPS section 2.1.5). Significant wildlife habitat (SWH) was considered by the Technical Team, but is not specifically addressed in the Natural Heritage Systems Study due to inconsistency of data.

It is recommended that significant wildlife habitat be addressed by local municipalities as more refined studies are completed. Any known SWH should be included in the identification of significant features within Huron County. The Significant Wildlife Habitat Technical Guide (SWHTG) provides technical information on the identification, description, and prioritization of SWH (OMNR 2000). The SWHTG is intended for use in the municipal policy and development process under the *Planning Act*. An addendum to the SWHTG provides further detail on characterizing and identifying SWH in Ecoregions 6E and 7E (OMNR 2012).

Earth Science Areas of Natural and Scientific Interest (ANSI) are also protected through the PPS. These features, however, were not included in the Natural Environment Update, as Earth Science ANSIs do not mean there are unique natural heritage features on the ground surface.

2.2 Landforms: Definitions and Significance

Landforms are the physical features that form the landscape. The vast majority of landforms mapped in Huron County are on the coast of Lake Huron and along waterways. Landforms provide connectivity on the landscape, and are an important part of the natural heritage system (Appendix B). Landforms can be classified into coastal or hinterland landforms, depending on their proximity to the shoreline (Figure 2.3). The following sections include definitions of landforms in Huron County, and the criteria used to determine the significance of natural heritage patches associated with landforms (Table 2.1).

Coastal Landforms	**Hinterland Landforms**
- Littoral: near shore, beach, sand dune	- Valleylands
- Shore bluff	- Other landforms
- Gully	

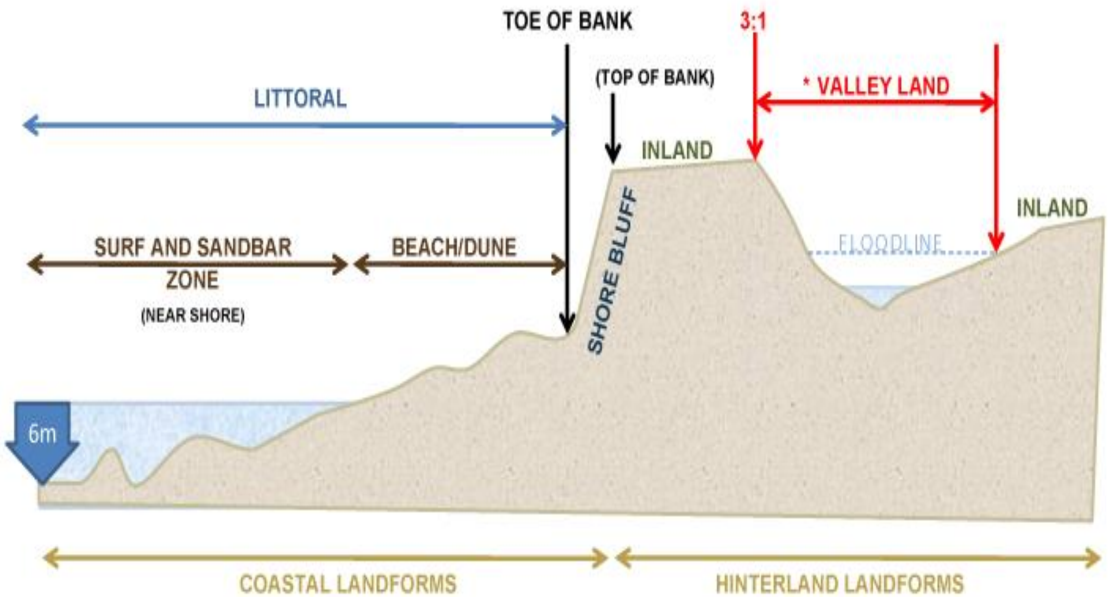

Figure 2.3. Conceptual diagram representing coastal and hinterland landform types. Hinterland landforms begin 100 m from top of bank. This figure is not intended to be a depiction of the organization of these landforms in Huron County. For example, in Huron active and relic dunes can be found several hundred metres inland.

2.2.1 Coastal Landforms

2.2.1.1 Littoral Landform

The littoral area is defined as the area between the toe of the shore bluff or bank, out to the 6 m bathymetry contour line. It includes sand bars that are created by wave action, the surf zone, beaches, and dunes that are all linked by the interchange of sand. The littoral area provides important linkage functions in a natural heritage system, regardless of width.

Surf and Sand Bar (Near Shore) Zone

The near shore zone is the most productive portion of Lake Huron and supports a higher richness and diversity of fish and invertebrates than habitats in open water ecosystems (Taylor *et al.* 2010). The structure and function of the near shore zone influences several other biodiversity features, including open water ecosystems, coastal wetlands, native migratory fish and coastal terrestrial systems.

Beach

Beaches are composed of sand, gravel, cobbles or boulders and form lake ward from the toe of the shore bluff (Plummer and McGeary 1985). One of the principal functions of a beach is to absorb wave energy and reduce or prevent erosion of the bottom of the bluff from frequent wave action (Bowles 1993). These areas undergo continuous change and are not suitable for structures or buildings.

The beach is the portion of the littoral zone where accumulated unconsolidated sediment continuously moves as a result of naturally occurring processes associated with wind and water. The naturally occurring physical and ecological processes that continuously shape and reshape the landscape include: shoreline regression, erosion by waves, near shore currents, sediment transport, wind action, water level fluctuations, ice, weathering, and human activities (GRCA 2006). These naturally occurring processes change the rate of sediment supply. As a result, there are two types of beaches found along Lake Huron:

Narrow Beaches:

High energy, exposed shores tend to have steeper and narrower beaches that are associated with source areas from which the fine sand material is washed away (Lang and Armour 1990). Where the beach is very narrow, or non-existent, the beach has little capacity to protect the bluff and the lake impinges directly on the bottom of the bluff (Bowles 1993). There may be some germination of seedlings or vegetative growth on narrow beaches, but plants are usually removed in storm events.

Wide Beaches:

Where lag deposits and shoals attenuate wave energy, beaches tend to be wider with a larger proportion of finer sand material deposited (Lang and Armour 1990). Wider beaches at low lake periods can have native and non-native grasses colonizing the habitat. Driftwood and debris are also usually present. Shorebirds and gulls may nest or roost in the backshore areas of wider beaches.

Dunes

Dunes are subject to the same naturally occurring processes as beaches. Dunes are deposits of wind-blown sand and frequently line the littoral zone below the bluffs (at the toe of the bluff) and just behind the beach (Plummer and McGeary 1985). The velocity of the wind dictates the size of deposited material on dunes. The leeward edge of the active dunes is the inland limit of aeolian sand deposition. Vegetation is crucial for dune formation, as vegetation initiates sand accumulation and further acts to bind the sand together as the dune grows and develops.

Sand dunes provide long-term stability to the littoral zone by protecting shore bluff areas from wave action and by acting as storage areas for sand (Michigan Sea Grant 1979). If left unaltered, dunes naturally protect inland shoreline development from the destructive impacts of shoreline flooding and erosion (OMNR 1997). However, dune systems are highly unstable and fragile, and are easily damaged by human activity (e.g. trampling, ATVs).

Vegetated dunes are regionally unique habitats and provide habitat for a variety of herpetofauna (LHCCC 2010) and other species. Dune vegetation includes grasses, bearberry, and common juniper. Dunes are considered to be one of the Great Lakes' most vulnerable ecosystems (LHCCC 2010). In fact, the Great Lakes contain the most extensive freshwater dune systems in the world (Henson *et al.* 2010).

Many beaches along the Huron County portion of Lake Huron are narrow and have very limited vegetation cover. In low hazard areas where the beach is wide and the bluff is protected, beach vegetation is usually herbaceous and located along the top of the beach above normal wave action. There may be wet meadows and open water behind dune ridges. Dune building on wide beaches with shallow near shore shelves helps protect some bluff areas (Bowles 1993). Removal of vegetation can expose the sand surface to the forces of wind erosion. Since dune formations are fragile, even slight alterations in dune formation or trampling of vegetation may lead to significant disruptions in the protective role of dunes. Several dune vegetation types are listed as globally or provincially imperiled.

2.2.1.2 Shore Bluff Landform

Shore bluffs form the main topographic feature of the coastal landscape of Huron County and separate the lake from the hinterland (Bowles 1993). Shore bluff erosion occurs from wind, anthropogenic influence, and wave action at the base of the bluff immediately above the beach. Mass wasting also occurs as a result of groundwater movement and surface runoff (Bowles 1993). A steep, wave-cut toe and rills formed by surface runoff are often apparent and abundant. Slumping and mass wasting may be exaggerated by uncontrolled stormwater and drainage, vegetation removal, excessive weight of buildings, and decreased groundwater infiltration as a result of roads, field drains, eaves troughs and septic tanks.

Eroding shore bluffs contribute the sands that form beach–dune systems at other shore locations. Materials eroded from the shore bluff are washed into the lake and carried by long shore currents where they are deposited as beach material (Bowles 1993). Established vegetation is absent on actively eroding slopes, while dense white cedar and deciduous woodland stands occur on stable slopes. Steep slopes, patchy vegetation and erosion faces create unique natural features for specialized assemblages of plants and animals.

The Lake Huron shoreline bluff is a prominent natural, dynamic and cultural feature in the landscape of Huron County. This feature, however, is sensitive and prone to significant erosion. Such erosion or recession is a natural process and a significant lakeshore management concern. The beaches along the shoreline in the County of Huron are a very valuable natural resource for recreation.

Erosion is largely attributed to soil loss at the toe of the bluff due to normal coastal processes. As mentioned above, erosion can also be a function of soil composition, amount of precipitation, the presence and type of vegetation on the bluff face, the type of inland land use (Bowles 1993), development, and grading practices. Permanently vegetated buffers above and adjacent to the top of the shore bluff help protect the bluff by reducing rates of surface erosion, helping to bind the surface substrates, and providing linear connectivity along the shore. Valuable ecological function can be restored to the shore bluff by establishing buffer zones in existing residential areas. Buffers should be wide enough to accommodate long term shoreline recession.

2.2.1.3 Gully Landform

Gullies are formed by a combination of the down cutting action of swiftly flowing water, the slumping action of gully banks, and the removal of slumped material from the gully bed (Etmanski and Schroth 1980, Bowles 1993). Gullies interrupt the linear aspect of the shoreline by being oriented at right angles (perpendicular) to the shoreline and extending shore bluff features inland (Bowles 1993). The number of gullies per kilometre and their characteristics (stage of development, length, and degree of vegetation) may be important indicators of shoreline activity and of the overall erosion and movement of sediment from hinterland areas.

In Huron County, a major roadway (Highway 21) runs parallel to the shoreline of Lake Huron. Highway 21 is a barrier to natural processes such as erosion. Gully erosion eastward of Highway 21 is not expected, even in the most erosive conditions anticipated within 100 year planning cycles. For the purposes of this Technical Document and to be consistent with the Conservation Authorities' policy termination point across the shoreline, gullies are considered to start from the toe of the shore bluff and extend inland to Highway 21, the easterly limit of the Lake Huron Shoreline. Hinterland landforms (i.e. valleylands) are located east of Highway 21 (section 2.2.2).

Active erosion of the bluff takes place at most gullies. As they erode, gullies deepen, widen and move inland. When gullies erode, land area is lost. Actively eroding gullies have unstable slopes and little or no vegetation cover. Gullies that are stable have a healthy mature vegetation cover which reduces gully erosion. Gullies can be barriers to movement along the shore (e.g. sediment, animal, plant, etc.), or direct movement inland.

Much of the gully activity on the Lake Huron shore bluff is exacerbated by human activity. Excess weight near the top of the gully slope from buildings, roads or farm machinery can increase internal stresses. Structural attempts to stabilize gullies (for example with retaining walls or hardening the toe of the slope) can be expensive and are usually unsuccessful in the long term. Instead, a buffer of naturalized woody vegetation should be developed around gullies, starting from the gully head.

2.2.2 Hinterland Landforms

2.2.2.1 Valleylands

The NHRM (OMNR 2010) defines valleylands as "a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year". Valleylands are linear systems that stretch across the landscape from their origins in headwater areas to their outlets into aquatic systems such as wetlands and lakes. Some valleylands have unusual features associated with them, such as calcareous seeps, cliffs, and bedrock pavements. As the "backbone" of a watershed, valleylands perform critical ecological functions. They act as important linkages and contain diverse habitats and species due to microclimate variations (OMNR 2010). A variety of wildlife use valleylands for movement (Bowles 1993).

The NHRM (OMNR 2010) recognizes that an understanding of hydrological and geomorphic structure is important to identifying valleylands. The physical boundaries are generally determined as stable top of bank (top of slope) for well-defined valleys, and riparian vegetation, flooding hazard limit, meander belt, or highest seasonal inundation for less defined valleys. Vegetation on valleylands improves the water holding capacity of the landscape and reduces river erosion.

To ensure regeneration of tree species as well as encourage wildlife movement, vegetation should be at least 100 m wide from the top of slope on gullies or valleylands (Levenson 1981, Jackson and Jensen 2005, Tufford *et al.* 1998). All natural heritage patches within 100 m of a gulley or valleyland are considered significant (Table 2.1).

2.2.2.2 Limestone Outcroppings

Limestone outcroppings are ecologically important in terms of representation, quality and diversity of the valleylands in Huron County. The NHRM (OMNR 2010) recognizes that micro-environments within valleylands combined with bedrock outcrops may provide conditions for unusual communities and species. The Maitland River valley contains notable amounts of exposed limestone outcroppings. Steep rocky slopes, cliffs and bedrock pavements provide unique physical habitat and distinctive micro-climates, which can accommodate an array of slow-growing, long-lived, stress-tolerant flora that may not be particularly tolerant of competition or disturbance (Larson *et al.* 1989). The cliff and bedrock associations, are found mainly from Holmesville to Goderich and provide growing conditions for disjunct arctic species and in some cases globally rare Old-growth Eastern White Cedar (Szczerbak 2000). Limestone is also one of the most commonly noted streambed substrates associated with Queensnake (Gillingwater 2011). The Nature Conservancy of Canada (NCC) has mapped locations of limestone outcroppings (Copeland 2011, unpublished data).

2.2.2.3 Other Hinterland Landforms

There are additional hinterland landforms such as kames, drumlins and moraines in Huron County that were created when glaciers deposited sand, silt, clay and boulders in various mixtures and forms. These landforms were not delineated as part of the study. Instead, the vegetation and natural heritage features located on these landforms were identified.

Table 2.1. Summary of criteria for defining landforms as part of the natural heritage system, and significance criteria for natural heritage patches (section 2.3.3) that are proximal to landforms.

Landform	Criteria for Defining Landforms as part of the Natural Heritage System	Natural Heritage Patch Criteria for Significance
Dunes	All dunes were identified.	Not applicable.
Shore Bluff	All shore bluffs, including those which have been historically altered or developed.	All natural heritage patches found up to 100 m from the top of bank on shore bluffs.
Gully	All gully lands, including areas of agricultural land use operating in gullies.	All natural heritage patches found up to 100 m from the top of bank on gullies.
Valleylands	All valleylands, including areas of agricultural land use operating on valleylands.	All natural heritage patches found up to 100 m from the top of slope on valleylands.
Limestone outcroppings	All limestone outcroppings and associated 30 m buffer (regardless of whether there was an associated natural heritage patch), including areas of agricultural land use operating on limestone outcroppings or within the buffer.	Not applicable.

2.3 Natural Heritage Features: Definitions and Significance

A hierarchy of three vegetation levels was developed for the various components (features) of the natural heritage system in Huron County (Figure 2.4). The identification of vegetation groups and natural heritage patches was based on the delineation of vegetation communities.

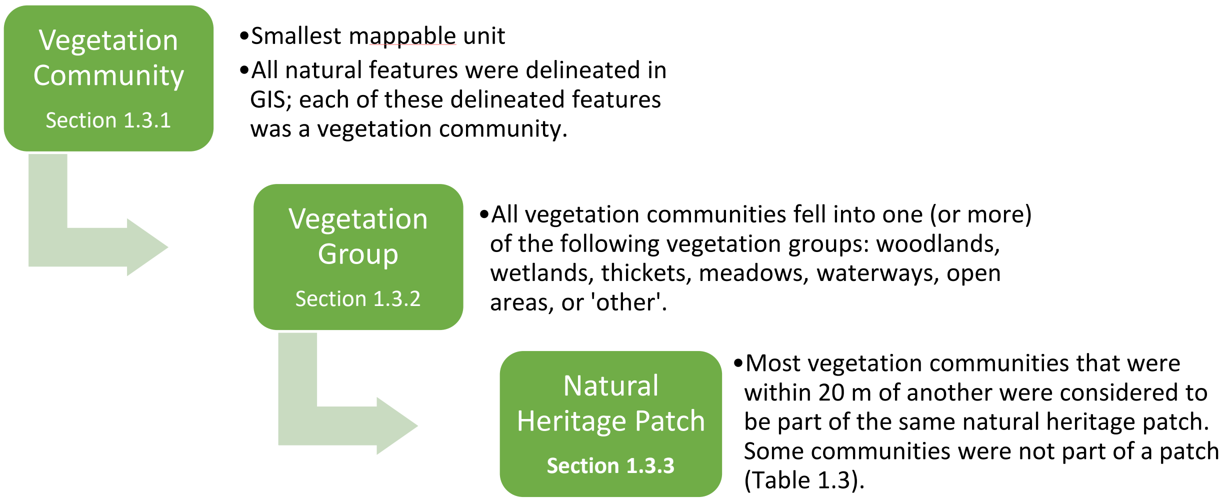

Figure 2.4. Hierarchy of vegetation levels used to define natural heritage features in Huron County

Evaluation of significance

Significance criteria based on a variety of metrics (such as size, interior habitat, proximity, wildlife habitat, diversity, etc.) were developed at both the vegetation group and natural heritage patch levels. The details of these criteria and their scientific justification are discussed in sections 2.3.2 and 2.3.3.

Various methods have been used to assess the ecological significance of natural areas. Most evaluations use more than one criterion and include landscape metrics such as size, connectedness, regional representation and hydrological function (Riley and Mohr 1994, Forman 1995), as well as site characteristics such as wildlife habitat, community and species diversity, quality and condition. In general, regional (i.e. County-wide) natural heritage studies evaluate natural areas based on landscape metrics, while local (i.e. lower tier) natural heritage studies tend to use both landscape metrics as well as site-specific metrics such as species richness.

The location, size and shape of a vegetation patch have been identified as critical factors in the maintenance of species diversity and abundance in fragmented landscapes (Burgess and Sharpe 1981, Forman and Godron 1986, Harris 1984, Turner and Gardner 1991). These metrics can be easily measured using remote sensing and provide important information in the absence of more detailed or site-specific study (Schiefele and Mulamoottil 1987, Robbins *et al.* 1989, Hounsell 1989). However, these indicators provide only a partial picture of the complexity of ecosystem functioning.

Carter (2000) found that while relationships exist between site and landscape characteristics, one is a poor predictor of the other. Only a small amount of variability in site specific features is accounted for by landscape features and vice versa. Bowles (1997) found that no single feature can sufficiently measure the true value of a natural feature. For example, Bowles (1997) considered interior habitat measures including size, core area and shape, and found no correlation in ability to predict the number of interior bird species within a woodlot.

Natural heritage patches are considered significant if they met a single criteria for significance, although it was possible that a patch could meet many criteria. Patches that met multiple criteria are not considered 'more' significant than patches that met only one. A 1000 m 'buffer' was mapped around the perimeter of Huron County to ensure that all patches that intersect the County boundary were evaluated.

2.3.1 Vegetation Communities

The smallest units mapped in Huron County, the vegetation community, are units of vegetation that are normally visible and consistently interpreted on remotely sensed images such as air-photos (e.g. woodlands, wetlands, thickets, meadows, waterbodies, etc.). They are usually internally homogenous and distinguished by the type of plant form that characterizes the community. Remote sensing enables coarse level identification of vegetation communities without a site visit. The minimum size of vegetation community delineated was 0.5 ha, which is consistent with aerial photo interpretation methods in Ecological Land Classification (ELC) for Southern Ontario (Lee *et al.* 1998). Vegetation communities were mapped and updated following the manual on-screen digitizing procedures outlined in the Southern Ontario Land Resource Information System (SOLRIS) Image Interpretation Manual (OMNR 2004), not based on biological definitions, such as those in ELC (Lee 2008).

2.3.2 Vegetation Groups

Once all the vegetation community boundaries were updated or created, each vegetation community was then attributed to a broader vegetation unit, the 'vegetation group'. The NHRM was heavily relied upon to develop significance criteria for all vegetation groups. A summary of significance criteria for vegetation groups can be found in Table 2.2.

2.3.2.1 Woodland Vegetation Groups

The PPS (OMMAH 2014) states "*Woodlands include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels. Woodlands may be delineated according to the Forestry Act definition or the Province's Ecological Land Classification system definition for "forest*"". Woodlands are defined in this study as areas with > 35% tree cover to include both woodlands (> 35% tree cover) and forests (> 60% tree cover) as defined in the Ecological Land Classification for Southern Ontario (ELC; Lee 2008). Therefore, treed areas classified as 'woodlands' in the Natural Environment Update include areas with less dense tree cover than woodlands as defined in the PPS.

Woodlands occur on dry land or on land of high elevation such that the soils do not typically experience seasonal wetness. Woodlands contain less than 20% standing water, while wooded wetlands (see section 2.3.2.2) contain greater than 20% standing water (Lee 2008). The woodland vegetation group comprises five vegetation communities including coniferous woodland, deciduous woodland, mixed woodland, young plantation and mature plantation. Woodlots at least 30 m wide are classified as part of the woodland vegetation group. Thirty meters is considered the minimum width to ensure protection of the tree roots. Tree roots often extend out at least the equivalent distance as the height of the tree. The average height of trees in Huron County is 30 m.

Plantations ('Treed Agriculture', as defined in Lee (2008)) typically consist of one or two tree species, grown as even-aged stands that are intensively managed and harvested periodically (Taki *et al.* 2010). Plantations can be important components to marginal ecosystems in that they are a means for the net removal of carbon dioxide from the atmosphere, produce oxygen, modify wind and temperature and remediate soil pollution. Plantations have the potential to quickly improve wildlife habitat, especially when used to increase woodland interior and woodland size, and may improve biodiversity by increasing the presence of species in adjacent woodlands and in the local landscape.

Even so, plantations have limited features and functions compared to naturalized woodlands. For example, the diversity and abundance of pollinators has been found to be greater in agricultural fields adjacent to natural woodlots compared with fields adjacent to plantations (Taki *et al.* 2010). This suggests that replacing natural woodlands with plantations may have adverse effects on the conservation and restoration of biodiversity. Restoring monoculture plantations to a more naturalized state would likely have an overall benefit to the natural heritage system. In the Natural Environment Update, mature plantations are distinguished from young plantation since they are generally more naturalized, and can exhibit similar characteristics to a natural woodland (for example, rows are less visible, and there is some dieback and natural regeneration).

Large size criteria

Size is one of the most important measures for sustaining stable, diverse, and viable populations of wildlife species. Larger woodland vegetation communities tend to have a greater diversity of habitat niches and are more effectively buffered from external negative influences such as environmental disturbances, nest predation, parasitism (Villard *et al.* 1999, Schwartz 1999, Soulé and Terborgh 1999, Burke and Nol 2000, Forman 1995, Bennett 2003).

Riley and Mohr (1994) and the NHRM (OMNR 2010) recommend that the minimum standard for determining the size of treed patches that are significant within the planning area is a function of the percentage of forest cover within that area. In Huron County as a whole, woodland cover is mapped at 16.6%. However, there is a distinct difference in woodland cover between the northeast and the southeast portions of the County that corresponds to the physiography of the area (Chapman and Putnam 1984). In the northeast, the physiography is a drumlinized till plain interspersed with kame moraines, drumlins and spillways, while in the southeast the physiography is predominantly undrumlinized till plain. A broad band of undulating moraines runs from north to south across the County (Figure 2.5). The diversity in physiography has an important impact on the pattern and types of land use between the two areas.

Within the lower tier municipalities woodland cover ranges from 10% in the Municipality of South Huron to 20% in the Township of Howick. Similar ranges exist for sub-watersheds. The Little Ausable sub-watershed has 6% woodland cover while the Nine Mile River watershed has 27% woodland cover. In a regional analysis such as the Huron Natural Heritage Plan it was not practical to apply different significance criteria to the sub-watersheds, even though there is a broad range of percent tree cover.

The Official Plan policies of the Townships of Ashfield-Colborne-Wawanosh and North Huron, and the Municipalities of Bluewater, Central Huron, and Morris-Turnberry protect woodlands greater than or equal to 4 ha in size. All of these go beyond the recommended policies in the Natural Heritage Reference Manual (NHRM; OMNR 2010). The Municipalities of Huron East and South Huron also go beyond the NHRM guidelines by protecting all areas of natural environment and areas larger than 2 ha, respectively. The Township of Howick does not have a significance criterion, but states that woodland significance will be determined in conjunction with the local Conservation Authority and the County of Huron.

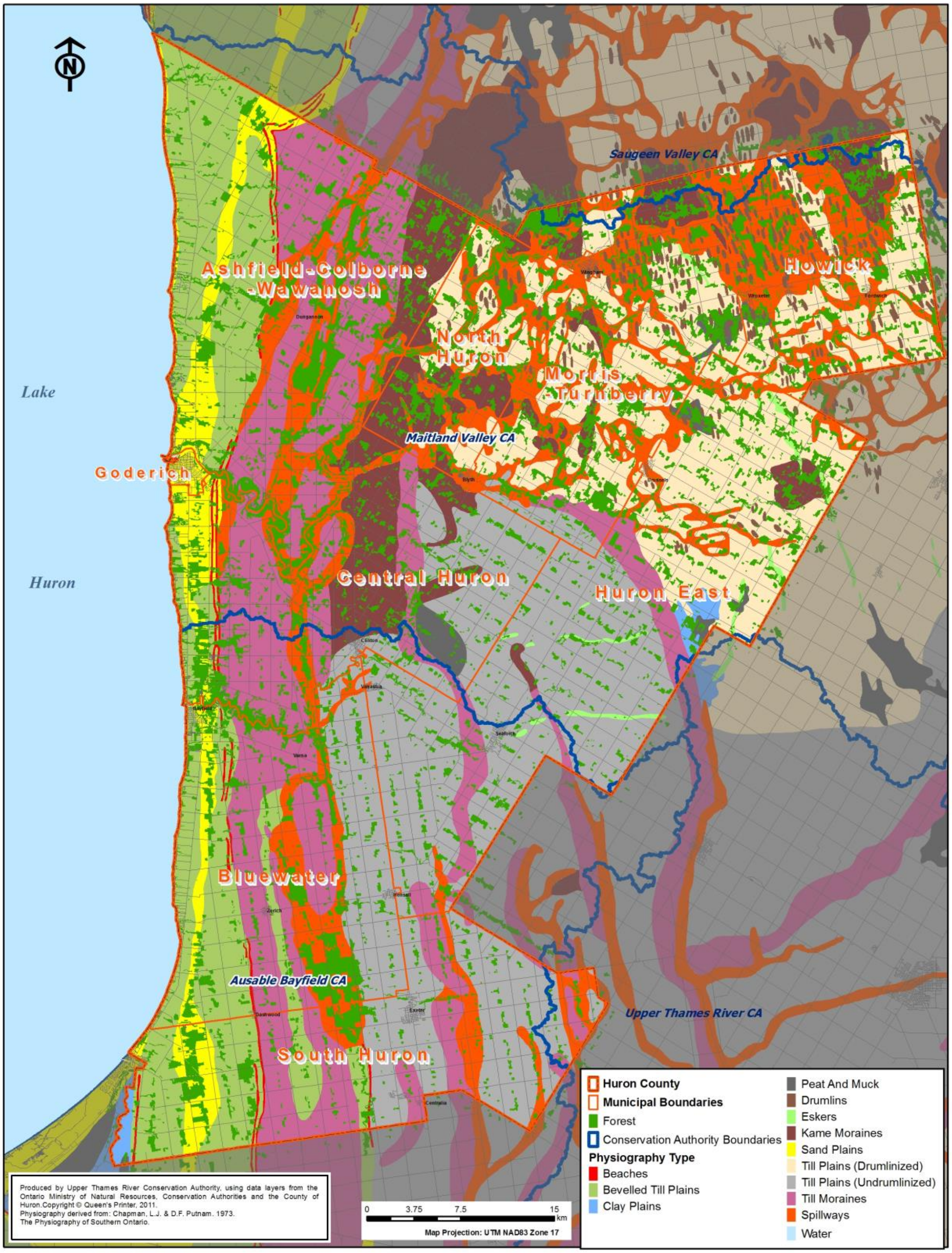

Figure 2.5. Map of physiography and woodland cover of Huron County.

The NHRM guidelines state that where woodland cover is about 15 to 30% of the land cover, woodlands 20 ha and greater should be considered significant. The NHRM goes on to note that in the absence of more detailed information that could only be obtained by site inspection (such as composition, diversity, age), the size threshold of woodlands should be reduced. Therefore, woodlands in Huron County 4 ha or greater are considered significant. Four hectares is the NHRM threshold for areas with 5-15% woodland cover. The significance of this size of woodland is supported in the literature, as outlined below.

Studies indicate that smaller woodlands (<10 ha) provide ecosystem benefits, and should therefore be considered significant and worth protecting. This is especially true in a highly fragmented landscape. For instance, woodlands greater than 4 ha (200 m x 200 m) have potential to provide interior forest habitat, depending on the shape of the forested area (interior forest habitat defined as habitat greater than 100 m from the forest edge) (Environment Canada 2013). From a biodiversity viewpoint, some smaller woodlands are valuable habitat for wildlife since they typically have a greater density of large trees and dead wood (Gotmark and Thorell 2003). Small mammals, such as mice and voles, use woodlands as small as 0.1 ha. In agricultural landscapes, these small woodlands become especially important during harvest, when these rodents are displaced from the field (Fitzgibbon 1997). Such woodlands have also been recognized as important refuges for amphibians (Weyrauch and Grubb 2004).

Small forest fragments (1 to 4 ha) appear to be particularly important for migratory birds as stopover sites (Swanson *et al.* 2005). Although small patches are often regarded as poor habitat for breeding birds, these small forest fragments provide suitable habitat for the limited amount of time that migratory birds spend there (Packett and Dunning 2009). In agricultural areas with low forest cover, some migratory birds (e.g., Wood Thrush) can utilize woodlands as small as 1 ha during the winter season (Roberts 2011), and can experience high pairing success (Friesen *et al*. 1999). Insects, especially bees and butterflies, also rely on small woodlands in a fragmented landscape. Small habitat patches may be just as important as larger ones for pollinator diversity and abundance (Banaszak 1996, Cane 2001, Donaldson *et al.* 2002).

Woodlands are important in providing clean air; forest edges are able to function as traps for wind-borne nutrients and pollutants (Weathers *et al.* 2001). Furthermore, trees are effective in carbon sequestration, storing carbon long-term as they grow (Roulet and Freedman 2008). Small woodlots are also important for nutrient cycling and the hydrologic cycle, especially when woodland cover is very low.

In fragmented, agricultural landscapes, small woodlands are important components of the natural heritage systems. Woodlands in Huron County 4 ha or greater are considered significant. Woodlands that are 0.5 to 4 ha also provide ecosystem benefits such as nutrient and hydrologic cycling, reduction of flood and soil erosion potential, clean air production, carbon storage, wildlife habitat, and sustainable woodlot products. Therefore, woodland areas that are 0.5 to 4 ha are considered ‘candidate woodlands’ that require further on-the-ground field study to verify significance.

Interior habitat criteria

Habitat along the edge (perimeter) of a woodland community is characterized by a climate and community composition different from that of the interior woodland habitat. Edge habitats are affected by light, wind, and soil conditions from the surrounding landscape. Studies have demonstrated that air temperature, soil temperature, relative humidity, and wind speed all have gradient effects along the edge that typically extend from 30 m to greater than 240 m into the woodland (Matlack 1993, Chen *et al.* 1995, Hamill 2001). In testing for edge effect in a study in southern Ontario, Sandilands and Hounsell (1994) determined that some bird species typically nest 100 m or further from the edge, while others nested 200 m or further. Although edge habitat increases the number of generalist species, it is not suitable habitat for many specialist species (Askins and Philbrick 1987, LRC and OMNR 2000). In woodland environments, nest predation and brood parasitism rates increase near edges (Marini *et al.* 1995, Horn and Koford 2004), while interior habitat is often less prone to disturbance and supports fewer predators (Larson *et al.* 1999, LRC and OMNR 2000).

Edge habitat is considered to be a zone of influence that varies in width depending on where and what is being measured (Meffe and Carroll 1997). The NHRM (OMNR 2010) notes that woodland edge characteristics usually extend 100 m inward from the outermost trees. Therefore, 100 m was used to define the limit of interior habitat in Huron County (Figure 2.6).

There are differing opinions regarding the amount of interior woodland habitat that should be considered significant. Environment Canada (2013) recommends that at least 10% of woodland cover should be interior. Huron County has 3.5% interior habitat based on the criterion of 100 m from the edge. The Natural Heritage Reference Manual (NHRM; OMNR 2010) recommends that the size of interior habitat that is significant within the planning area is a function of the percentage of forest cover within that area. In Huron County woodland cover is 16.6%. The NHRM recommends that woodlands should be considered significant if they have at least 2 ha of continuous interior habitat where woodlands cover is between 15 and 30% of the landscape. The NHRM represents the minimum standard, and woodland cover of 16.6% is very close to the cut-off of 15% (the percentage at which the NHRM recommends that woodlands with *any* interior habitat should be significant). Therefore, in Huron County all woodlands and swamps with at least 0.5 ha (the smallest mappable vegetation community size) of continuous interior habitat are considered significant.

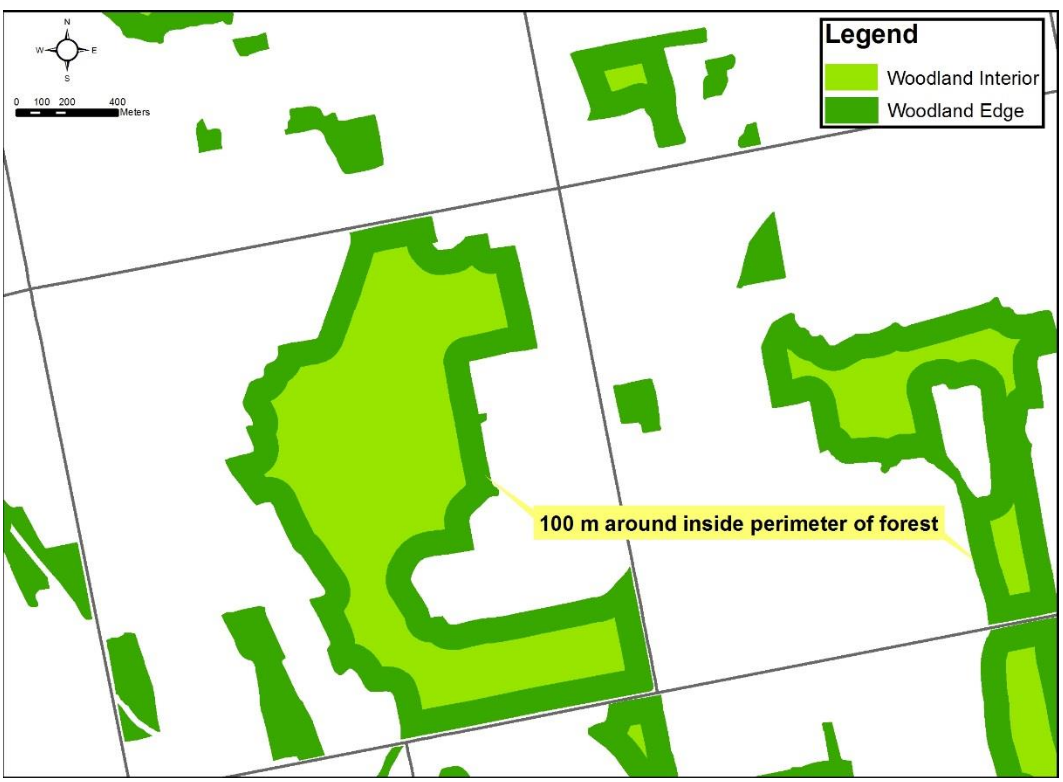

Figure 2.6. Illustration of interior habitat (dark green = edge, light green = interior). An edge of 100 m around the inside perimeter of the woodland community was delineated. Any habitat within the woodland community, but not within the 100 m wide edge, was identified as woodland interior.

Proximity for woodlands

The presence of large natural heritage patches is not sufficient to counteract the effects of fragmentation, especially if there are relatively few such tracts, if they are widely dispersed, or if there are few natural corridors linking them (Riley and Mohr 1994). Research shows that a local landscape that includes large natural areas linked to the regional landscape mosaic by a network of smaller interacting natural areas and corridors offers the highest probability of maintaining overall ecological integrity on the landscape (Larson *et al.* 1999, Villard *et al.* 1999). Natural areas close to protected areas are increasingly seen as important to the ecological integrity of the protected sites. As well, small woodlands that are close to big woodlands are more important in feature and function than those that are isolated. In Huron County, woodlots within 100 m of another natural feature are considered significant.

The NHRM (OMNR 2010) recognizes that the distance between individual woodlands is an important factor in maintaining woodland integrity (Figure 2.7). Woodlands that are situated near each other or near other natural features have greater potential for restoring connectivity. In areas where large patches do not exist, clusters of natural areas that span a range of habitats and are arranged close together support a greater diversity of ecological processes and reduce the effects of fragmentation. Concentrations of habitat are also of greater mutual benefit to wildlife, since the ability and willingness of wildlife species to move between patches and successfully settle in different habitat patches is affected by the distance between patches (Baguette and Van Dyck 2007). Smaller patches of natural woodland cover that are closely spaced can serve as stepping stones for species movement. Linkages are important for both animal and plant dispersal. Most seeds, dispersed by wind, can travel up to 100 m (Nathan *et al.* 2002).

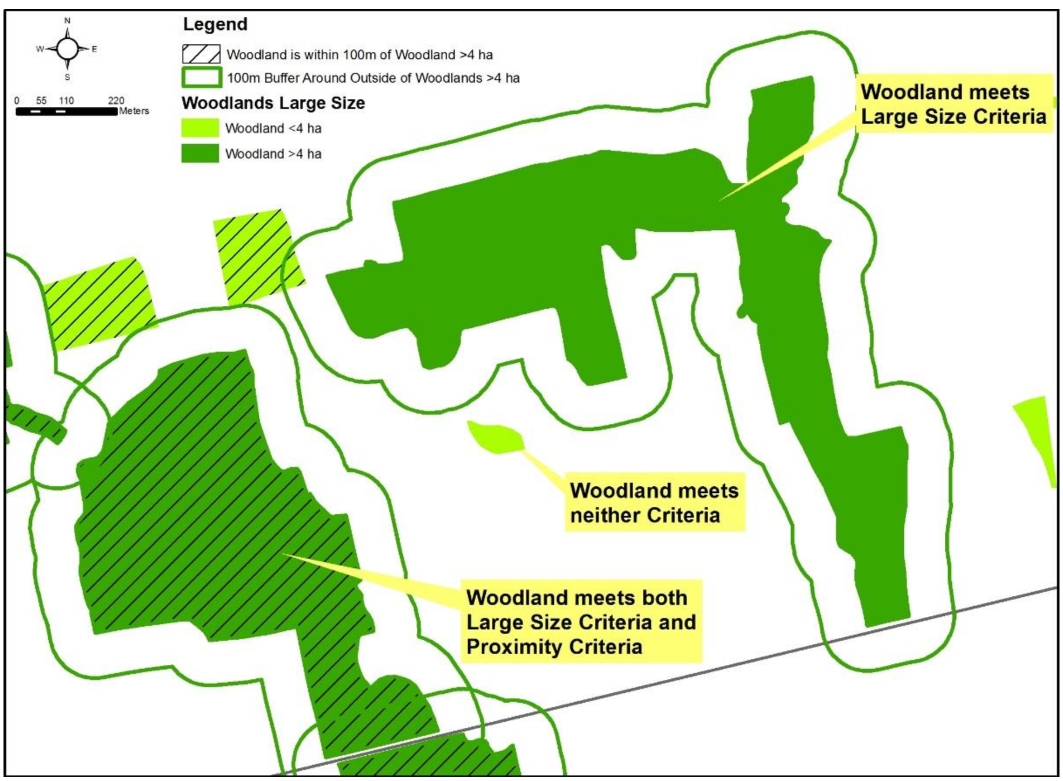

Figure 2.7. A 100 m buffer was delineated on all woodlands greater than 4 ha in size and any woodland that touches that buffer is significant for proximity.

2.3.2.2 Wetland Vegetation Groups

Wetlands are seasonally or permanently covered by shallow water or occur where the watertable is close to or at the surface. The presence of abundant water has caused the formation of hydric soils and has favoured the dominance of water tolerant plants (Lee *et al.* 1998). The four types of wetland are swamps, marshes, bogs and fens. The wetland vegetation group comprises four wooded vegetation communities including coniferous swamps, deciduous swamps, mixed swamps, and plantation swamps, and one non-treed (marsh, bog, or fen) wetland vegetation community. Coastal wetlands are defined in OMNR (2013) as any wetland that is on the Great Lakes or any wetland that is on a tributary to the Great Lakes and lies, either wholly or in part, downstream of a line located 2 km upstream of the 1:100 year floodline (plus wave run-up) of the large waterbody to which it is connected. Wetlands found within the nearshore, shore bluff, or gullies, are considered coastal wetlands and are significant (section 2.4.2.3.2).

Large size criteria

Wetlands provide important habitat, maintain the hydrological regime of the surrounding area, and are breeding and overwintering habitat for reptiles and amphibians. It has been well documented that wetlands improve water quality and base flow by filtering out contaminants, encouraging infiltration and storing water on the landscape. Draining wetlands reduces the water holding capacity of the landscape and can increase river and gully erosion. In catchment basins which contain wetland storage areas in the headwaters, water peaks in the gullies are dampened and the potential for erosion is greatly reduced. Therefore, it is important to protect as many wetlands on the landscape as possible.

Historically, wetland coverage in Huron County was 20.3% (Ducks Unlimited Canada 2010). In Wisconsin, Hey and Wickencamp (1996) found that increasing the amount of wetland in a watershed up to 10% wetland cover resulted in reduced flooding, higher base flows and reduced occurrence of high flows. Watersheds containing less than 10% wetlands are more susceptible to incremental losses of wetlands than those with more wetlands (Johnson *et al.* 1990). Environment Canada (2013) summarized wildlife use of various swamp and marsh habitats and found that even smaller, more isolated wetlands are important in that they provide habitat for many wetland-dependent reptiles and amphibians. Larger, or more continuous wetlands are important for area-sensitive species such as Prothonatory Warbler and Black Tern.

As with woodland cover, there is also a distinct difference in wetland cover between the northeast and the southeast that corresponds to the physiography of the area (Chapman and Putnam 1984). Rather than attempting to analyze the two areas separately, the size threshold was determined by considering the ratio of wetland area to County area. All non-treed wetlands 10 ha and greater are considered significant, swamps (treed wetlands) greater than 4 ha are significant, and thicket swamps greater than 2.5 ha are significant.

Proximity for wetlands

The amount of natural habitat that is located adjacent to wetlands can be particularly important to the maintenance of wetland functions and attributes. The value of a wetland is enhanced where wetlands are located so near to each other that wildlife moves between them to take advantage of favourable habitat, food, etc. (Golet 1976). For example, wetlands situated within 100 m of other wetlands are more likely to have movement of amphibians among them, and the two or more patches are more likely to collectively support more species than they would if they are isolated from each other (Environment Canada 2013). Wetland proximity can be especially important when a wetland is small, and meets the specialized needs of certain wildlife species (OMNR 2013). According to the Southern Ontario Wetland Evaluation Manual (OMNR 2013), any wetland located within 1000 m of another wetland, regardless of hydrological connectivity, is considered to be functionally connected to that wetland from a biological and social context (Figure 2.8).

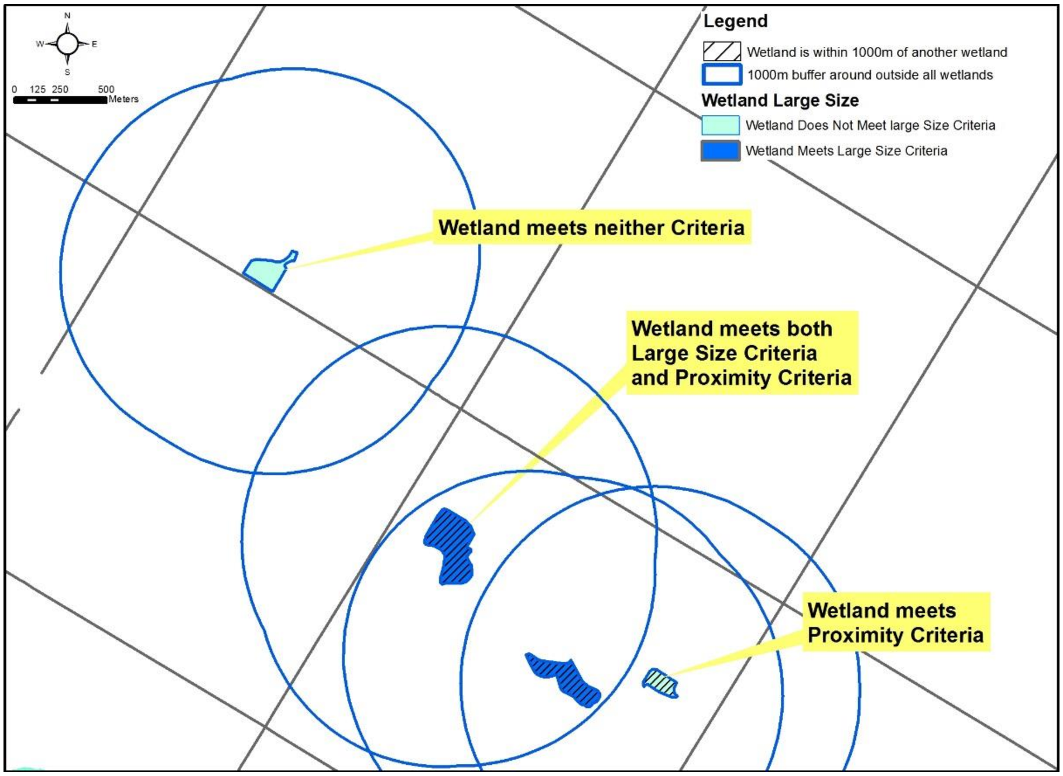

Figure 2.8. Diagram showing a 1000 m buffer delineated on all wetlands. Any wetland that touches that buffer is significant for proximity.

2.3.2.3 Thicket Vegetation Groups

Thickets are comprised of more than 25% shrub species, with less than 10% tree species. Trees may have not reached full size due to either age or edaphic conditions. Thickets may be associated with uplands (usually as early successional communities), wetlands, or riparian corridors.

Large size criteria

Human land use and natural secondary succession in the absence of fire and active reforestation efforts have altered the composition and structure of shrub land habitats (Curtis 1959, Niemi and Probst 1990, Askins 2000). Many of the bird species that typically utilize thickets and early successional stages of woodland development are declining rapidly (Sauer *et al.* 2001). Larger thicket habitats are most likely to support and sustain a diversity of species (Rodewald and Vitz 2005, OMNR 2012). In Huron County, thickets comprise less than 0.5% of the landscape (Table 2.3). Thicket communities in the 75th percentile for size (2.5 ha or greater) are significant. Given the rarity of thickets in Huron County, 2.5 ha was an appropriate size to be considered significant.

Interior habitat criteria

Thicket interior was defined as the area more than 30 m from the perimeter (edge) of the thicket. Corace *et al.* (2009) found that edge habitat characteristics extend the distance of the height of the adjacent woodland trees into the shrub land vegetation community. The influence from adjacent woodland habitat types was used to identify interior shrub habitat - a typical mature tree in Huron County is approximately 30 m tall, which is roughly three times the height of most shrub species. This is consistent with the relationship observed in forests with regards to wind, humidity and other physical edge effects (Meffe *et al*. 1997). All thicket communities with at least 0.5 ha of continuous interior habitat are considered significant. All interior habitat is considered significant in Huron County (see section 2.3.2.1 – woodlot interior for additional discussion).

2.3.2.4 Meadow Vegetation Groups

Meadows are open communities with a very low cover of woody vegetation, either shrubs or trees. The dominant plants are grasses and broad-leaved herbaceous species. Many meadows in Huron County are of cultural origin that are maintained by hydrologic features such as frequent flooding along watercourses.

Large size criteria

The amount of native grassland and meadow habitat has declined drastically throughout North America. Grassland birds are of special concern since they have suffered more serious population declines than any other group of birds (Igl and Johnson 1997, Peterjohn and Sauer 1999, Sauer *et al.* 2001). Larger meadows preserve a larger number of individuals of a given species than smaller meadows (Horn and Koford 2004).

Studies have found that the density of open country species is regulated by the interaction of field size, shape and edge type, although larger open land does tend to support a more diverse bird community (Corace *et al.* 2009, Ribic and Sample 2001). Grassland species such as Bobolink, Savannah Sparrow, Eastern Meadowlark and Grasshopper Sparrow are more abundant as breeding birds in grasslands between 4 and 6 ha of continuous open fields (Ochterski 2006, Mitchell *et al.* 2000). Whereas significant wildlife habitat for open country breeding birds is defined as grassland areas greater than 30 ha (OMNR 2012), the Recovery Strategy for Bobolink and Eastern Meadowlark states these species prefer grassland habitats greater than 10 ha (McCracken *et al.* 2013). The Significant Wildlife Habitat Technical Guide (OMNR 2000) identifies 15 ha blocks of undisturbed grasslands adjacent to woodlands as excellent foraging, resting, and roosting habitat for raptors in the winter. In Huron County, all meadows 10 ha or greater are considered significant. Ten hectares is the minimum preferred grassland area for various species of grassland birds (Mitchell *et al*. 2000, OMNR 2000).

Table 2.2. Summary of criteria used to identify the significance of vegetation groups with respect to size, amount of interior habitat, or proximity to other features.

Vegetation Group	Large Size	Interior	Proximity
Woodlands	All woodlands (***including wooded wetlands***) 4 ha in size or greater.	All woodlands with at least 0.5 ha of continuous interior habitat.	All woodlands that are within 100 m of another woodland community greater than 4 ha.
Wetlands	All non-treed wetlands 10 ha in size or greater.	Not applicable.	All wetlands (including wooded, thicket or meadow wetlands) that are within 1000 m of another wetland community.
Thickets	All thickets (***including thicket swamps***) 2.5 ha in size or greater.	All thickets with at least 0.5 ha of continuous interior habitat	Not applicable.
Meadows	All meadows (***including marsh meadows***) 10 ha in size or greater.	Not applicable.	Not applicable.

2.3.2.5 Waterbody Group
Waterbodies contain permanent water that is not flowing in a watercourse. They may be natural or constructed, for any variety of purposes (for example, ponds that are natural, constructed, or associated with construction or aggregate extraction). Waterbodies that are within 20 m of another type of vegetation group are considered part of the patch. Any natural heritage patch within 30 m of a waterbody is significant (see section 2.3.3.4).

2.3.2.6 Watercourse Group
Watercourses are linear features that contain flowing water for at least part of the year. They may be natural or channelized. Watercourses include streams, rivers, creeks and open drains. Watercourses are classified as either major or minor (see section 2.3.3.4). Major watercourses are a component of a patch, whether or not they are associated with another natural feature, and minor watercourses are not part of a patch. Any natural heritage patch within 30 m of a major or minor watercourse is significant. Note: all watercourses are considered components in the natural heritage system, irrespective of their association with natural heritage patches (Appendix B).

2.3.2.7 Hedgerow Connected Vegetation Group
Hedgerows are narrow, linear communities, usually of trees and / or shrubs. They are an important component of the natural heritage system because they provide windbreaks and corridors for wildlife movement. Hedgerows were only identified if they connected two or more natural heritage features.

2.3.2.8 Open Group
Some locations are exposed to continuous or severe natural disturbance processes that prevent the establishment of vegetation. These areas are part of the open group. Only open features found on shore bluffs, gullies, dunes and valleys were identified.

2.3.2.9 Other Group
The ‘other group’ included areas that do not have a natural component (e.g. residential development), or are features that maintained by human disturbance (e.g. agriculture) and are located on valleylands.

Hedgerows, open areas and ‘other’ areas are not considered significant in isolation, but it is possible for these vegetation communities to be components of significant natural heritage patches.

2.3.3 Natural Heritage Patches
When natural features are managed at the landscape level, the context (where the natural feature is located in the landscape relative to other natural and man-made features) is just as important as content (what the natural feature contains). Patch characteristics including size, shape, distribution and linkage on the landscape can be used to assess features and functions. A natural heritage patch, as defined in this study, is a mosaic of one to many different abutting vegetation communities (Figure 2.12). Not all vegetation communities are considered part of a natural heritage patch (Table 2.3). Natural heritage patches can contain vegetation communities that are significant based on the significance criteria for the corresponding vegetation group, in which case the patch is considered significant. For example, if a contiguous patch (made up of various meadows, thickets, woodlands, etc.) contains a woodland greater than 4 ha, the whole patch (including the communities adjacent to the large woodland) is significant. Other natural heritage patches are significant regardless of the types of vegetation communities within the patch. These significance criteria are discussed in this section. All natural patches in association with shore bluff, gullies, or valleyland landforms are significant (see Table 2.1).

Table 2.3. Vegetation groups that are considered: i) part of the woodland or natural heritage patch (marked by an 'X'), ii) not part of the woodland or natural heritage patch (-), or iii) part of the woodland or natural heritage patch depending on requirements (*).The total area of Huron County is approximately 3415.3 km^2.

Vegetation Group	Woodland	Patch	Total Number of Communities Identified	Area Occupied by Vegetation Group (km^2)	Proportion of Total Area (%)
Coniferous Woodland	X	X	1068	24.8	**0.73**
Deciduous Woodland	X	X	4091	226.5	**6.63**
Mixed Woodland	X	X	2230	76.2	**2.23**
Plantation Young	X	X	568	9.5	**0.28**
Plantation Mature	X	X	584	19.5	**0.57**
Coniferous Swamp	X	X	203	7.3	**0.21**
Deciduous Swamp	X	X	1372	146.1	**4.28**
Mixed Swamp	X	X	630	57.1	**1.67**
Young Plantation Swamp	X	X	30	0.2	**0.00**
Mature Plantation Swamp	X	X	115	1.2	**0.03**
Marsh / Bog / Fen	-	X	228	4.7	**0.14**
Thicket	-	X	665	8.5	**0.25**
Riparian Thicket	-	X	606	10.1	**0.30**
Thicket Swamp	-	X	146	2.5	**0.07**
Meadow	-	X	1270	20.6	**0.60**
Riparian Meadow	-	X	2054	41.9	**1.23**
Marsh Meadow	-	X	211	2.0	**0.06**
Waterbodies	-	*	451	11.1	**0.33**
Major Watercourse	-	X	24	9.8	**0.29**
Minor Watercourse	-	-	-	-	**-**
Hedgerow Connected	-	X	49	0.4	**0.01**
Open	-	*	134	0.9	**0.03**
TOTAL	**9**	**17**	**16729**	**681.0**	**19.94**

* Waterbodies that touch another type of vegetation group are considered part of the patch, and only open features found on shore bluffs, gullies, dunes and valleylands were identified.

2.3.3.1 Rare Species Occurrence
The characteristics of significant habitat of endangered and threatened species include areas that are occupied or habitually occupied by endangered or threatened species during all or any part of their life cycle, and the habitat is necessary for the maintenance, survival and / or recovery of naturally occurring or reintroduced endangered or threatened species (OMNR 2010).

The Natural Heritage Reference Manual (NHRM; OMNR 2010) recognizes species rarity as an ecological function since habitats that contain rare species are more valuable than habitats that do not (see Table 3-4 in the NHRM, OMNR 2010). The NHRM recognizes that rarity is relative and can be recognized in five different ways:

i) species that are scarce but occur over a wide geographical area
ii) species that inhabit only one place
iii) species that are geographically separated from their main range
iv) species that are at the edge of their geographical range
v) declining species that were once more abundant and / or widespread but are now depleted

Certain species are naturally uncommon or have become rare due to human activities. Rare or uncommon species can be indicators of unusual and rare habitats and are often used to guide conservation strategies (Lesica and Allendorf 1995, Lomolino and Channell 1995). Programs exist to identify and classify species by category according to their abundance and the threats to them. The number of these species, and the pace at which species are added to these categories, can be used as an indication of biodiversity loss (OMNR 2010).

Patches that contain observations of species listed under the following categories are considered significant:

- In Canada, endangered, threatened or special concern species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
- In Ontario, endangered, threatened or special concern species listed by the OMNR Committee on the Status of Species at Risk (COSSARO)
- Provincially rare species as identified with an S-Rank of S1, S2, or S3

See section 2.4.2.3.1 details about the Species at Risk (SAR) observations that were included in the model. Chapter 4 contains additional details about rare species in Huron County.

2.3.3.2 Provincially and Locally Designated Wetlands and Life Science ANSIs
The NHRM (OMNR 2010) recognizes that significant areas are typically used as a starting point in natural heritage studies as they provide a logical foundation on which a planning area's natural heritage system can be designed. Life Science Areas of Natural and Scientific Interest (ANSIs) are identified as provincially significant or locally significant by the OMNR using evaluation procedures established by the Province. Both provincially and locally significant wetlands (as evaluated and mapped by the OMNR) are significant in Huron County. Note that at the time of this study not all wetlands in Huron County had been mapped by the OMNR, and not every mapped wetland had been evaluated (see section 2.4.2.2.2).

2.3.3.3 Extra-large patch size
Size is a key landscape-level factor affecting the presence, abundance, and diversity of species (Mazerolle and Villard 1999, Lovett-Doust and Kuntz 2001, Lovett-Doust *et al.* 2003, Bender *et al.* 1998).

The NHRM (OMNR 2010) recognizes that large patches of natural area are more valuable than smaller patches. Extra-large natural areas are the building blocks of natural heritage systems and the larger the area, the better, provided that size is not the only consideration. Extra-large areas should be big and intact enough to be resilient to typical natural disturbances.

The size of an area considered to be extra-large depends on the landscape of the planning area. In a planning area with a low percentage of natural feature cover that is highly fragmented, extra-large areas would be smaller than in a region where natural feature cover is extensive, although some ecological functions are diminished in smaller patches (Sandilands 2010). For example, Burke and Nol (2000) found that reproductive success of forest birds in southern Ontario was consistently higher for patches greater than 94 ha. In Huron County, all patches 100 ha or greater are significant.

2.3.3.4 Riparian watercourse areas

Riparian watercourse areas are lands that include or are adjacent to watercourses or waterbodies. They contain both aquatic and terrestrial habitat features. The relationship of aquatic resources to other natural heritage features should be factored into natural heritage system design to protect areas of hydrological importance (quality and quantity of water). Surface water features should be identified to assist in maintaining linkages and related functions among surface water and other natural heritage features. Given the sensitivity of aquatic habitats and the impacts that they have on the entire river ecosystem, the adjacent terrestrial habitats are extremely important. Vegetation buffers on watercourses can: i) influence aquatic communities, ii) reduce erosion rates and iii) restore corridor functions with little loss of productive farmland.

i) Aquatic communities:

The NHRM (OMNR 2010) recognizes that the relationship between water features and vegetation is interactive. For example, the physical processes operating in and adjacent to the stream channel create and maintain fish habitat in streams. Fish community composition and productivity in streams is partly related to the condition and health of adjacent lands beside the stream. The vegetation along the banks of a drain or natural watercourse provides food (organic input), shade for water temperature regulation, habitat from input of large woody debris, as well as cover in the form of vegetation. Aquatic species tend to have very specific habitat requirements that are easily affected by a change in habitat such as a change in water temperature, pollution, loss of spawning grounds, or absence of a specific food source.

ii) Filtering and erosion control

Riparian vegetation protects water quality by filtering out sediments and excess nutrients, trapping toxins, and reducing soil erosion by retaining water run-off (Bosch and Hewlett 1982, Mooney 1993, Filyk 1993).

iii) Corridor functions

Vegetated buffer strips along streams provide important habitat in their own right. Watercourses and associated riparian areas can provide important linkage functions in a natural heritage system because the land–water interface usually supports a high level of biodiversity that meets the needs of multiple species. Many plants and animals benefit from riparian meadows where the water and the high level of nutrients derived from overland flow create primary centres of bird activity and critical locations for amphibians and reptiles (Harris and Gallagher 1989, Harris 1984). These locations should therefore be protected and enhanced as habitat and as continuous corridors for the movement of wildlife (Wegner and Merriam 1979).

A number of studies have identified various widths of stream-side vegetation buffers, depending on adjacent land use and slope (reviewed in Castelle *et al.* 1994). Some have shown that vegetation strips 15-30 m wide along streams should be adequate to protect the stream from sedimentation, erosion and increased water temperature (Budd *et al.* 1987, Environment Canada 2013), while other sources conclude that if 25% of the land within 100 m of streams was natural, the water quality would be unimpaired regardless of the surrounding landscape (Griffiths 2001, Steedman 1987). Based on over 600 references compiled by REMA Ecological Services LLC (Logan 1999), a buffer of 30 m on both sides of a watercourse is the minimum width required to protect water quality on gentle slopes and 50 m is the minimum required to encourage wildlife movement. Any natural heritage patch within 30 m of a watercourse or a waterbody in Huron County is significant.

2.3.3.5 Diversity of patches

Natural areas (or clusters of areas) that span a range of topography, soil types, and moisture conditions tend to contain a wider variety of plant and animal species, and support a greater diversity of ecological processes. An area with diverse habitat types can contain a broader range of resources (food, shelter, etc.). Similarly, many species use more than one type of habitat to meet their life cycle requirements. Therefore it is important for natural heritage patches to comprise different habitat types.

An effective way of preserving biodiversity using natural heritage planning is to protect a broad range of both rare and common natural features on the landscape (OMNR 2010). Fragmentation is well documented as one of the leading causes of biodiversity decline (Noss *et al.* 2006). In the Natural Environment Update, the diversity of habitats within a patch was measured by the number of vegetation community polygons it contained (Figure 2.9). Patches within the 75th percentile for the number of vegetation communities (15 within one patch) are considered significant.

2.3.3.6 Seepage areas

The NHRM (OMNR 2010) recognizes that areas that make an important contribution to groundwater flows through groundwater release (springs, seepage slopes, and wetlands) should be protected. Both the NHRM (OMNR 2010) and the Significant Wildlife Habitat Technical Guide (OMNR 2000) recognize seeps as significant wildlife habitat. Areas of calcareous groundwater seepage act as umbrella systems which support a diverse variety of isolated, rare, and uncommon species and vegetation community types. These tend to be small occurrences (i.e. not picked up by satellite imagery), but are important in maintaining stream flow and water quality and vital wildlife habitats within watersheds.
Due to the lack of data, seeps were not mapped as part of the Natural Environment Update.

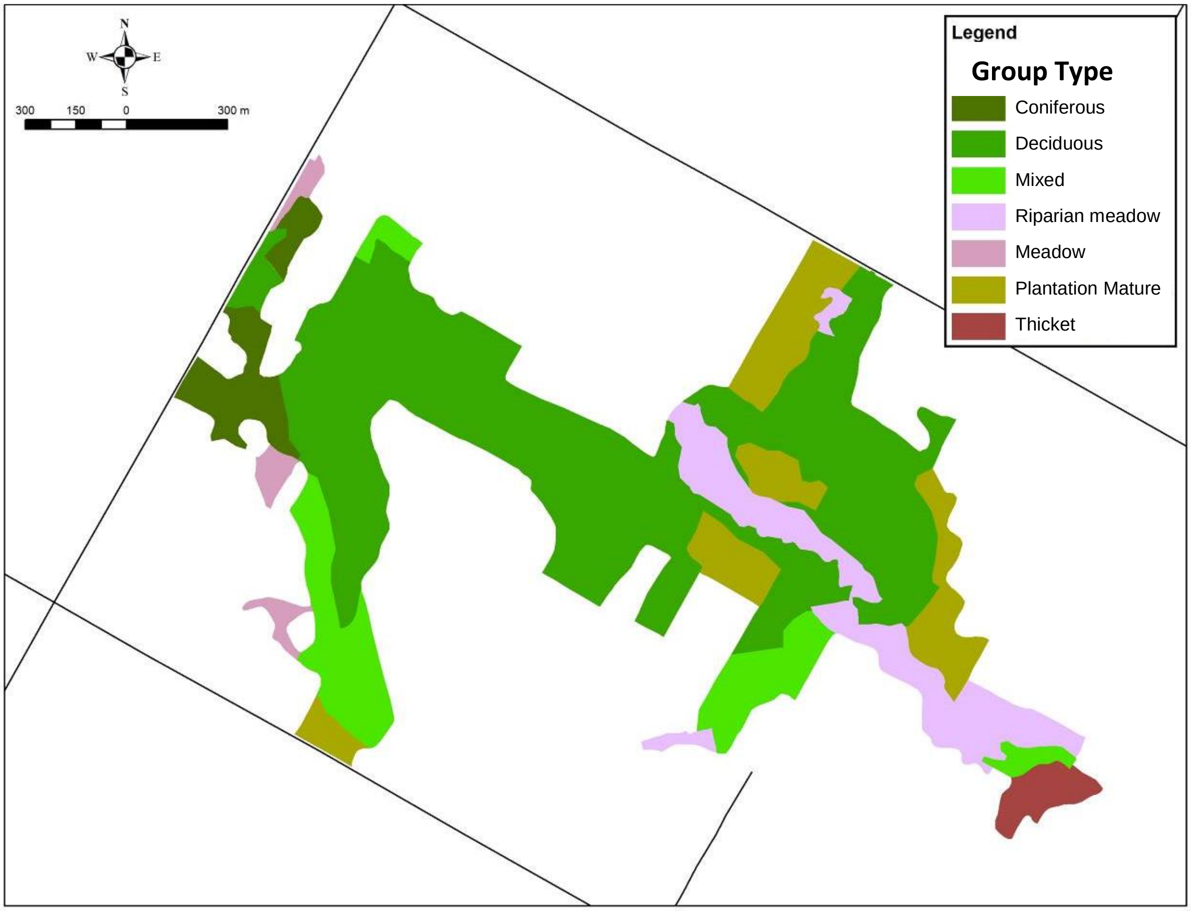

Figure 2.9. Natural heritage patch made up of 20 vegetation community polygons (note: there are 7 different types of vegetation communities in this patch, but the criterion is based on community polygons).

2.4 Mapping Methods

The following describes the methodology used to map natural heritage features in Huron County. The definitions for coastal and hinterland landforms, vegetation communities and groups, and vegetation patches are for mapping purposes and do not describe the biology of the features. For detailed biological definitions of woodlands, wetlands, valleylands, etc., refer to the Natural Heritage Reference Manual (OMNR 2010) and Ecological Land Classification in Southern Ontario (Lee *et al.* 1998).

Once the features were delineated and classified into landforms and vegetation groups, the significance criteria (Figure 2.2) were applied to natural heritage patches using a landscape model. The output of the model included data and a map of natural heritage patches in Huron County that are designated as significant and patches that are considered candidate for designation as significant (see section 2.3.2.1 for description of candidate woodlands, and the results of the model in section 2.5; Appendix A for map).

2.4.1 Landforms

Coastal and hinterland landforms were overlain on the natural heritage patches layer to identify vegetation in these different landform types. Natural heritage patches that are associated with landform features are considered significant.

2.4.1.1 Coastal Landforms

2.4.1.1.1 Littoral Landform

<u>Surf and Sand Bar (Near Shore) Zone</u>

The near shore zone was not mapped, since the 6 m bathymetry contour line is not in a fixed location.

<u>Beaches</u>

Not mapped in this study.

<u>Dunes</u>

The extent of sand dunes in Huron County has been identified in Shoreline Management Plans and updated through the completion of updated mapping and analysis of existing shoreline conditions using the shoreline experience of the ABCA and MVCA, combined with a Digital Elevation Model (DEM) developed from 2007 shoreline mapping.

2.4.1.1.2 Shore Bluff Landform

The shore bluff was identified as the area between the toe of bank to the top of bank using a Digital Elevation Model (DEM) developed from 2006 mapping (Figure 2.10).

2.4.1.1.3 Gully Landform

The horizontal boundaries of gullies were estimated from an approximated 3:1 slope boundary taken from the toe of the gully slope. Elevation data came from either 2007 shoreline mapping, available from the Conservation Authorities, and / or 0.5 m contour Ontario Base Mapping (OBM). The area associated with gullies and with shorelines may overlap (see orange area in Figure 2.10).

Figure 2.10. Example of shore bluff and gully landforms

2.4.1.2 Hinterland Landforms

2.4.1.2.1 Valleylands

Valleylands were identified using components of the Conservation Authority generic regulation limits including the 3:1 slope line and flood limits, where available (Figure 2.11). Valleyland limits were defined using the following mapping rules:

i. Greater than or equal to 100 m in width and a minimum length of 2000 m (i.e. 2 km)
ii. Where valley slope is 3:1 on one side with no slope on the opposite side of the watercourse, use 100 m from centre line of watercourse or floodplain limit to create the opposite valley limit for a continuous valley feature
iii. If there are 3:1 slopes on both sides of the river, but they are not continuous, use the floodplain limit or contour information and professional judgment to delineate a continuous valleyland feature.

In general, valleylands found west of Highway 21 were classified as both gullies and valleylands, while valleylands east of Highway 21 were classified as valleylands. Similar processes affect both gullies and valleylands. It is recognized that this analysis only captures well-defined valleylands, and that it may appear as if the valleys are not contiguous because portions of them are ill-defined where the slope of the valleyland form begins to grade into the surrounding hinterland.

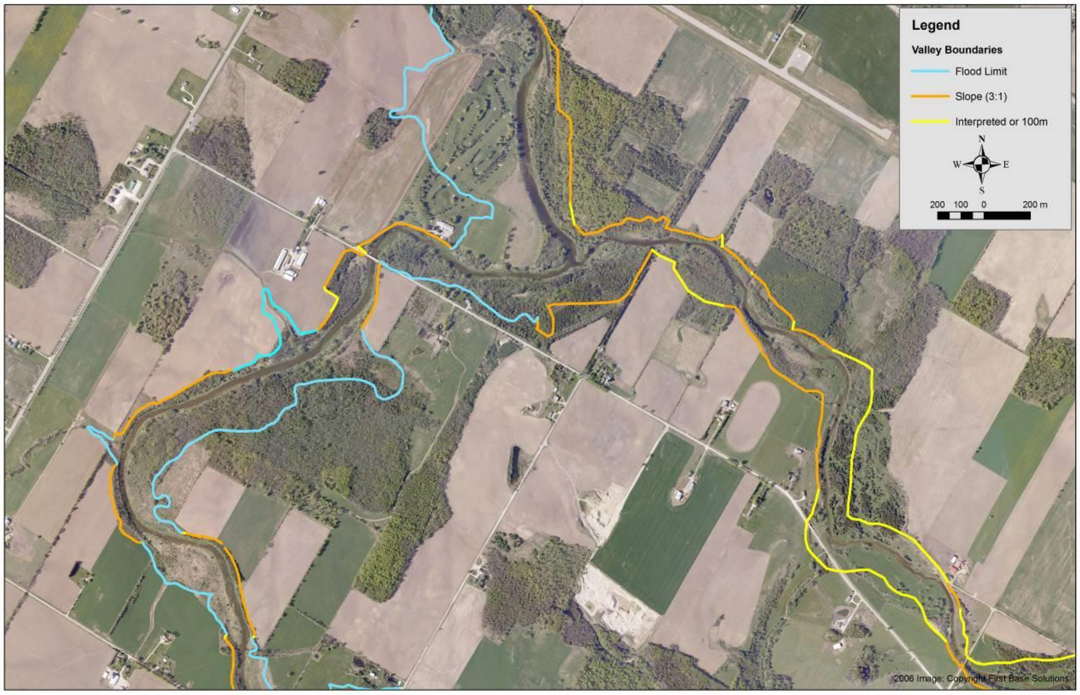

Figure 2.11. Aerial photo showing regulation limits used to define a valleyland boundary.

2.4.1.2.2 Limestone Outcroppings

The limestone cliffs, slopes and pavements were mapped along the Lower Maitland as line segments, representing the vertical 'face' of the outcrop. A 30 m buffer was mapped on either side of the line to identify the minimal area needed to protect these features.

2.4.2 Natural Heritage Features

2.4.2.1 Vegetation Communities

Vegetation communities were mapped and updated following the manual on-screen digitizing procedures outlined in the Southern Ontario Land Resource Information System (SOLRIS) Image Interpretation Manual (OMNR 2004). The 2006 photo imagery was compared to the OMAF Agriculture Resource Inventory. Each individual vegetation community was digitally reviewed and adjusted, creating a single natural heritage layer. Vegetated and non-vegetated features maintained by human disturbance such as agriculture, pasture, aggregate operations, orchards, impervious land uses, etc., were not identified in this project as vegetation community units.

A Minimum Mapping Unit (MMU) of 0.5 ha was the minimum size of the vegetation community delineated from a 1:2,000 scale aerial photo. This is sufficient for an MMU at the scale of the County. Very high-resolution imagery typically provides far more detail than can be efficiently used for landscape mapping. Land use/land cover classifications commonly use an MMU of 0.5 to 1 ha for large scale maps and much larger MMU sizes, such as 10 to 100 ha, for very small-scale land cover maps.

2.4.2.2 Vegetation Groups

Once all the vegetation community boundaries were updated or created, each vegetation community was then attributed to a vegetation group. Vegetation groups organize the vegetation communities into broader groups based on similar ecological patterns and processes (Table 2.4 to Table 2.12). Adjacent vegetation communities in the same vegetation group were combined if they are within 20 m of each other and are not separated by permanent structures (see Table 7-2 in the Natural Heritage Reference Manual, OMNR 2010). The Natural Heritage Resource Manual states that woodland areas are considered to be generally continuous even if intersected by narrow gaps 20 m or less in width between crown edges. In the Natural Environment Update, roads did not separate vegetation communities, except when woodland interior was calculated. The area of the developed opening (e.g. a maintained public road or rail line) was not included in the woodland area calculation.

2.4.2.2.1 Woodland Vegetation Groups

Table 2.4. A summary of how the woodland vegetation group was identified and attributed.

Community	Description
Coniferous Woodland	- Vegetation community comprising cone-bearing trees. - Dark red or green tones in IRS imagery.
Deciduous Woodland	- Vegetation community comprising trees that lose their leaves at the end of the growing season. - Individual deciduous trees have a billowy texture on air photography. If image is taken when trees are not in leaf, individual trees have a translucent appearance such that tree trunks can be seen through the canopy. - Bright red tones in IRS imagery.
Mixed Woodland	- Vegetation community comprising a combination of coniferous and deciduous trees scattered throughout patch where each plant type comprises greater than 25% but less than 75% of the canopy. - Bright red (deciduous) and green (coniferous) tones in IRS imagery.
Plantation Young	- Vegetation community comprising coniferous or deciduous trees. - Individual tree or rows of trees discernible at a scale of 1:2,000. - Dark red or green tones in IRS imagery.
Plantation Mature	- Vegetation community comprised of coniferous or deciduous trees. - Area is distinguishable by shape or location. - Individual tree or rows of trees not clearly discernable at a scale of 1:2,000. - Bright red (deciduous) and green (coniferous) tones in IRS imagery.

2.4.2.2.2 Wetland Vegetation Groups

Three sources of wetland data were used to assist in delineating the wetland vegetation community feature layer:

<u>Ontario Ministry of Natural Resources and Forestry (OMNRF) Mapped Wetlands</u>
The OMNRF delineates wetlands in GIS, and provides Conservation Authorities with mapping that includes both ‘evaluated’ and ‘unevaluated’ wetlands. The OMNRF evaluates the significance of wetlands based on the Southern Ontario Wetland Evaluation Manual (OMNR 2013), and determines whether or not a wetland is provincially significant. Local significance is determined by municipalities. Some wetlands have been mapped but have not been evaluated (considered ‘unevaluated’). Often, the perimeter of the OMNRF-mapped wetland does not match the natural heritage feature boundary based on ortho-imagery. For the wetland vegetation community feature layer, boundaries of the wetland were adjusted to the ortho-image. However, for policy decisions the designated wetland boundary should be used.

Maitland Valley Conservation Authority (CA) Wetlands (not mapped by the OMNRF)

The Maitland Valley CA began identifying wetlands in the early 1980's in an attempt to locate and improve the accuracy of wetlands that were not accounted for in the mapping. These wetland areas have been progressively updated using the following procedure:

i) Wetland information from the OMNRF layer and from historical hard copy maps (i.e. water / land resource hardcopy maps) were digitized and used to indicate possible locations of wetlands on the 2006 aerial imagery.
ii) Verification to see if the wetlands still exist in those particular areas was conducted through air photo interpretation, current drainage patterns, site visits and soil analysis.

Ausable Bayfield Conservation Authority (CA) Wetlands (not mapped by the OMNRF)

The Ausable Bayfield CA developed a methodology for progressively updating their regulated wetland layer in 2006. Regulated wetlands include:

i) Permanent wetland features identified by adjusting the Natural Resource Value Information System (NRVIS) water polygon layer using 1999 aerial spring photography and the following criteria:
    a. Area > 0.5 ha
    b. Area not an irrigation pond, sewage lagoon, or cultivated field.
ii) ABCA digitized wetland layer based on the existing ABCA Environmentally Significant Areas (ESAs) digital layer (ABCA 1994), and adjusted according to boundaries drawn on 1978 air photos from site visits, photo interpretation of 1999 aerial photography, soil mapping (Experimental Farm Service 1952), and 1 m contours from a Triangulated Irregular Network (TIN) layer.
iii) Other wetland mapping including:
    a. Vector marsh dataset created by First Base Solutions (2007) from 10 cm shoreline imagery flown in 2007.
    b. Updated mapping in the Bayfield North ANSI in 2011 based on field verification and Jalava (2004).
    c. Marshes identified in the Ontario Base Map series (OMNR 1986).

The process to update the wetland mapping by the CA's was done to consolidate information and better represent natural features in the watersheds.

Table 2.5. A summary of how the wooded wetland vegetation group was defined and attributed. Wooded wetlands are at least 30 m wide and contained greater than 20% standing water. The presence of moisture is indicated by darker tones in ortho-imagery.

Community	Description
Coniferous Swamp	A coniferous vegetation community with more open canopy (indicating lower tree vigor) located in an identified wetland area (OMNRF or CA defined). Dark red or green tones in IRS imagery.
Deciduous Swamp	A deciduous vegetation community with more open canopy (indicating lower tree vigor) located in an identified wetland area (OMNRF or CA defined). Bright red tones in IRS imagery.
Mixed Swamp	A mixed vegetation community located in an identified wetland area (OMNRF or CA defined). Bright red (deciduous) and green (coniferous) tones in IRS imagery.
Young Plantation Swamp	A young plantation vegetation community located in an identified wetland area (OMNRF or CA defined). Dark red or green tones in IRS imagery.
Mature Plantation Swamp	A mature plantation vegetation community located in an identified wetland area (OMNRF or CA defined). Bright red (deciduous) and green (coniferous) tones in IRS imagery.
Thicket Swamp	A thicket vegetation community located in an identified wetland area where greater than 25% of the canopy comprises woody plants < 6 m, and less than 10% of the canopy comprises woody plants that are capable of reaching heights ≥ 6 m. Casts short shadows on IRS imagery.

Table 2.6. A summary of how the non-wooded wetland vegetation group was defined and attributed.

Community	Description
Marsh	- Vegetation community at least 30 m wide located in an identified wetland area where there is less than 25% tree and shrub cover (OMNRF or CA defined). - Appears dark and granular, sometimes with a spotty texture (e.g. a cattail stand), in IRS imagery.
Bogs	- Not distinguishable from marshes in IRG imagery. - ELC (Lee 2008) defines bogs (in part) as a wetland areas where there is ≤ 25% tree cover, trees are less than 2 m in height, is rarely flooded and always saturated.
Fens	- Not distinguishable from marshes in IRG imagery. - ELC (Lee 2008) defines fens (in part) as a wetland area where there is ≤ 25% tree cover, and sedges, grasses and low shrubs (< 2 m) dominate.

2.4.2.2.3 Thicket Vegetation Groups

Table 2.7. A summary of how the thicket vegetation group was defined and attributed.

Community	Description
Thicket	- Vegetation community at least 30 m wide where greater than 25% of the canopy comprises woody plants that are not capable of reaching heights of ≥ 6 m and less than 10% of the canopy comprises woody plants that are capable of reaching heights ≥ 6 m. - Casts short shadows on IRS imagery.
Riparian Thicket	- A thicket adjacent to a watercourse. - Casts short shadows on IRS imagery.

2.4.2.2.4 Meadow Vegetation Groups

Table 2.8. A summary of how the meadow vegetation group was defined and attributed.

Community	Description
Meadow	- Open vegetation community at least 20 m wide, where less than 10% of the canopy is comprised of woody plants. - Appears granular with some texture and of uniform height on IRS imagery.
Riparian Meadow	- A meadow adjacent to a watercourse. - Appears granular with some texture and of uniform height on IRS imagery.

2.4.2.2.5 Waterbody Group

This group includes the following types of waterbodies:

- pond associated with a construction or extraction area (e.g. aggregate pit)
- reservoir created by a dam or barrier (e.g. flood control and old mill dams such as those found in Exeter, Brussels, and Gorrie)
- man-made pond
- natural pond within a wetland or as part of a natural water feature such as a kettle lake
- sewage lagoon found in or on the outskirts of an urban area

Table 2.9. A summary of how the waterbody vegetation group was defined and attributed.

Community	Description
Waterbodies	- A body of standing water at least 20 m wide, and associated with a vegetation community. - May be a flat plain surface or show patterns of wind disturbance or reflect clouds and appears black, blue, grey or different shades of brown on IRS imagery. - Aerial photography is taken in the spring when floating vegetation is not present. Other imagery may show floating aquatic vegetation.

2.4.2.2.6 Watercourse Group

Major watercourses (equal to or greater than 20 m wide) were mapped as a polygon where the bankful width of the watercourse was delineated from aerial photography flown in the spring. The widths of major tributaries can vary from 15 m to 40 m or more, depending on the season (note that an upper limit was not established for mapping purposes). To delineate the outer boundary of minor tributaries (less than 20 m wide), 10 m was added to either side of the centre line for permanent watercourses, and 3 m was added to either side of the centre line for intermittent watercourses. The dimensions provided are for mapping purposes only and do not constitute buffer dimensions of the features.

Table 2.10. A summary of how the watercourse group was defined and attributed.

Community	Description
Major Watercourse	- A linear feature equal to or greater than 20 m wide. - Appears black, blue, grey or different shades of brown on IRS imagery.
Minor Watercourse	- A linear feature less than 20 m wide. - Appears black, blue, grey or different shades of brown on IRS imagery.

2.4.2.2.7 Hedgerow Connected Vegetation Group

Hedgerows were mapped if they are less than 750 m in length (OMNR 2013), between 20 and 30 m in width, and connected two or more natural heritage features. Only treed hedgerows were mapped.

Table 2.11. A summary of how the hedgerow connected vegetation group was defined and attributed.

Community	Description
Hedgerow Connected	- A linear feature comprised of woody plants that connects two or more natural heritage features, is less than 750 m in length, and between 20 and 30 m wide. - Individual tree or rows of trees and shrubs discernible at a scale of 1:2,000. - Dark red or green tones on IRS imagery.

2.4.2.2.8 Open Group

Some areas are exposed to continuous or severe natural disturbance processes that prevent vegetation from becoming established, such as areas along steep valley slopes exposed to rapid undercutting and erosion, as well as along coastal areas of Huron County where there is wave action. Only open features found on shore bluffs, gullies, dunes and valleylands were identified.

Table 2.12. A summary of how the unvegetated group was defined and attributed.

Community	Description
Open	- An area of bare soil at least 20 m wide that is not being actively cultivated and where there is no evidence of vegetation or water. - Smooth textured and light brown tone on IRS imagery.

2.4.2.2.9 Other Group

These are areas that do not have a natural component (e.g. residential development), or are features that are maintained by human disturbance (e.g. agriculture) and are located on valleylands.

2.4.2.3 Natural Heritage Patches

Natural heritage patches cover approximately 20% of the land base in Huron County. A natural heritage patch, as defined in this study, is a mosaic of one to many different abutting vegetation groups (Figure 2.12). The perimeter of the natural heritage patch was the outside boundary of all contiguous vegetation groups (Figure 2.12). Note that not all identified vegetation communities are part of the patch layer (Table 2.3).

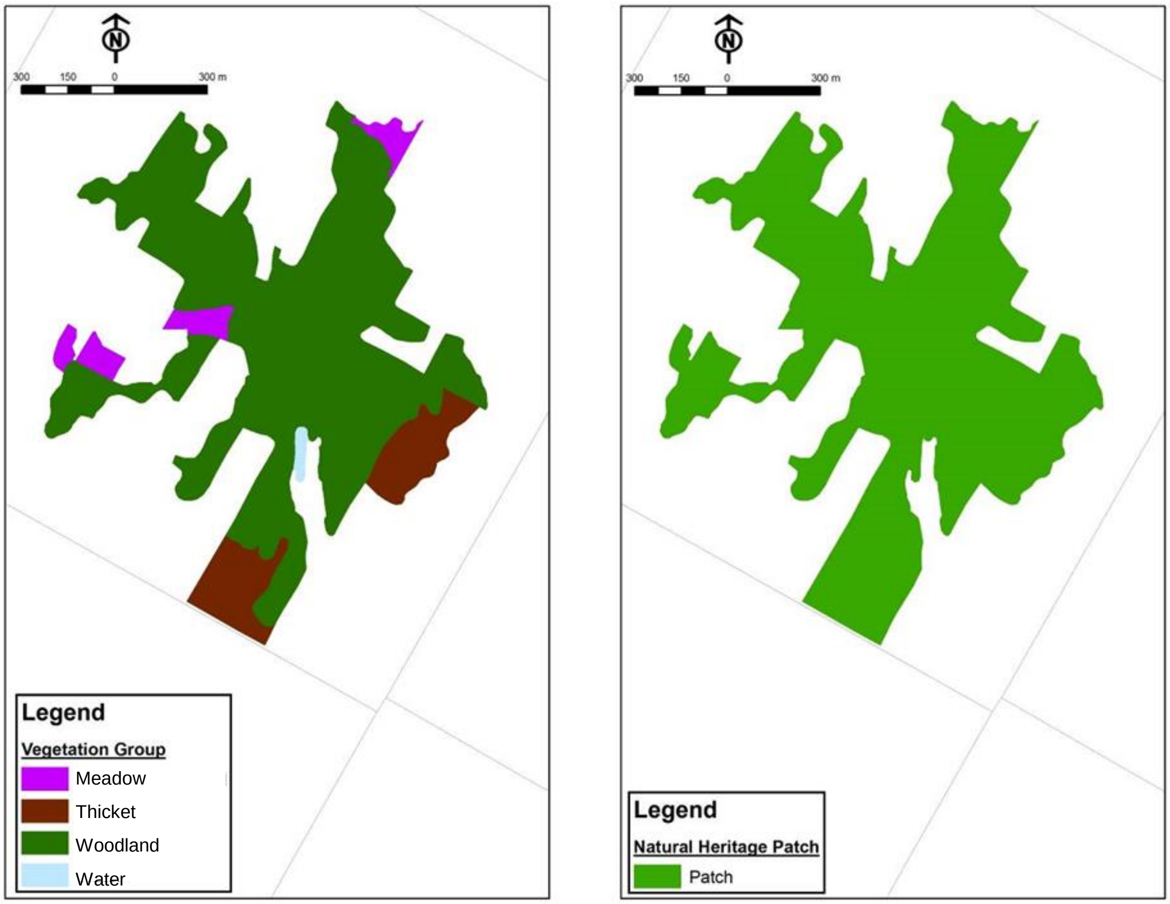

Figure 2.12 The perimeter of the natural heritage patch was the outside boundary of all contiguous vegetation communities (which in this figure are colour-coded to their respective vegetation groups).

2.4.2.3.1 Rare Species Occurrence

Species at Risk (SAR) occurrence records in Huron County were retrieved from the Natural Heritage Information Centre (NHIC). The observations were mapped in ArcGIS, and if a patch contained an observation of SAR it is considered significant. Note the following:

- The element occurrence records of federally and provincially rare species were used to identify significant natural heritage patches.
- Historic records prior to 1980 were not included in the model. Older records were assigned larger buffers because technology did not allow for precise observation locations to be reported. Therefore, to eliminate records prior to 1980, element occurrence polygons that have a buffer 1 km or greater were not included in this analysis.

- Bird SAR data were not included in this analysis. The occurrence of bird species does not reliably indicate the location of that species' critical habitat. Occurrence data of bird species at the time of the study was considered incomplete.
- Aquatic SAR (fish and mussels) data were not included in this analysis. All watercourses are considered part of the natural heritage system (Appendix B).
- The delineated habitat of endangered and threatened species is considered sensitive information and therefore the exact locations will not be identified in municipal or other publicly available planning documents.

2.4.2.3.2 Provincially and Locally Designated Wetlands and Life Science ANSIs
Areas that were identified as representing significant wetland ecosystems in Huron County include:
- Provincially and locally significant wetlands
- All coastal wetlands (i.e. wetlands found within near shore, shore bluff and gullies)
- Provincially designated Life Science Areas of Natural and Scientific Interest (ANSI)

2.4.2.3.3 Extra Large Patch Size
All patches 100 ha in size or greater. Extra-large patches were identified based on the delineation of vegetation groups and the analysis of patches (section 2.4.2.2).

2.4.2.3.4 Riparian Watercourse Areas
In Huron County, watercourse polygons were delineated as follows:
- For major watercourses, ≥ 20 m wide, the bankful width of the watercourse was delineated from aerial photography flown in the spring.
- For minor permanent watercourses, less than 20 m wide, the outer boundary of the watercourse was set at 10 m on either side of the centerline.
- For intermittent watercourses, less than 20 m wide, the outer boundary of the watercourse was set at 3 m on either side of the centerline.

Once the outer boundaries of the watercourse and waterbody polygons were identified, an additional 30 m on either side of the boundary was delineated to determine riparian buffers.

2.4.2.3.5 Diversity of patches
All natural heritage patches in Huron County that comprise 15 or more vegetation community polygons are significant under this criterion.

2.5 Results

The results of the Huron Natural Systems Study show that natural heritage features cover approximately 20% of the land base in Huron County (see Appendix A for map). A landscape model was used to apply significance criteria to all natural heritage patches in Huron County. The results of the model are discussed in the following sections.

2.5.1 Significance Criteria

Total Number of Patches Meeting Significance Criteria

A total of 2722 patches were designated significant, since they met at least one criterion (Figure 2.13). Patches that met no significance criteria are candidate patches. More than 21% of natural heritage patches (730) do not meet any criteria of significance and are considered candidate patches. The 730 candidate patches cover 13.0 km^2, which corresponds to 0.4% of Huron County's total land cover (Appendix A).

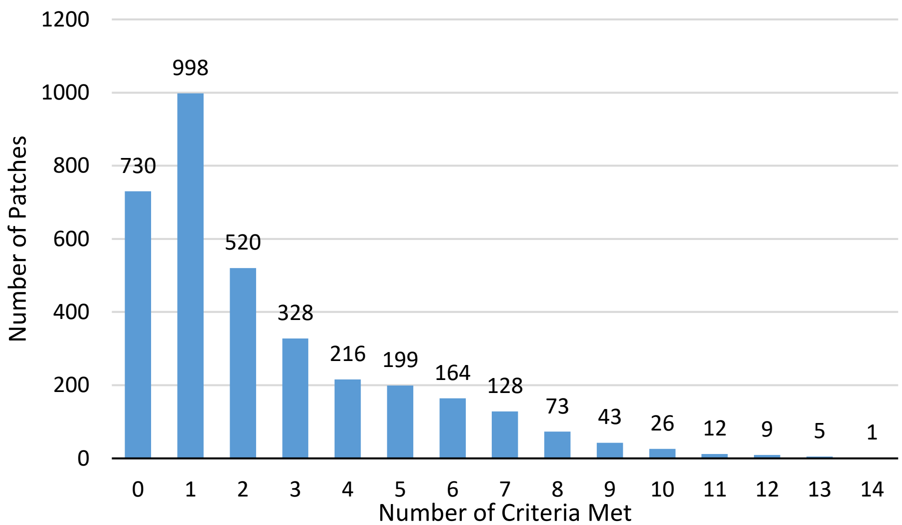

Figure 2.13 Number of patches that met between 0 and 14 significance criteria. No patch met more than 14 criteria.

2.5.1.1 Landforms Significance Criteria

The following table (Table 2.13) contains a summary of results based on the application of the significance criteria for landforms in Huron County. The numbers of natural heritage patches that are directly adjacent to (touching), or within 100 m of a landform are significant. Note that a patch may contain more than one landform.

Table 2.13. Summary of results for landform significance criteria, and area occupied by landforms in Huron County.

Landform	Number of significant natural heritage patches associated with landform (both vegetated and non-vegetated)	Area covered by landform (km^2)	Area of Huron County occupied by landform (%)
Dunes		0.89 km^2	0.03
Shore Bluffs	43 patches touched a shore bluff 19 patches within 100 m of a shore bluff	3.37 km^2	0.10
Gully	40 patches touched a gully 37 patches within 100 m of a gully	8.30 km^2	0.25
Valleyland	181 patches touched a valleyland 71 patches within 100 m of a valleyland	111.51 km^2	3.26
Limestone outcropping		0.77 km^2	0.02
TOTAL		116.54 km^2	3.40

The most common and abundant landform in Huron County are valleylands. The least common landform are limestone outcroppings.

2.5.1.2 Vegetation Groups Significance Criteria

Approximately 16.6% of the land base in Huron County is covered in woodlands (Figure 2.14). Deciduous woodlands are the most common (i.e. 6.6% deciduous woodlands and 4.3% deciduous wetland in Huron County; Table 2.3). Approximately 6.5% of the land base in Huron County is covered in wetlands. This cover is comprised primarily of wooded wetlands (5.8% of the land base). The remaining land base is comprised of thickets (0.49%), meadows (1.8%), water features (0.54%), hedgerows (0.01%), and open areas (0.03%). See also Figure 2.15.

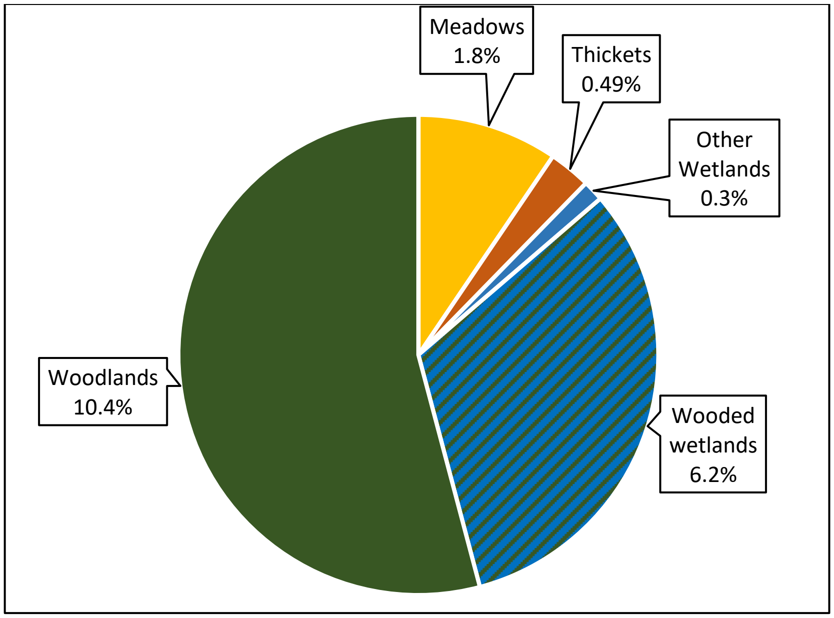

Figure 2.14. Area occupied by the woodland, wetland, thicket, and meadow vegetation groups (approximately 658.8 km^2 total) as a percentage of total area in Huron County (3415.3 km^2). Note that some vegetation groups (water features, hedgerows, and open areas) are not included.

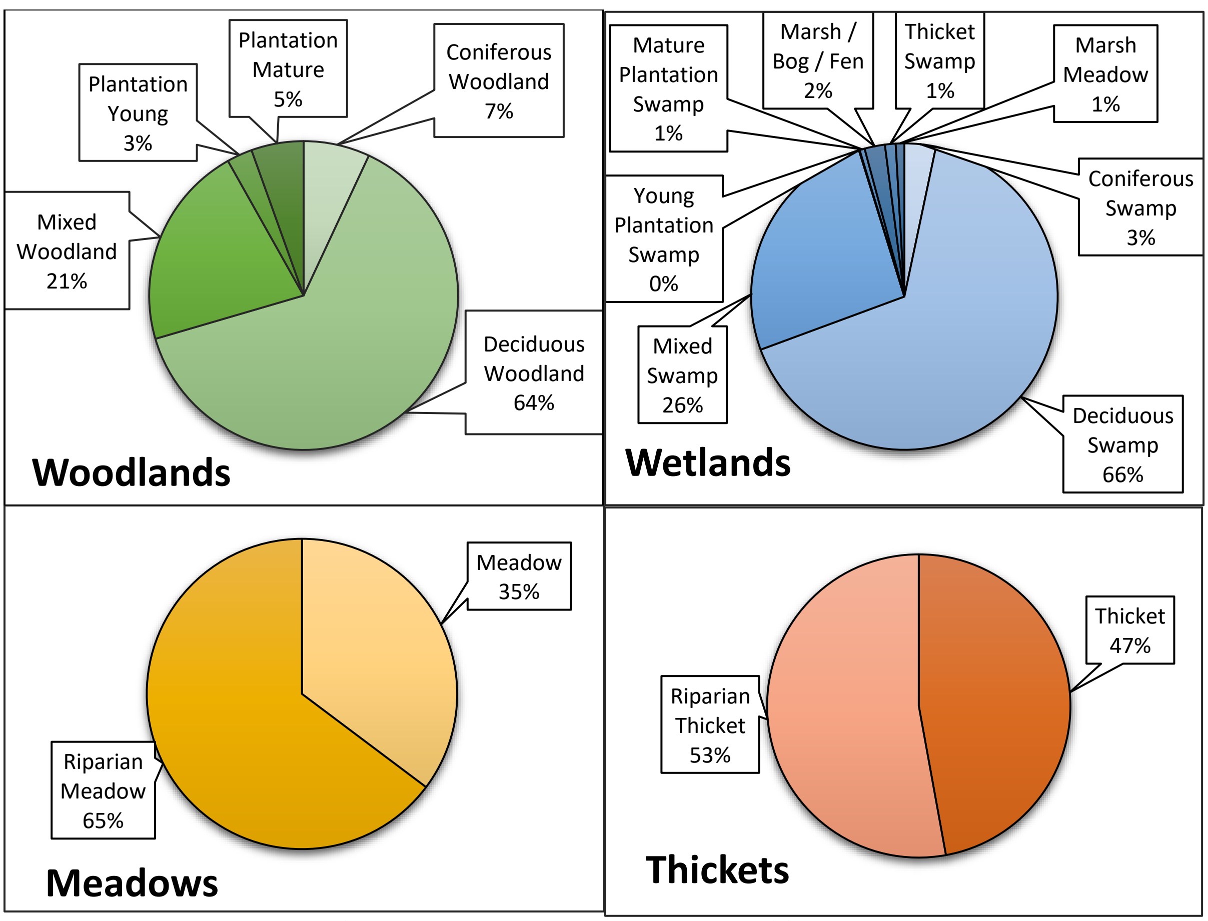

Figure 2.15. The composition of vegetation communities within each of four vegetation groups: woodlands, wetlands (including wooded wetlands), thickets, and meadows.

The following tables (Table 2.14 - Table 2.17) contain summaries of results based on the application of the significance criteria for vegetation groups in Huron County: woodlands, wetlands, thickets, and meadows, as part of the patches. Applying the large woodland size criteria resulted in the greatest number of significant patches, which combined covered the greatest area of all vegetation group significance criteria. Over 43% of the patches contain a woodland that is greater than 4 ha in size.

Table 2.14. Summary of results based on the application of significance criteria for woodlands in Huron County.

Woodland Criteria	Description/Justification	Number of Patches (% of total patches that met the criteria)	Area of Huron County covered by patches that contain the significant feature (%)
Large Size – Patch contained a large woodland.	Patch contained a woodland that was 4 ha or greater.	1499 patches (43.4)	18.7
Interior – Patch contained an interior woodland vegetation community.	Patch contained at least one woodland with interior area (at least 0.5 ha in size). Interior was defined as the area > 100 m from the woodland edge. Note: interior area was not calculated by adding up very small pieces.	709 patches (20.5)	16.1
Proximity – Patch contained a woodland that is near to another woodland > 4 ha	Patch contained a woodland vegetation community that was within 100 m of another woodland community equal to or greater than 4 ha.	1249 patches (36.2)	15.4

Table 2.15. Summary of results based on the application of significance criteria for wetlands in Huron County.

Wetland Criteria	Description/Justification	Number of Patches (% of total patches that met the criteria)	Area of Huron County covered by patches that contain the significant feature (%)
Large Size – Patch contained a large wetland.	Patches that contained either: - A 4 ha wooded wetland - A 10 ha wetland meadow or marsh - A 2.5 ha thicket swamp	648 patches (18.8)	14.1
Proximity – Patch contained a wetland that was near to another wetland.	Wetlands rely on supporting habitat within 1000 m.	910 patches (26.4)	14.7

Table 2.16. Summary of results based on the application of significance criteria for thickets in Huron County.

Thicket Criteria	Description/Justification	Number of Patches (% of total patches that met the criteria)	Area of Huron County covered by patches that contain the significant feature (%)
Large Size – Patch contained a large thicket community.	Patches that contained a thicket community > 2.5 ha.	158 patches (4.6)	6.8
Interior – Patch contained a thicket vegetation community with interior habitat.	Patch must have thicket interior area that is 0.5 ha or greater in size to be significant. Interior was defined as > 30 m from thicket community's edge. Note: interior is not calculated by adding up very small pieces.	132 patches (3.8)	6.2

Table 2.17. Summary of results based on the application of significance criteria for meadows in Huron County.

Meadow Criteria	Description/Justification	Number of Patches (% of total patches that met the criteria)	Area of Huron County covered by patches that contain the significant feature (%)
Large Size – Patch contained a large meadow community	Patches that contained a meadow > 10 ha.	40 patches (1.2)	4.6

According to these results, it is relatively rare to find meadows greater than 10 ha in Huron County, in comparison of large patches of other vegetation types.

2.5.1.3 Natural Heritage Patches Significance Criteria

The following table (Table 2.18) contains a summary of results based on the application of the significance criteria for natural heritage patches in Huron County. Over half of the natural features in Huron County are located within 30 m of a watercourse. Approximately 1% of the patches are greater than 100 ha in size. Approximately 5% of the patches contain more than 15 vegetation community polygons.

One hundred and thirty-two patches are significant for containing an observation of a Species at Risk (SAR). Out of 132, only 7 patches are significant for the SAR significance criteria alone. All other patches met at least two criteria for significance.

Table 2.18. A summary of results based on the application of significance criteria for natural heritage patches.

Patch Criteria	Description/Justification	Number of Patches (% of total patches that met the criteria)	Area of Huron County covered by patches that contain the significant feature (%)
Patch within 100 m from landform feature	Patches are located within 100 m from the top of slope of: - Gullies - Shore bluffs - Valleylands	309 patches (9.0)	6.4
Patch contained a Species at Risk (IUCN, COSEWIC, COSSARO)	A record of a Species At Risk was located within the patch (excludes records of bird and aquatic species).	126 patches (3.7)	7.2
Patch contained a Provincially or Locally Designated Area	Patch contained at least part of an OMNRF-mapped wetland, life science ANSI or coastal wetland.	509 patches (14.7)	11.3
Patch was X-Large Size	Patch was greater than 100 ha	34 patches (1.0)	6.5
Patch was located adjacent to a watercourse or waterbody	Patch located within 30 m of a watercourse or waterbody.	1815 patches (52.6)	17.8
Patch had high biodiversity	Patch contained 15 or more vegetation community polygons	173 patches (5.0)	9.9
Patch contained seeps	Seeps to be mapped when identified	Not Available	Not Available

2.6 Summary

The Natural Heritage Systems Study (NHSS) was completed to define the natural heritage system in Huron County. The NHSS identified significant natural heritage features based on a set of significance criteria supported by current science. The landscape model in the NHSS incorporated the inter-relatedness of different types of natural features (woodlands, wetlands, valleylands, etc.) as part of the natural heritage system, which also includes linkage features such as landforms, watercourses, and hedgerows. All natural heritage patches should be maintained, restored, or enhanced. The model identified the vast majority (98%) of natural areas in Huron County as significant. The remaining 2%, which includes many small candidate patches that cover 0.4% of the County's land base, are also important components of the natural heritage system. Candidate patches are patches that did not meet any criteria for significance and require further on-the-ground field study to verify significance with respect to significant wildlife habitat, habitat for Species at Risk, and other criteria that are difficult to assess at a landscape scale. The large number of small candidate patches is an indicator that the landscape is highly fragmented. Connections between natural features should be enhanced where possible.

Provincial policy requires natural heritage systems to be protected for the long term. The NHSS can be used to inform the planning policies at various municipal levels in Huron County to ensure they are consistent with provincial direction. Even with the immense amount of research that has gone into developing the criteria for the model there is room to improve the NHSS in the future as new information becomes available, such as incorporating more comprehensive criteria for aquatic features. Chapter 5 contains a list of recommendations that addresses how the results of the NHSS can be incorporated into future planning to ensure the long-term protection of natural areas in Huron County.

2.7 References

Askins, R.A. 2000. Restoring North America's Birds: Lessons from Landscape Ecology. Yale University Press, new haven, CT. 320 pp.

Askins, R.A., and M.J. Philbrick. 1987. Effects of changes in regional forest abundance on the decline and recovery of a forest bird community. Wilson Bulletin 99: 7-21.

Ausable Bayfield Conservation Authority (ABCA). 1994. Environmentally Significant Areas. Appendix to: Environmentally Significant Areas Watershed Plan Report #2 (1984).

Baguette, M., and H. Van Dyck. 2007. Landscape connectivity and animal behaviour: functional grain as a key determinant for dispersal. Landscape Ecology 22: 1117 – 1129.

Banaszak, J. 1996. Ecological bases of conservation of wild bees. Pages 55–62 in A. Matheson, S. Buchamann, C. O'Toole, P. Westrich, and I. Williams, editors. The conservation of bees. Academic Press, London, UK.

Bender, D.J., T.A. Contreras and L. Fahrig. 1998. Habitat loss and population decline: a meta-analysis of the patch size effect. Ecology 79(2): 517-533.

Bennett, A.F. 2003. Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland and Cambridge, UK. xiv + 254 pp.

Bosch, J. and M. Hewlett. 1982. A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. Journal of Hydrology **55**: 3-23.

Bowles, J.M. 1993. Ecological model of the Lake Huron shoreline terrestrial ecosystems. Maitland Valley Conservation Authority. 74pp.

Bowles, J. 1997. Oxford County Terrestrial Ecosystems Study: Life Sciences Report. Upper Thames River Conservation Authority, London, Ontario.

Bowles, J.M., T.D. Schwan, D. Kenny, N. Gaetz, and R. Steele. 2000. Maitland Valley Conservation Authority Forest Resource Assessment. 70pp. + maps

Budd, W.W., P.L. Cohen, P.R. Saunders, and F.R. Steiner. 1987. Stream corridor management in the Pacific Northwest: determination of stream corridor widths. Environmental Management 11(5): 587-597.
Burgess, R.L., and D.M. Sharpe. (eds.). 1981. Forest Island Dynamics in Man-Dominated Landscapes. Springer-Verlag, New York, New York.
Burke, D.M. and E. Nol. 2000. Landscape and Fragment Size Effects on Reproductive Success of Forest-breeding Birds in Ontario. Ecological Applications **10**:1749-1761.
Cane, J. H. 2001. Habitat fragmentation and native bees: a premature verdict? Conservation Ecology 5: 3.
Carter, N. 2000. Predicting internal conservation value of woodlots in south western Ontario using landscape features. 4th year honours thesis. Department of Plant Sciences. University of Western Ontario. 41pp. + Appendices.
Castelle, A.J., A.W. Johnson, and C. Conolly. 1994. Wetland and stream buffer size requirements – a review. Journal of Environmental Quality 23: 878 – 882.
Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario. 3rd ed. Ontario Geological Survey. 270p.
Chen, J., J.F. Franklin and T.A. Spies. 1995. Growing Season Microclimate Gradients from Clear cut Edges into Old-growth Douglas-Fir Forests. Ecological Applications **5**:74-86.
Copeland. 2011. Nature Conservancy of Canada. Unpublished data.
Corace, R.G. III, P.C. Goebel, and T.C. Wyse. 2009. A multi-scale assessment and evaluation of historic open lands at Sleeping Bear Dunes National Lakeshore. Vol. Natural Resource Technical Report NPS/GLKN/NRTR?2009/150 Fort Collins, CO: National Park Service.
County of Frontenac. 2012. Natural Heritage Study Final Report. County of Frontenac. 70 p.
Curtis, J.T. 1959. The Vegetation of Wisconsin. University of Wisconsin Press, Madison, Wisconsin.
Donaldson, J., I. Nanni, C. Zachariades, J. Kemper and J. D. Thompson. 2002. Effects of habitat fragmentation on pollinator diversity and plant reproductive success in renosterveld shrublands of South Africa. Conservation Biology 16:1267–1276.
Ducks Unlimited Canada. 2010. Southern Ontario Wetland Conversion Analysis – Final Report. 23pp. + Appendices.
Environment Canada. 2013. How Much Habitat Is Enough? 3rd ed. Environment Canada, Toronto, Ontario. 127 pp. ISBN 978-1-100-21921-9.
Etmanski, A., and R. Schroth. 1980. An inventory of gully erosion problems along the Lake Huron shoreline. Maitland Valley Conservation Authority. 77pp.
Experimental Farm Service. 1952. Soil map of Huron County, Ontario. Soil Survey Report No. 13. Compiled, drawn, and published by the Experimental Farm Service from base maps supplied by the Department of Mines and Technical Surveys, Ottawa.
Filyk, G. 1993. Agricultural Stewardship. In: Marczyk, J.S., and D.B. Johnson (eds.). 1993. Sustainable Landscapes. Proceedings of the Third symposium of the Canadian Society for Landscape Ecology and Management. Polyscience Publications, Morin Heights, Canada. Pp. 37 - 43.
First Base Solutions. 2007. Selected Vector Compilation - Ausable Bayfield Conservation Authority (ABCA). Markham, Ontario.
Fitzgibbon, C.D. 1997. Small mammals in farm woodlands: the effects of habitat, isolation and surrounding land-use. Journal of Applied Ecology 34: 530-539.
Forman, R.T.T. 1995. Some general Principles of Landscape and Regional Ecology. Landscape Ecology 10(3): 2-9.
Forman, R.T.T., and M. Godron. 1986. Landscape Ecology. John Wiley & Sons, New York.
Friesen, L.E., Wyatt, V.E. and M.D. Cadman. 1999. Pairing success of wood thrushes in a fragmented agricultural landscape. Wilson-Bulletin 11(2): 279-281.
Gillingwater, S. D. 2011. Recovery Strategy for the Queen snake (*Regina septemvittata*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 34 pp.
Golet, F.C. 1976. Wildlife Wetland Evaluation Model. In: Models for the Evaluation of Freshwater Wetlands. J.S. Larson (ed.). Water Resources Research Centre, University of Massachusetts. Pp. 13 – 34.
Gotmark, F. and M. Thorell. 2003. Size of nature reserves: densities of large trees and dead wood indicate high value of small conservation forests in southern Sweden. Biodiversity and Conservation 12: 1271-1285.
Grand River Conservation Area (GRCA). 2006. GRCA Lake Erie Shoreline Protection Policy. 5 pps.

Griffiths, R.W. 2001. Mapping the water quality of watercourses in the Region of Halton. Planning and Public Works, Regional Municipality of Halton.
Hamill, S. 2001. Biodiversity Indicators for Woodland Owners. Prepared for Canadian Biodiversity Institute and eastern Ontario Model Forest. 23pp.
Harris, L.D. 1984. The Fragmented Forest: Island Biogeography Theory and the Preservation of Biotic Diversity. University of Chicago Press, Chicago, Illinois.
Harris, L.D., and P.B. Gallagher. 1989. New initiatives for wildlife conservation: the need for movement corridors. In: Defense of Wildlife. Preserving Communities and Corridors. Washington, D.C. Defenders of Wildlife.
Henson, B.L., D.T. Kraus, M.J. McMurtry and N.N. Ewert. 2010. Islands of Life: A Biodiversity and Conservation Atlas of the Great Lakes Islands. Nature Conservancy of Canada. 154pp.
Hey, D.L., and J.A. Wickencamp. 1996. Effects of wetlands on modulating hydrologic regimes in nine Wisconsin Watersheds. The wetlands Initiative. Chicago, Illinois.
Horn, D.J. and R.R. Koford. 2004. Could the area-sensitivity of some grassland birds be affected by landscape composition? Proceedings of the 19th North American Prairie Conferences. pp. 109 – 116.
Hounsell, S.W. 1989. Methods for assessing the sensitivity of forest birds and their habitats to transmission line disturbances. Land Use and Environmental Planning Department. Ontario Hydro, Toronto, Ontario.
Igl, L.D., and D.H. Johnson. 1997. Changes in breeding bird populations in North Dakota: 1967 to 1992-93. Auk 114: 74-92.
Jackson, M.W., and J.R. Jensen. 2005. An evaluation of remote sensing-derived landscape ecology metrics for reservoir shoreline environmental monitoring. Photogrammetric Engineering & Remote Sensing 71(12): 1387 – 1397.
Jalava, J.V. 2004. Inventory and evaluation of the Bayfield North Area of Natural and Scientific Interest. Ontario Ministry of Natural Resources, Guelph District, Guelph. 88pp. + 2 maps.
Johnson, C.A., N.E. Detenbeck, and G.J. Nieme. 1990. The cumulative effects of wetlands on stream quality and quantity, a landscape approach. Biogeochemistry, Vol. 10 (3): 105 – 141.
Lake Huron Centre for Coastal Conservation (LHCCC). 2010. Dune Planting Guide: Wise Stewardship of Lake Huron Coastal Dunes. 52pps.
Landowner Resource Centre (LRC) and Ontario Ministry of Natural Resources (OMNR). 2000. Conserving the Forest Interior: A Threatened Wildlife Habitat. Queen’s Printer for Ontario.
Lang, R., and A. Armour. 1990. Environmental Planning Resource Book. Lands Directorate, Environment Canada in association with Supply and Services Canada and Multiscience Publications Limited.
Larson, B.M., J.L. Riley, E.A. Snell and H.G. Godschalk. 1999. The Woodland Heritage of Southern Ontario. A Study of Ecological Change, Distribution and Significance. Federation of Ontario Naturalists. 262pp.
Larson, D.W., S.H. Spring, U. Matthes-Sears, and R.M. Bartlett, 1989. Organization of the Niagara Escarpment cliff community. Can. J. Bot 70:2731–2742.
Lee, H., W. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig, and S. McMurray. 1998. Ecological Land Classification for Southern Ontario. First Approximation and its Application. Ontario Ministry of Natural Resources, South-Central Science section, Science Development and Transfer Branch. SCSS Field Guide FG-02.
Lee, H. 2008. Southern Ontario Ecological Land Classification - Vegetation Type List. Ontario Ministry of Natural Resources: London, Ontario.
Lesica, P. and F.W. Allendorf. 1995. When are Peripheral Populations Valuable for Conservation? Conservation Biology **9**(4):753-760.
Levenson, J.B. 1981. Woodlots as biogeographical islands in south eastern Wisconsin. Pp. 13 – 14 in R.L. Burgess and D.M. Sharpe (eds.). Forest island dynamics in man-dominated landscapes. Springer-Verlag. 310 pp.
Logan, G. 1999. Riparian Buffer Function, Performance and Limitations, Urban Riparian Buffers Conference and Technical Training Session. REMA Ecological Services LLC.
Lomolino, M.V. and R. Channell. 1995. Splendid Isolation: Patterns of Geographic Range Collapse in Endangered Mammals. Journal of Mammalogy **76**:335-347.
Lovett-Doust, J., M. Biernacki, R. Page, M. Chan, R. Natgunarajah and G. Timis. 2003. Effects of Land Ownership and Landscape-level Factors on Rare-species Richness in Natural Areas of Southern Ontario, Canada. Landscape Ecology **18**:621-633.
Lovett-Doust, J. and K. Kuntz. 2001. Land Ownership and other Landscape-level Effects on Biodiversity in Southern Ontario’s Niagara Escarpment Biosphere Reserve, Canada. Landscape Ecology **16**:743-755.

Marini, M.A., S.K. Robinson, and E.J. Heske. 1995. Edge effects on nest predation in the Shawnee National Forest, Southern Illinois. Biological Conservation 74:203-213.

Matlack G.R. 1993. Microenvironment Variation Within and Among Forest Edge Sites in the Eastern United States. Biological Conservation **66**:185-194.

Mazerolle, M.H. and M.A. Villard. 1999. Patch Characteristics and Landscape Context as Predicators of Species Presence and Abundance: A Review. Ecoscience **6**:117-124.

McCracken, J.D., R.A. Reid, R.B. Renfrew, B. Frei, J.V. Jalava, A. Cowie, and A.R. Couturier. 2013. Recovery Strategy for the Bobolink (*Dolichonyx oryzivorus*) and Eastern Meadowlark (*Sturnella magna*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. viii + 88 pp.

Meffe, G.K., and C.R. Carroll. 1997. Principles of Conservation Biology, 2nd ed. Sinauer Associates Inc. Sunderland, Massachusetts.

Michigan Sea Grant. 1979. A guide to sand dune and coastal ecosystem functional relationships. Michigan State University Co-operative Extension Service. Extension Bulletin E-1529. MICHU-SG-81-501. 17pp.

Middlesex County. 2014. Middlesex Natural Heritage Systems Study. 150 p.

Mitchell, L.R., C.R. Smith, and R.A. Malecki. 2000. Ecology of grassland breeding birds in the Northeastern United States: A literature review with recommendations for management. USGS, Biological Resources Division, New York Cooperative Fish and Wildlife Research Unit, Cornell University, Ithaca, NY.

Mooney, P.F. 1993. Structure and connectivity as measures of sustainability in agro ecosystems. In: Marczyk, J.S., and D.B. Johnson (eds.). 1993. Sustainable Landscapes. Proceedings of the Third symposium of the Canadian Society for Landscape Ecology and Management. Polyscience Publications, Morin Heights, Canada. pp. 13 – 25.

Nathan, R., G.G. Katul, H.S. Horn, S.M. Thomas, R. Oren, R. Avissars, S.W. Pacala, and S. Levin. 2002. Mechanisms of long-distance dispersal of seeds by wind. Nature 418: 409 – 413.

Niemi, G.J., and J.R. Probst. 1990. Wildlife and fire in the upper Midwest. Pages 31-46 **IN**: J.M. Sweeney (ed.). Management of Dynamic Ecosystems. The Wildlife Society. Lafayette, IN.

Noss, R.F., B. Csuti, and M.J. Groom. 2006. Habitat Fragmentation. In M.J. Groom, G.K. Meffe, and C.R. Carroll (eds.). Principles of Conservation Biology, 3rd edition. Sinauer Associates, Sunderland, Massachusettes. 779pp.

Ochterski, J. 2006. Transforming fields into grassland bird habitat. Cornell Cooperative Extension of Schuyler County, NY. SCNY Agriculture Team Natural Resources.

Ontario Ministry of Municipal Affairs and Housing (OMMAH). 2014. Provincial Policy Statement, 2014. 50pp.

Ontario Ministry of Natural Resources (OMNR). 1986. Ontario Base Map Series. Scale 1:10,000.

Ontario Ministry of Natural Resources (OMNR). 1997. Natural Hazards Training Manual.

Ontario Ministry of Natural Resources (OMNR). 2000. Significant Wildlife Habitat Technical Guide. 151p.

Ontario Ministry of Natural Resources (OMNR). 2004. Southern Ontario Land Resource Information System (SOLRIS). Image Interpretation Manual.

Ontario Ministry of Natural Resources (OMNR). 2010. Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement. 2nd edition. 233pp.

Ontario Ministry of Natural Resources (OMNR). 2012. Draft Significant Wildlife Habitat Ecoregion Criterion Schedules: Addendum to Significant Wildlife Habitat Technical Guide. 42pp.

Ontario Ministry of Natural Resources (OMNR). 2013. Ontario Wetland Evaluation System. Southern Manual. Covering Hill's Site Regions 6 and 7. 3rd ed., Version 3.2.

Ontario Nature. 2014. Best Practices Guide to Natural Heritage Systems Planning. 87 pp.

Packett, D.L. and J.B. Dunning. 2009. Stopover habitat selection by migrant landbirds in a fragmented forest-agricultural landscape. The Auk 126: 579-589.

Peterjohn, B.G., and J.R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966 – 1996. Studies in Avian Biology 19: 27-44.

Plummer, C.C., and D. McGeary. 1985. Physical Geology. Wm. C. Brown publishers College Division, U.S.A.

Ribic, C.A., and D.W. Sample. 2001. Associations of grassland birds with landscape factors in southern Wisconsin. American Midland Naturalist **146**: 105-121.

Riley, J.L. and P. Mohr. 1994. The Natural Heritage of Southern Ontario's Settled Landscapes. A review of Conservation Biology and Restoration Ecology for Land use and Landscape Planning. OMNR, Southern Region, Aurora, Science and Technology Transfer, Technical Report TR-001. 78pp.

Robbins, C.S., D.K. Dawson, and B.A. Dowell. 1989. Habitat area requirements of breeding birds of the middle Atlantic states. Wildlife Monographs, Vol. **103**. 34 pp.

Roberts, D.L. 2011. Conservation value of forest fragments for wood thrushes (*Hylocichla mustelina*) in Costa Rica's Caribbean lowlands. Latin American Journal of Conservation 2(1): 8-17.

Rodewald, A.D. and A.C. Vitz. 2005. Edge- and area-Sensitivity of Shrub land Birds. The Journal of Wildlife Management 69(2): 681-688.

Roulet, N. and B. Freedman. 2008. What trees can do to reduce atmospheric CO_2. Tree Canada Foundation. Ottawa, Ontario. 12pp.

Sandilands, A.P. 2010. Birds of Ontario: habitat requirements, limiting factors, and status. UBC Press.

Sandilands, A.P., and S.W. Hounsell. 1994. The effects of 5000kV transmission facilities on forest birds in two wetland forest systems in southern Ontario – testing for the edge effect. In: Snodgrass, W.J. (ed.). Wetland Impacts Workshop. Grand River Conservation Authority. Cambridge, Ontario.

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American Breeding Bird Survey, Results and Analysis 1966 – 2000. Version 2001.2. U.S. Geological Survey, Pawtuxet Wildlife Research Center, Laurel, Maryland.

Schiefele, G.W., and G. Mulamoottil. 1987. Predictive models applicable to Ontario's wetland evaluation system. Pp. 267 – 273 in C.D.A. Rubec and R.P. Overend (eds.). Symposium '87 Wetlands / Peatlands. Edmonton, Alberta. Environment Canada. 704pp.

Schwartz, M.W. 1999. Choosing an appropriate scale for conservation reserves. Annual Review Ecology and Systematics **30**: 83-108.

Soulé, M.E. and J. Terborgh. 1999. Conserving nature at regional and continental scales – a scientific program for North America. Bioscience **49**: 809-817.

Steedman, R.J. 1987. Comparative analysis of stream degradation and rehabilitation in the Toronto area. PhD thesis. University of Toronto.

Szczerbak, S., ed. 2000. Lower Maitland River Valley River Project Information Report. Unpublished Report for the Lower Maitland River Valley Stewardship Group. University of Guelph, Guelph, Ontario.

Swanson, D.L., Dean, K.L., Carlisle, H.A. and E.T. Liknes. 2005. Riparian and woodlot landscape patterns and migration of neotropical migrants in riparian forests of eastern South Dakota. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Taki, H., Yamaura, Y, Okabe, K., and K. Maeto. 2010. Plantation vs. natural forest: Matrix quality determines pollinator abundance in crop fields. Scientific Reports **1** (132): 1-4.

Taylor, F., A. Derosier, K. Dinse, P. Doran, D. Ewert, K. Hall, M. Herbert, M. Khoury, D. Kraus, A. Lapenna, G. Mayne, D. Pearsall, J. Read, and B. Schroeder. 2010. The Sweetwater Sea: An International Biodiversity Conservation Strategy for Lake Huron – Technical Report. A joint publication of The Nature Conservancy, Environment Canada, Ontario Ministry of Natural Resources Michigan Department of Natural Resources and Environment, Michigan Natural Features Inventory Michigan Sea Grant, and The Nature Conservancy of Canada. 264 pp. + Appendices.

Tufford, D.L., H.N. McKellar, and J.R. Hussey. 1998. In-stream non-point source nutrient prediction with land-use proximity and seasonality. Journal of Environmental Quality 27: 100 – 111.

Turner, M.G., and R.H. Gardner (eds). 1991. Quantitative Methods in Landscape Ecology: the Analysis and Interpretation of Landscape heterogeneity. Springer-verlag, New York, New York.

Upsdell Wright, B., and M. Veliz. 2013. Water Quality Monitoring for the Watershed Based Best Management Practices Evaluation, Huron. Ausable Bayfield Conservation Authority, Exeter, Ontario. pp.32.

Villard, M.A., M.K. Trzcinski and G. Merriam. 1999. Fragmentation Effects on Forest Birds: Relative Influence of Woodland Cover and Configuration on Landscape Occupancy. Conservation Biology **13**(4):774-783.

Weathers, K.C., Cadenasso, M.L. and S.T.A. Pickett. 2001. Forest edges as nutrient and pollutant concentrators: potential synergisms between fragmentation, forest canopies and the atmosphere. Conservation Biology 15(6): 1506-1514.

Wegner, J.F., and G. Merriam. 1979. Movements by birds and small mammals between a woodland and adjoining farmland habitats. Journal of Applied Ecology 16: 349-357.

Weyrauch, S.L. and T.C. Grubb. 2004. Patch and landscape characteristics associated with the distribution of woodland amphibians in an agricultural fragmented landscape: an information-theoretic approach. Biological Conservation 115: 443-450.

Chapter 3

Aquatic Resources Study

Maitland River in Huron County

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3 Aquatic Resources Study

3.1 Introduction

Huron County's aquatic resources exist within a larger system of watersheds. A watershed can be described as an area of land where all of the surface water is drained into a body of water or watercourse (e.g. Ausable River). Watersheds are defined by a geographic area and not by municipal boundaries. Most watersheds within Huron County drain into Lake Huron; very few drain into Lake Erie; and the Upper Thames watershed drains into Lake St. Claire (Figure 3.3).

The condition of local waterbodies is an important component of the natural environment. The purpose of this chapter is to summarize existing information about aquatic resources in Huron County. Aquatic resources include: surface water quantity and quality, benthic invertebrates, and fish. This chapter also provides some descriptions of the programs that have collected the aquatic data. Please note that program objectives change over time, sometimes as an adaptation to lessons learned from past programs. Other times, programs are discontinued due to fiscal constraints.

The focus of this section of the report is to describe the surface water conditions and how that information was gathered. Information about groundwater resources has recently been summarized as part of the Source Protection Drinking Water Project (Luinstra *et al*. 2007).

Water chemistry data was used to summarize information about water quality (section 3.3). Aquatic habitat information (mainly flow, water temperature and clarity collected during the drain classification process 1999 to 2002 – section 3.5) was used to describe the aquatic habitat and provided the basis for a watercourse sensitivity analysis (section 3.6). The other sections of this chapter summarize aquatic monitoring programs.

Maintaining healthy watercourses is essential to ensuring the health and resiliency of Huron County's natural areas (Figure 3.1). Many species rely on watercourses directly or indirectly for survival. Aquatic species can provide an indication of the health of watercourses. In Huron County, several aquatic species are at risk of extinction and need to be protected to ensure the continued health of the County's valuable ecosystems. See Chapter 4 for more details.

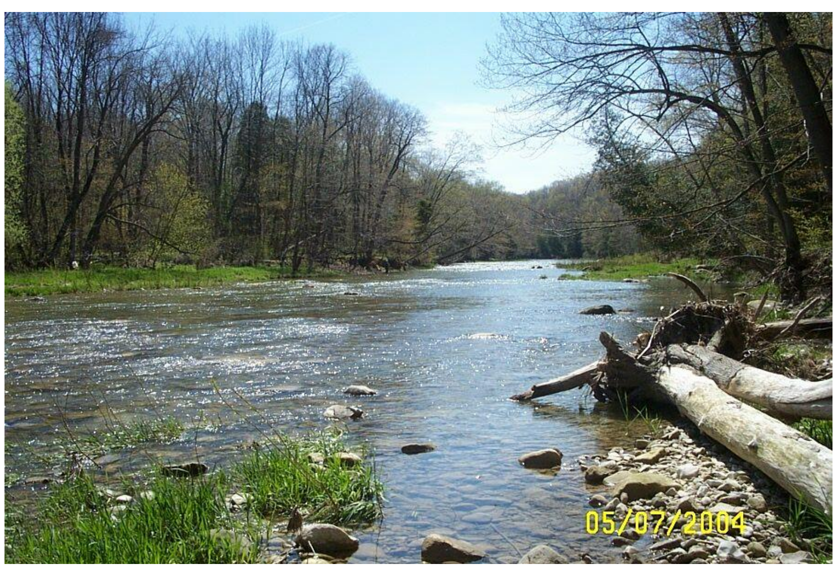

Figure 3.1 Photo of the Bayfield River at Wildwood Park in Huron County.

3.2 Surface Water Quantity

The discharge of groundwater to surface water streams, rivers and other waterbodies is defined as baseflow. It is this baseflow or groundwater discharge that supports the flow of water during extended dry periods. Information gathered regarding baseflow can help with water management decisions about irrigation, water supply, dilution of contaminants, and recreation.

To measure baseflow, stream discharge is monitored in local creeks during dry conditions (see Figure 3.2). Groundwater discharge is prevalent in the northern portions of the Ausable, Bayfield and Maitland Rivers. The Maitland River in particular has a large area with streams that have a significant baseflow contribution (Figure 3.3).

Figure 3.2 Measuring base flow in the Bayfield River (2007).

Monitoring base flow provides valuable data to determine the quantity of groundwater discharge and its spatial distribution. This information can be used to develop water budgets and contribute to watershed models that can help explain water quality and quantity conditions.

From 2007 to 2010, the Ausable Bayfield Conservation Authority (ABCA) and Maitland Valley Conservation Authority (MVCA) manually measured 69 locations for flow throughout the Ausable, Bayfield, Maitland and Nine Mile River watersheds. The Mean-Section Method (Hendry and Lynch 2010) was used to calculate discharge. Rainfall information, number of days without precipitation, catchment area, data from permanent gauge stations and sewage treatment plant discharge data can help to inform baseflow conditions.

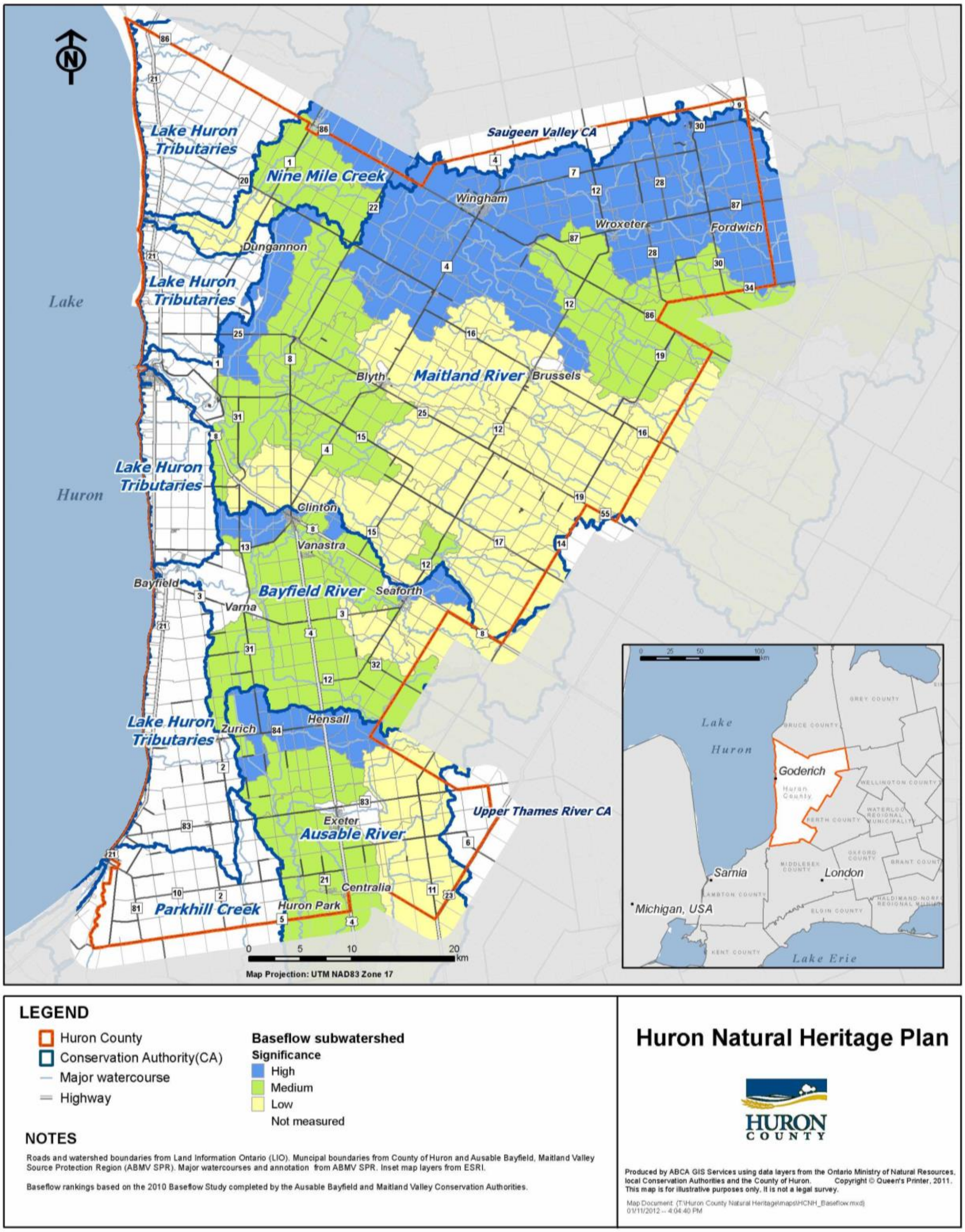

Figure 3.3 Significance of baseflow conditions in subwatersheds of Huron County.

3.3 Surface Water Quality

3.3.1 Background

Water is required for drinking, recreation, agriculture, industry, aquatic life and aesthetics. Typically the general public wants to know:

Is it drinkable? Is it swimmable? Is it fishable? Is it healthy?

To address each of these questions, indicators of water quality are collected and summarized. Although there are many measures of water quality that may be collected, certain indicators provide the best information depending on the end use of the water. For example, indicators of water quality for industrial purposes differ from indicators of quality for drinking. Indicators may be chemical, physical, radiological or biological.

For the purposes of this report, it is necessary to select a few key indicators to discuss water quality in order to develop a general understanding of major issues and pathways. Indicators of nutrient enrichment and erosion are most commonly used. The United States Environmental Protection Agency has documented that for the waterbodies listed as 'impaired' in the National Water Quality Inventory, the three top pollutants are bacteria, total suspended solids, and nutrients (nitrate and total phosphorus) (USEPA 2014). Swimming in Lake Huron is a favoured human activity, therefore, the use of the fecal coliform, *Escherichia coli* (*E.coli*) as an indicator is warranted. Chloride and copper concentrations can be measures of human industrial impacts on water quality. Therefore, six indicators (total phosphorous, nitrate, total suspended solids, chloride, copper, and *E. coli*), are summarized for this report (Table 3.1).

Water quality sampling is often embedded into different programs as an evaluation tool and therefore there are sites that exist for a limited time that may only have data for one or perhaps two indicators. In 2012, water quality information was gathered from 148 known locations in Huron County (Figure 3.4). Many of the sites are or have been a part of the Provincial Water Quality Monitoring Network (PWQMN). This network is a partnership between local agencies, often the Conservation Authorities, and the Ministry of the Environment and Climate Change (MOECC) and has been operating in the area since 1964. Sites are sampled from eight to twelve times a year and consist of single grab samples. The indicators analyzed for this program include nutrients, basic water properties, common metals, bacteria (1970 to 1994) and heavy metals (since 1998). The MOECC performs the laboratory analysis.

Table 3.1 Water quality indicators. Guidelines are based on the Provincial Water Quality Objectives (MOE 1994), unless otherwise stated.

Indicator	***Importance***	***Sources***	***Impacts***	***Guideline***
Total Phosphorus (TP)	• Influences plant growth and oxygen levels • Closely associated with rainfall and runoff	• Air • Agricultural and lawn fertilizer • Manure • Septic systems • Sewage treatment effluent • Milkhouse washwater	• Can cause eutrophication and algal blooms	0.03 mg/L
Nitrate	• Stimulates plant and algal growth • Highly soluble and can move into shallow groundwater systems • Indicator of pollution from sewage or organic waste	• Agricultural and lawn fertilizer • Manure • Septic systems • Sewage treatment effluent • Air	• Toxic to fish and amphibian eggs	>2.93 mg/L
Total suspended solids	• Includes silt, clay, fine organic & inorganic particles, plankton, microscopic organisms less than 2 µm • Influences water clarity • Soil erosion indicator	• Soil erosion • Urban runoff • Bottom-feeding fish • Naturally present depending on soil types, currents & watercourse morphometry	• Adversely affect benthic invertebrates, periphyton & fish communities	<80 mg/L
Chloride	• Water soluble element	• Road salt application • Industrial activity • Sewage treatment effluent • Septage • Animal waste • Potassium chloride (potash in fertilizer)	• Toxic to aquatic animals (impaired survival, growth, and/or reproduction) • Can create an unpleasant taste	<150 mg/L
Copper	• Good indicator for heavy metals from human activities	• Sewage treatment effluent	• Toxic to aquatic plants and animals	5 µg/L (hardness of CaCO3 is > 20 mg/L)
Escherichia coli (E.coli)	• Indicator for harmful bacteria and pathogens to humans	• Human and animal waste	• Harmful to humans • Can lead to beach closures	100 cfu/100 mL (recreational guideline)

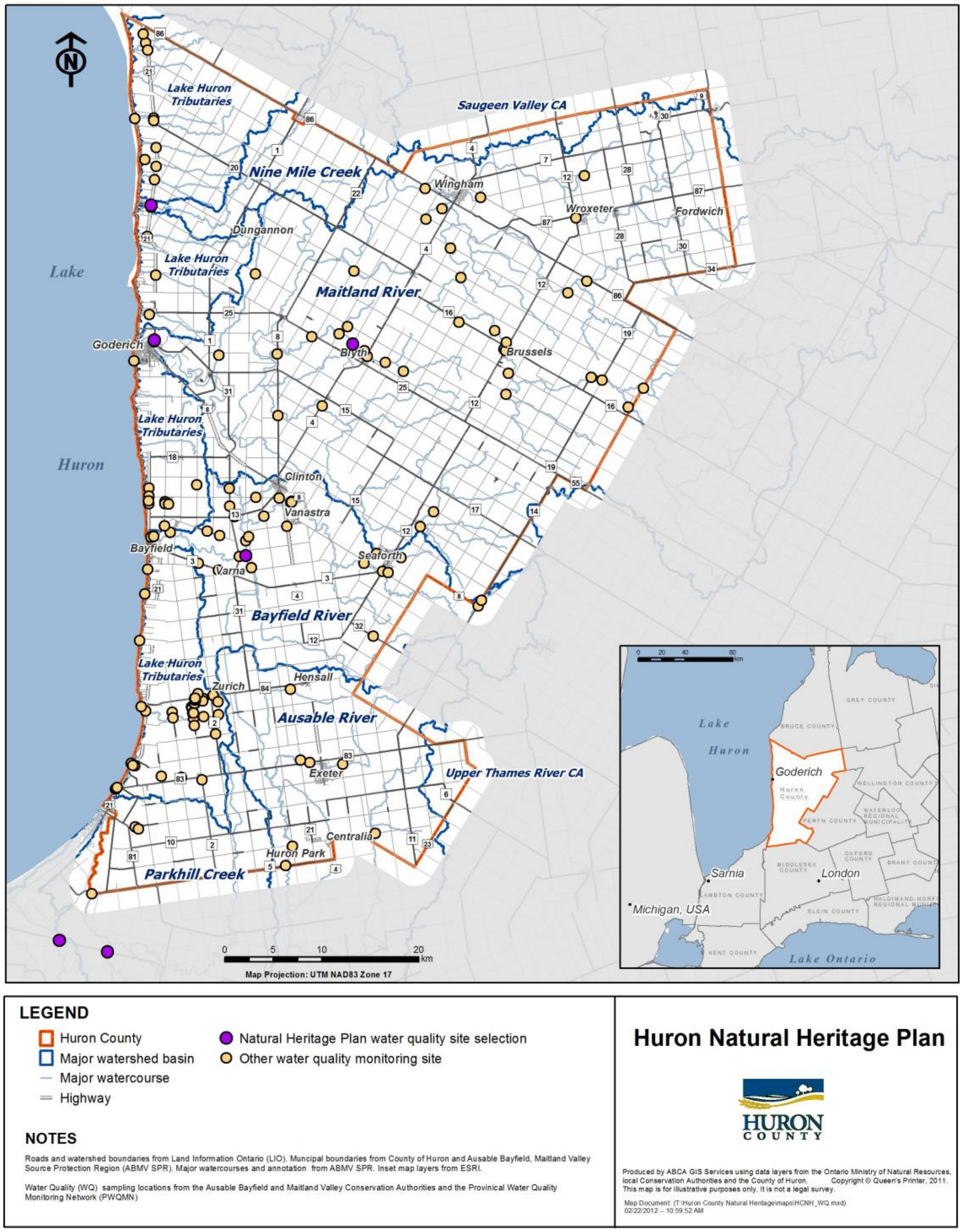

Figure 3.4 Huron County water quality monitoring sites.

The collection of *E.coli* data in Huron County is completed by different agencies to meet different objectives (Table 3.2). This indicator of water quality is collected at public bathing areas along the shoreline (as mandated by local Public Health agencies). It is also collected as a part of the drinking water surveillance program for the water treatment plants at Port Blake (north of Grand Bend) and Goderich. Samples collected as a part of the PWQMN are not analyzed for *E.coli* concentrations. However since 2002, water collected from the PWQMN sites in the Ausable Bayfield Conservation Authority (ABCA) watersheds are analyzed at a private lab for *E.coli*. Local community groups also monitor for *E.coli* at local beaches and shoreline tributaries.

Table 3.2 Agencies that collect water quality data in Huron County. Agencies that Monitor *Escherichia coli* are marked with an 'X'.

Organization	Tributary	Lake Huron
Ministry of the Environment and Climate Change– Drinking Water Surveillance Program		X
Ministry of the Environment and Climate Change– Provincial Water Quality Monitoring Network		
Huron County Health Unit		X
Saugeen Valley Conservation Authority[a]		
Maitland Valley Conservation Authority	X	
Ausable Bayfield Conservation Authority	X	
Upper Thames River Conservation Authority[a]		
Ashfield Colborne Landowners Association	X	X
Bluewater Shoreline Residents Association	X	X
Bayfield Ratepayers Association	X	

[a] data collected but not in Huron County

For the purposes of this report, the data for all the sites identified in Table 3.2 was not summarized. The data may have been collected to inform very specific questions such as what is the impact of this quarry, landfill, weeping bed, etc., on "Creek A" under rain events and dry conditions. Summarized information has been drawn from the Watershed Characterization Report by the Source Water Protection Team (Luinstra *et al*. 2007).

This is a summary of monitoring that was completed for six rivers in Huron County for total phosphorous, nitrate, total suspended solids, chloride and copper:

- **Nine Mile River** - PWQMN site from 1964-1994, 1998-2005 (site name Port Albert)
- **Maitland River** – PWQMN site from 1964-1994, 1998-2005 (site name Goderich)
- **Blyth Brook** – PWQMN site from 1964-1994, 1998-2005 (site name Blyth – a tributary of the Maitland River)
- **Bayfield River** – PWQMN site from 1975-1995, 2000-2005 (site name Varna)
- **Parkhill Creek** - PWQMN site from 1972-1995, 2003-2005 (site name Downstream Parkhill)
- **Ausable River** – PWQMN site from 1980-1998, 2000-2005 (site name Thedford)

Some summary information is provided about *E.coli* from the lake (Huron County Health Unit and Bluewater Shoreline Residents Association) and tributaries (PWQMN – Varna and Bluewater Residents Association).

3.3.2 Results

3.3.2.1 Phosphorus

Phosphorus is an element which encourages plant and algae growth. Once the algae die, they decompose, which consumes oxygen from the water. The reduced oxygen in the water can limit other aquatic organisms. Eutrophication is the process of reduced oxygen levels in an aquatic environment brought about by excessive plant growth and die-off as a result of elevated nutrients (predominantly phosphorus, but also nitrogen).

Phosphorus ions form ionic bonds with clay through a process called adsorption. Phosphorus therefore often moves while attached to soil particles. For this reason, excess phosphorus is very closely associated with rainfall and runoff and is generally found in those areas that have higher clay content soils. Potential sources of phosphorus are from agricultural and lawn fertilizer, manure, septic systems, sewage treatment effluent, and milkhouse washwater.

3.3.2.1.1 Standards

A Provincial Water Quality Objective (PWQO) of 0.03 mg/L of total phosphorus has been established to avoid nuisance algae in streams and rivers (MOEE 1994). An objective of 0.02 mg/L is used for lakes during the ice-free period to avoid nuisance algae. The PWQO for phosphorus was not established to delimit toxicity, but rather to identify the indirect impacts of excessive phosphorus on aquatic ecosystems through oxygen imbalances.

3.3.2.1.2 Results

Total phosphorus concentrations have slightly declined or remained constant from 1962 to 2007 (Figure 3.5). Parkhill Creek has shown significant declines from 1985, but phosphorus concentrations remain five times the PWQO. In Huron County, phosphorus enrichment and resultant algal blooms may be an issue in most streams, but particularly southern streams.

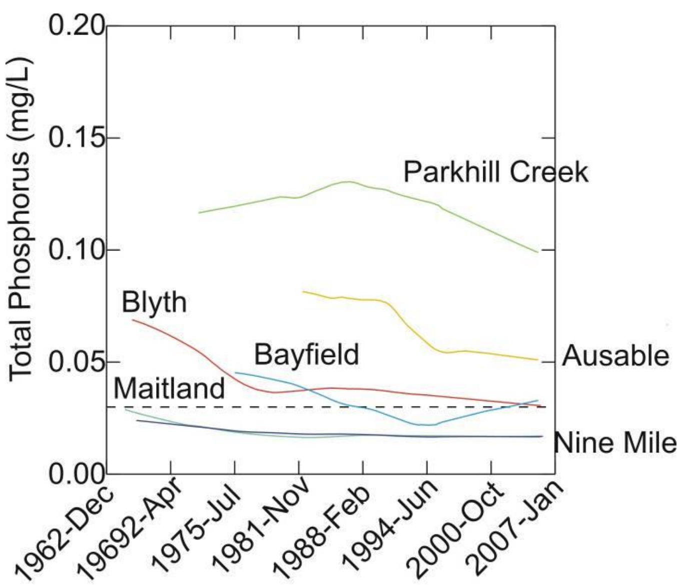

Figure 3.5 Total Phosphorus concentrations (mg/L) in six Provincial Water Quality Network Streams that are located in Huron County. Note that concentration as a line was computed with a LOWESS interpolation of discrete sampling events. The dashed line represents the Provincial Water Quality Objective (PWQO) for total phosphorus.

3.3.2.2 Nitrate

Nitrogen occurs naturally in rocks and groundwater. Nitrogen is an element that stimulates plant (and algal) growth. The forms of nitrogen found in water include nitrite (NO_2) and nitrate (NO_3). Nitrate is the primary source of nitrogen for aquatic plants. All forms of inorganic nitrogen (nitrite and ammonia) have the potential to undergo nitrification to nitrate. Nitrates are highly soluble and can move into shallow groundwater systems. Manure and fertilizer application are thought to contribute nitrates to watercourses in agricultural areas.

Nitrite is unstable in aerated water and is generally considered to be an indicator of pollution through improper disposal of sewage or organic waste. Also, nitrate can be an indicator of such pollution, but the pollution may have occurred further away or a longer time ago.

3.3.2.2.1 Standards

The Ontario (and Canadian) drinking water quality standard for nitrate and nitrite (as nitrogen (-N)) is 10 milligrams per litre (mg/L). A concentration of nitrate in water that is above the guideline can cause a potentially fatal condition for infants less than six months old. Laboratories typically report nitrate-N and nitrite-N together, however the nitrite-N component is usually relatively small compared to the nitrate-N component.

The water quality guideline for nitrate (-N), established by the Canadian Council of Ministers of the Environment (CCME), for the protection of aquatic ecosystems is 2.93 mg/L. Above this level, nitrate can be toxic to fish and amphibian eggs. In rural areas, potential sources of nitrogen are agricultural and lawn fertilizer, manure, septic systems, sewage treatment effluent and atmospheric deposition. Nitrate is soluble in water and therefore can easily be transported in water in overland runoff or into streams via diverted infiltrating water from tile drainage or aquifers. The fate of nitrogen in natural systems is complex, as it is utilized by all plants and is subject to many biological processes that can bind and transform nitrogen.

3.3.2.2.2 Results

Concentrations of nitrate have increased in streams in Huron County from 1968 to 2009 (Figure 3.6). As of 2009, four of the six streams were above the aquatic protection guideline. The exceptions were the Maitland River and the Nine Mile River, which have concentrations below the aquatic protection concentration at both Lucknow and Port Albert. At all locations, the increase in concentration seemed to have occurred between 1970 and 1985. Since all sites exhibit this trend, it indicates that there may have been a widespread adoption of a land management practice, or practices, which increased the amount of nitrate in watercourses.

In the Maitland watershed, concentrations of nitrate have remained steady or even declined since 1985, possibly indicating that this practice or practices are still in use in the Maitland watershed, but not intensifying. Increasing concentrations are still apparent in the Bayfield River, Parkhill Creek, and the Ausable River. The increased nitrate concentrations for these systems may indicate that land management change is still occurring or potentially intensifying.

A considerable number of samples in the Bayfield River were above the Ontario Drinking Water Standard. Even though there are no current surface water uses of the river, the reason for the high concentrations should be further investigated.

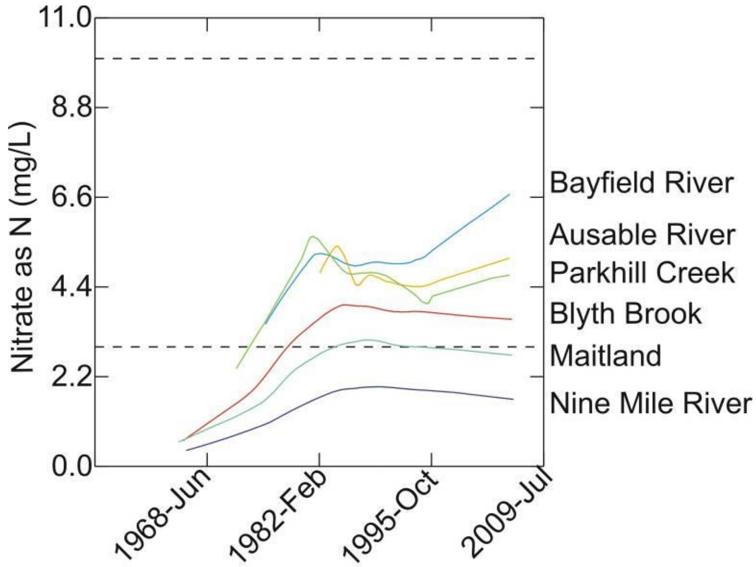

Figure 3.6 Nitrate concentrations (mg/L) in six Provincial Water Quality Network streams that are located in Huron County. Note that concentration as a line was computed with a LOWESS interpolation of discrete sampling events.

3.3.2.3 Sediment

Total suspended solids (TSS) is a measure of material suspended in the water column such as microorganisms, phytoplankton, detritus, clay and other mineral substances. Suspended solids may smother stream life, block light and settling material may bury habitat.

Suspended solids is an indicator for the amount of soil erosion that has occurred from runoff, streambank erosion, and channel processes. In addition, other water quality indicators (e.g. phosphorus and aluminum) are bound to soil particles. Understanding sediment movement makes it possible to interpret transport and risks these water quality contaminants may pose. Higher suspended solids concentrations often result from soils with higher clay or silt contents.

3.3.2.3.1 Standards

Standards for suspended solids are difficult to develop because there are many site-specific conditions that affect the response of aquatic organisms to suspended material. As a result, a variety of standards have been set by different environmental agencies. The CCME (2002) recommends suspended solids guidelines for the protection of aquatic life based upon flow condition (clear flow versus high flow), length of exposure, and background levels. For example, under high-flow conditions, suspended solids concentrations should increase by no more than 25 mg/L above background levels when background levels are between 25 and 250 mg/L (CCME 2002). In Ontario, 30 mg/L is the maximum standard for suspended material permitted in effluent discharged to surface water. The European Inland Fisheries Advisory Committee (EIFAC 1965 *In* Kerr 1995) reported that there was no evidence that TSS concentrations less than 25 mg/L have any harmful effects on fisheries. Good fisheries can be maintained in waters between 25 to 80 mg/L, whereas between 80 and 400 mg/L are considered unlikely to support good fisheries, and only poor fisheries are likely to be found above 400 mg/L (EIFAC 1965 *In* Kerr 1995). For analysis in this report, 25 mg/L was used as a standard for aquatic protection.

3.3.2.3.2 Results

Suspended solids concentrations have declined or remained constant over the record for the Nine Mile River, Maitland River, Bayfield River and Blyth Brook with concentrations at these sites all below 25 mg/L (Figure 3.7). Improvements have occurred in the Ausable River with concentrations at or slightly above this benchmark. Suspended solids concentrations in Parkhill Creek are above the recommended concentrations for aquatic protection in more than half of the samples, but concentrations have declined since 1995. The higher suspended solids concentrations in this system are potentially related to the local soils with higher clay or silt contents. The reduction in both total phosphorus and sediment concentrations in Parkhill Creek since the mid-1990s suggests that there may be similar sources and transport pathways for these pollutants. The declines in sediment loads might be attributed to various agricultural soil erosion mitigation measures that have been implemented in the watershed.

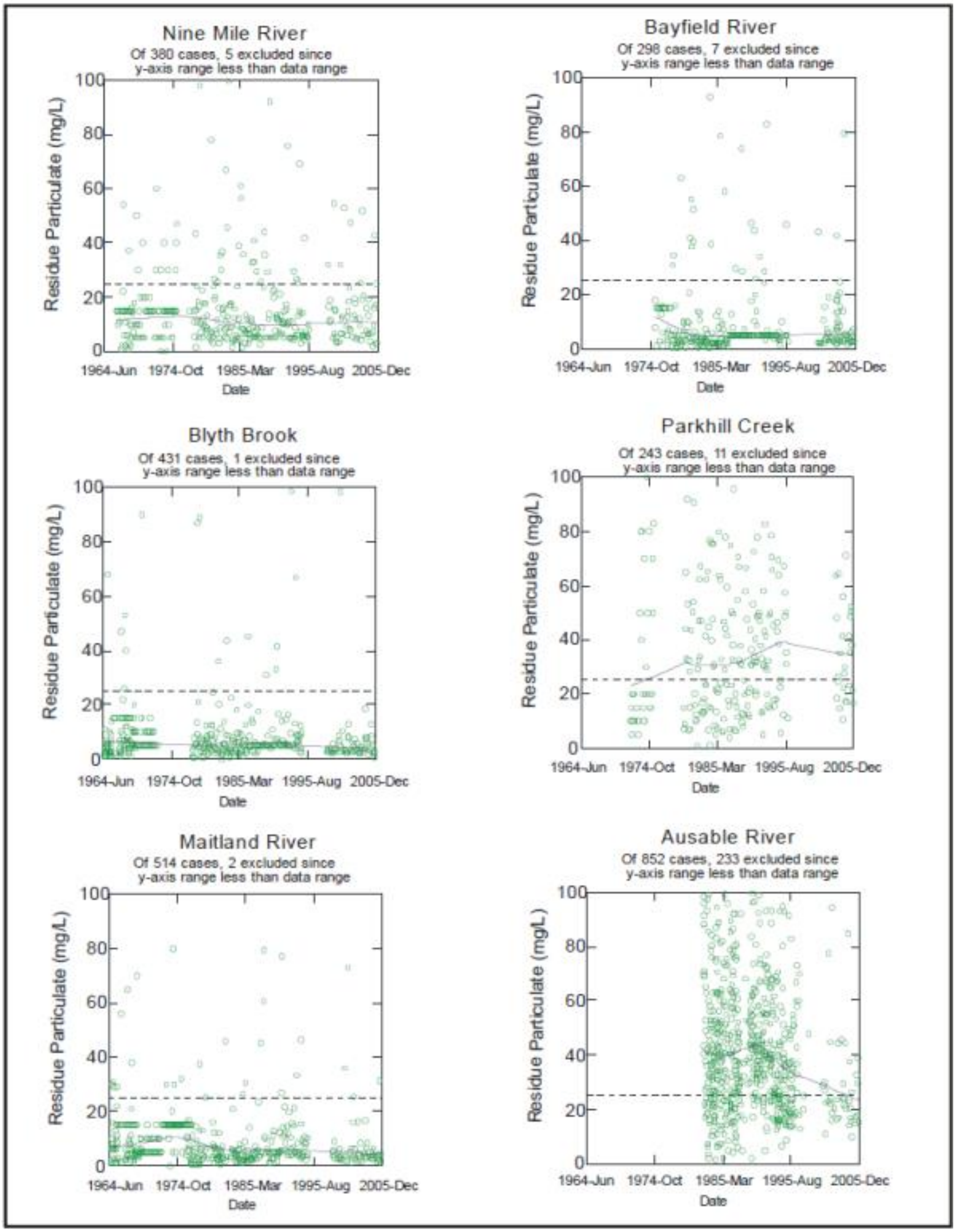

Figure 3.7 Suspended solids as residue particulate concentrations (mg/L) in six Provincial Water Quality Network Streams. Note that concentration as a line was computed with a LOWESS interpolation of discrete sampling events.

3.3.2.4 Chloride

Chloride is a water soluble and conservative element that is not typically present in natural groundwater or surface water systems in large concentrations. The largest potential source of chloride is from the use of road salt for winter ice control, but it is also derived from sewage treatment effluent, seepage, animal waste and potassium chloride (potash in fertilizer).

3.3.2.4.1 Standards

Chloride is not considered a health hazard in the concentrations found in groundwater in this area of Ontario (Luinstra *et al*. 2007); however, it imparts an undesirable taste above 250 mg/L, which has been designated as an aesthetic water quality objective for under the Ontario Drinking Water Standard. The benchmark identified in Environment Canada's Priority Assessment Report (2001) is 250 mg/L for aquatic protection. The British Columbia government has developed a standard of 150 mg/L for the protection of aquatic species.

3.3.2.4.2 Results

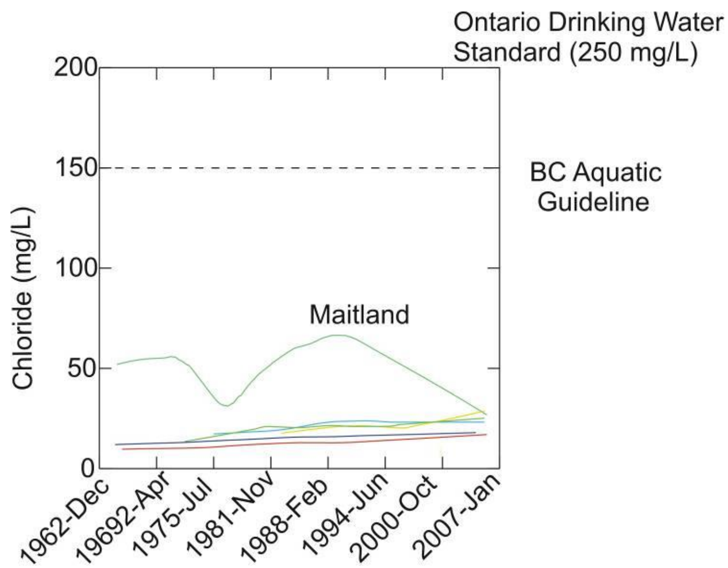

Figure 3.8 Chloride concentrations (mg/L) in six Provincial Water Quality Network Streams that are located in Huron County. Note that concentration as a line was computed with a LOWESS interpolation of discrete sampling events.

Over the period of record, there has been a slight increase in concentration of chloride (Figure 3.8) in Huron County streams. However, chloride concentrations are well below concentrations of concern for the protection of aquatic life (the British Columbia aquatic protection guideline are shown for reference). The Maitland River at Goderich has had the highest concentrations, which peaked in 1989 and since have declined significantly. None of the sites had any concentrations above the PWQO from 1962 to 2007. These results may reflect the more rural nature of the watershed region and the limited use of road salt. The chloride concentrations and changes over time at Goderich on the Maitland River are more likely related to salt extraction industry modifications than to road salt.

3.3.2.5 Copper

Copper is a persistent element that is not typically present in natural surface water systems and therefore is a good indicator for heavy metals from human activities. Locally, the main potential source is from sewage treatment effluent.

3.3.2.5.1 Standards

There is a PWQO for copper of 0.001 mg/L if water hardness as Calcium Carbonate ($CaCO_3$) is 0 to 20 mg/L, or 0.005 mg/L if water hardness is greater than 20 mg/L (MOEE 1994). All historic river and stream sampling results in the area have been above 20 mg/L of $CaCO_3$ and therefore the 0.005 mg/L guideline applies.

3.3.2.5.2 Results

Copper concentrations have declined or stayed constant over the period of record and no sites currently have concentrations above the PWQO (Figure 3.9). These results may reflect the more rural nature of the watershed region and lower level of industrialization.

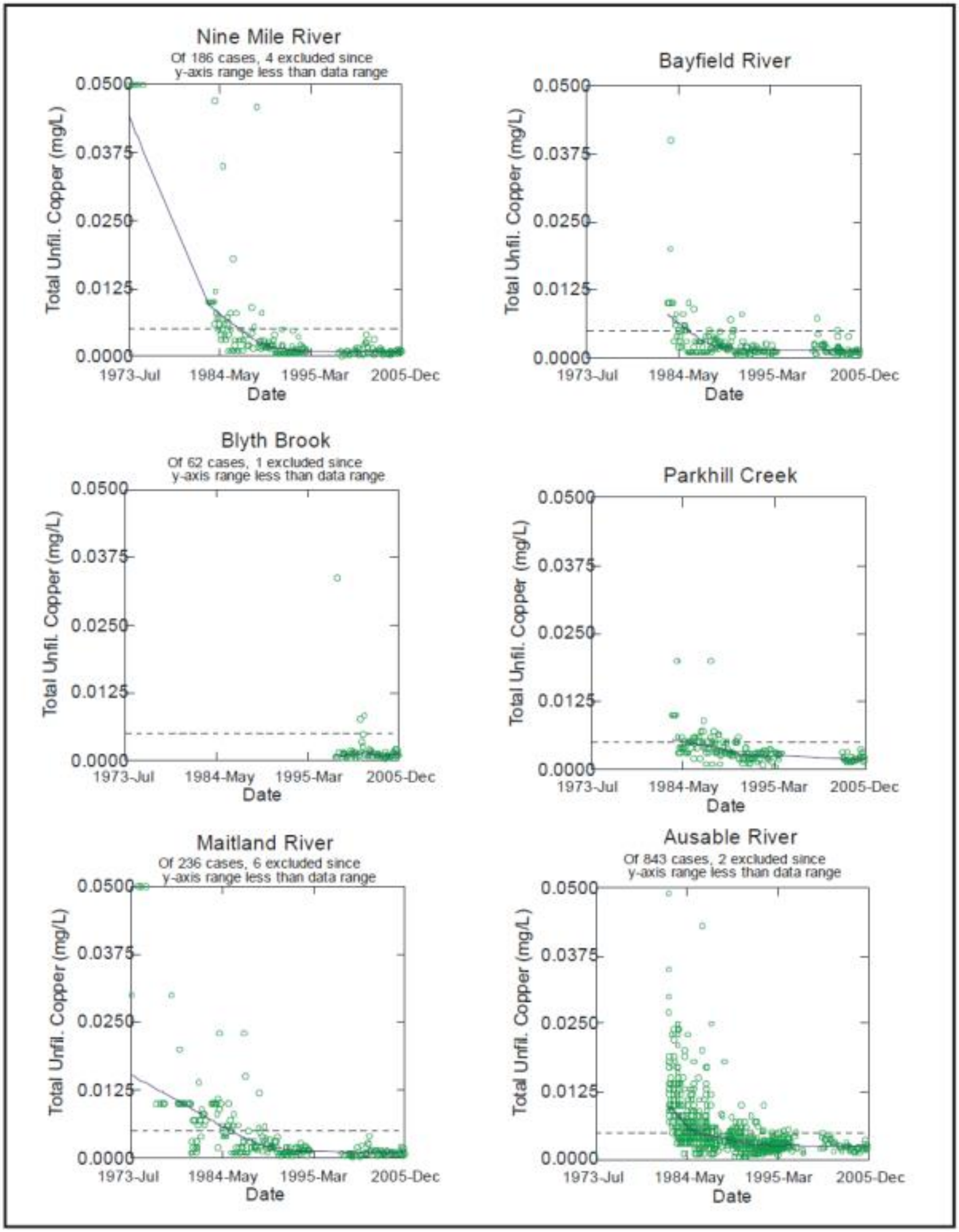

Figure 3.9 Copper concentrations (mg/L) in six Provincial Water Quality Network Streams. Note that concentration as a line was computed with a LOWESS interpolation of discrete sampling events.

3.3.2.6 Bacteria

Fecal coliform are a group of bacteria that inhabit the intestines of warm-blooded animals and the presence of these bacteria in surface water indicate a potential for harmful bacteria and pathogens to humans. *Escherichia coli* (*E.coli)* is a member of the fecal coliform group and is the current indicator bacterium.

As discussed above, there are a number of agencies and organizations that have collected *E.coli* data. The following is a summary of *E.coli* information from Lake Huron and local tributaries.

3.3.2.6.1 Huron County Health Unit

A report prepared by the Ministry of Environment and Climate Change (Howell *et al.* 2005) analyzed the Huron County Health Unit beach water data collected between 1993 and 2003. Over this period, the median *E. coli* concentration at the beaches sampled was between 50 and 100 cfu per 100 mL. The geometric mean *E. coli* concentrations at Lake Huron Beaches from 2006 to 2010 are for the most part consistent with the Howell *et al.* (2005) findings (Table 3.3). For some beaches the *E. coli* geometric means are lower than 50 cfu per 100 mL from 2006 to 2010. (The geometric mean is a measure of central tendency of a set of numbers. The geometric mean is calculated by using the product of their values, as opposed to the arithmetic mean which uses their sum. It is calculated as the *n*th root of a product of *n* numbers. It is often used when comparing numbers that have different ranges as it reduces the effect of uncommonly high or low concentrations on a mean.)

Table 3.3 Huron County Health Unit's beach water result summary.

Lakeshore Public Beach Locations	**5 Year 2006 to 2010 *E. coli* GM**	**1 Year 2010 *E. coli* GM**
Amberley Beach	54	97
Ashfield Township Park Beach	57	78
Bayfield Main Beach	33	27
Bayfield South Beach	36	26
Black's Point Beach	59	77
Goderich - Main Beach	*77	105
Goderich - Rotary Cove Beach	53	66
Goderich - St. Christopher's Beach	*64	79
Hay Township Park Beach	54	68
Houston Heights Beach	42	45
Port Albert Beach	*69	134
Port Blake Beach	35	53
St. Joseph's Beach	*62	90
Sunset Beach	25	23

Notes:

* Site included at least one annual geometric mean greater than 100 *E. coli* per 100 mL water in the last 5 years

5 Year *E. coli* Geometric Mean of 81 or greater
5 Year *E. coli* Geometric Mean between 61 and 80
5 Year *E. coli* Geometric Mean of 60 or lower

3.3.2.6.2 Bluewater Shoreline Residents' Association

The Bluewater Shoreline Residents' Association (BSRA) is an umbrella organization for a number of lakeshore associations in the Municipality of Bluewater. An important issue for many lakeshore residents is the state of the water quality in Lake Huron, and in the ravines that flow into the lake. In 2006, the BSRA partnered with the Ausable Bayfield Conservation Authority (ABCA) to undertake water quality monitoring in four ravines that enter Lake Huron from the Municipality of Bluewater (Wildwood, Houston Heights, St. Joseph, Ridgeway). Prior to 2006, the BSRA conducted water quality testing in some of the ravines along the lakeshore. In 2007, the BSRA requested that the ABCA also monitor water quality in the lake near the outlets of the four ravines. Since then, the ABCA has monitored water quality in the four ravines and adjacent lake locations. This section provides a summary of lake and ravine monitoring information from 2006 through 2011.

Sample Collection

Water samples were collected on a weekly basis each year in June through August from the ravines as well as from within Lake Huron. A reaching pole was used so that the sampler could stand on the bank and collect a sample from the centre of each ravine. Within the lake, samples were collected according to the protocol used in previous years by the Huron County Health Unit. This involved the collection of five replicate samples at different locations: one directly out from the mouth of the ravine, two samples north of the mouth, and two samples south of the ravine (with 50 paces between adjacent locations). All lake samples were collected by wading into the water to waist depth (unless wave conditions made it unsafe to do so). Using the reaching pole to minimize the collection of any sediment that was stirred up from wading, each sample was collected from approximately one foot under the surface of the water. All water samples were analyzed by ALS Environmental in Waterloo, Ontario, to determine the concentration of *E. coli* in colony forming units per 100 mL of water (cfu/100 mL).

Data Interpretation

Geometric means were used to summarize *E. coli* concentrations. The results were compared with two standards. The Ontario Ministry of Health and Long-term Care established a recreational guideline for *E. coli* of 100 cfu/100 mL that is based upon a geometric mean of at least five samples per site collected within a given swimming area within a one-month period (MOEE 1994). The internationally-recognized Blue Flag program requires that, for Ontario beaches, at least 80% of the daily geometric means not exceed 100 cfu/100 mL, with sampling occurring at least once per week at a minimum of five sites per beach (Environmental Defence 2012).

Results

Figure 3.10 and Table 3.4 demonstrate two manners in which *E. coli* data for the lake locations can be summarized. Neither manner of presenting the data is better than the other; they each provide different and useful information. The geometric mean concentration for each lake location during each year can be compared with the provincial guideline value of 100 cfu/100 mL to provide a simple snapshot of overall water quality. Evaluating the data against the Ontario Blue Flag criterion helps the community to determine how often it is safe to swim at these locations. While seasonal geometric mean concentrations of *E. coli* are well below 100 cfu/100 mL, some of the beaches did not meet the Blue Flag criterion in 2006, 2008, 2009, 2010, and 2011. Out of the four lake locations monitored, Houston Heights is the only beach that met the Blue Flag criterion consistently for the last five years.

It is significant to note that seasonal geometric means of the ravine *E. coli* concentrations were *consistently* above the Ontario recreational guideline of 100 cfu/100 mL, and were higher than those in the lake (Table 3.5).

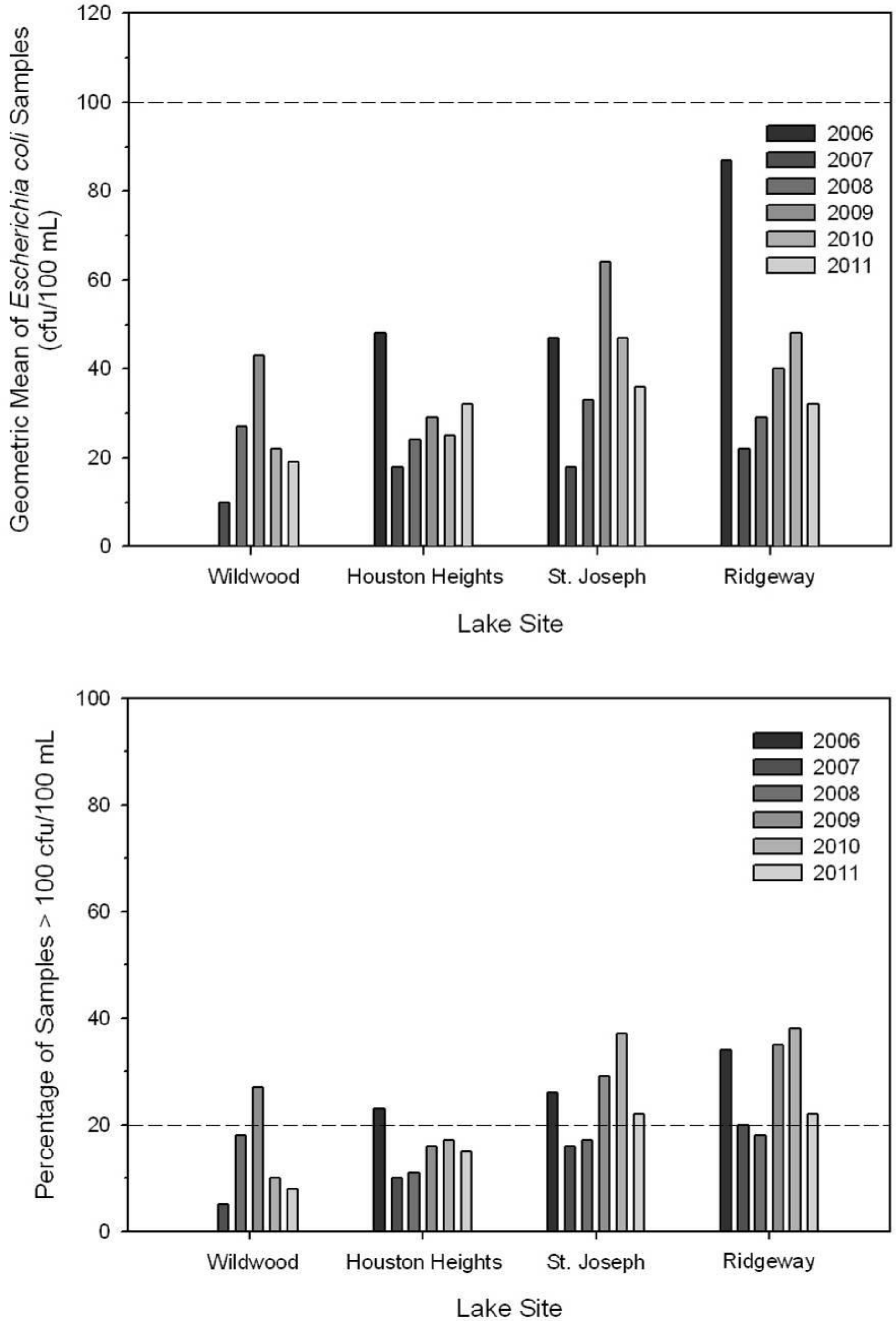

Figure 3.10 Top: Geometric mean *Escherichia coli* concentrations in colony forming units (CFU) per 100 mL, for four Lake Huron locations in 2006 through 2011. Ontario recreational guideline of 100 cfu/100 mL is indicated by a dashed line. Bottom: Percentage of samples exceeding 100 cfu/100 mL for the same location and years. Blue Flag criterion of not more than 20% is marked by a dashed line. (Data sources: BSRA 2009; Veliz and Brock 2007; Gutteridge and Veliz 2008; Upsdell and Veliz 2009a; Brock *et al*. 2010; Gutteridge and Veliz 2012).

Table 3.4 Geometric mean *Escherichia coli* concentrations in colony forming units (cfu) per 100 mL, and percentage of samples exceeding 100 cfu/100 mL for four Lake Huron locations in 2006 through 2011. Geometric means are calculated using all samples collected at all four locations over the entire summer sampling period. (Data sources: BSRA 2009; Veliz and Brock 2007; Gutteridge and Veliz 2008; Upsdell and Veliz 2009a; Brock *et al.* 2010; Gutteridge and Veliz 2012)

Lake Location	*Escherichia coli* Geometric Mean (cfu/100 mL)						Percentage of Samples > 100 cfu/100 mL					
	2006	2007	2008	2009	2010	2011	2006	2007	2008	2009	2010	2011
Wildwood	-	10	27	43	22	19	-	5	18	27	10	8
Houston Heights	38	18	24	29	25	32	23	10	11	16	17	15
St. Joseph	44	18	33	64	47	36	26	16	17	29	37	22
Ridgeway	85	22	29	40	48	32	34	20	18	35	38	22

Table 3.5 Geometric mean of *Escherichia coli* concentrations in colony forming units (cfu) per 100 mL, and percentage of samples exceeding 100 cfu/100 mL for four ravines draining into Lake Huron in 2006 through 2011. (Data sources: Veliz and Brock 2006; Veliz and Brock 2007; Gutteridge and Veliz 2008; Upsdell and Veliz 2009; Brock *et al*. 2010; Gutteridge and Veliz 2012).

Ravine	*Escherichia coli* Geometric Mean (cfu/100 mL)						Percentage of Samples > 100 cfu/100 mL					
	2006	2007	2008	2009	2010	2011	2006	2007	2008	2009	2010	2011
Wildwood	569	466	548	426	389	410	100	100	92	91	100	100
Houston Heights	567	179	294	480	501	527	85	85	77	100	83	100
St. Joseph	448	182	619	482	600	313	69	62	100	100	92	83
Ridgeway	1509	482	354	767	981	846	100	77	100	100	92	100

3.3.2.6.3 Bayfield Ratepayers Association

The Main Bayfield River watershed is valued by both local residents and tourists for Trout and Salmon fishing along the Bayfield River and for recreation at beaches along the Lake Huron shoreline. Issues surrounding water quality have been ongoing around the Lake Huron shoreline for many years. The Bayfield community has been interested in reducing *E. coli* concentrations in the Bayfield River in order to obtain and maintain a Blue Flag designation for the Bayfield Main Beach. This designation assures the local community and visitors that beach water quality is good. Since 2008, the Bayfield Ratepayers Association (BRA) and the ABCA have collaborated to monitor *E. coli* in the Main Bayfield River watershed.

Sample Collection

In 2011, water quality was monitored at ten sampling locations in the Main Bayfield River watershed, including two sites on the Bayfield River and eight sites on tributaries (streams or drains) flowing into the river. Seven of these locations were also monitored in 2008 through 2010. Water samples were collected every two weeks between June and November, except in 2008 when sampling began in August. The samples were analyzed by ALS Environmental in Waterloo, Ontario, to determine the concentration of *E. coli* in colony forming units per 100 millilitres of water (cfu/100 mL).

Data Interpretation

E. coli concentrations were summarized with geometric means and 90th percentiles. A 90th percentile is the concentration below which 90% of the samples for a given site occur. The 90th percentile is often used to summarize water quality information. Due to storm events, water quality results can be extremely variable. During routine water sampling, there can be a tendency to miss sampling storm events. Sometimes, it is necessary to show a typically high concentration (i.e., a 90th percentile value) to highlight the importance of storm events on water quality.

The results were compared with the Ontario Ministry of Health and Long-term Care recreational guideline of 100 cfu/100 mL, which is typically applied to beaches and reservoirs used for swimming (MOEE 1994).

Results

During 2011, the geometric mean of *E. coli* concentrations exceeded the 100 cfu/100 mL guideline at seven of the ten sampling locations (Table 3.6). Of the seven sites that were sampled in 2008 through 2011, five sites consistently had geometric means greater than the guideline. Geometric mean concentrations tended to be higher at the tributary sampling sites (those with HB site codes) than at the sites located on the Bayfield River (those with MB site codes).

The 90th percentile of *E. coli* concentrations was greater than 1000 cfu/100 mL (ten times the guideline value) at five of the 10 sites sampled in 2011 (Table 3.6). Of the seven sites sampled in 2008 through 2011, three sites consistently had 90th percentiles greater than 1000 cfu/100 mL.

Table 3.6 Geometric mean and 90th percentile of Escherichia coli concentrations, in colony forming units (cfu) per 100 mL, for sites in the Main Bayfield River watershed in 2008 through 2011. (Data sources: Upsdell and Veliz 2009b; Upsdell and Veliz 2009c; Upsdell and Veliz 2011; Upsdell and Veliz 2012).

Site	Geometric Mean (cfu/100 mL)				90th Percentile (cfu/100 mL)				Number of Samples			
	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011
HB1	53	555	492	70	414	1870	2750	190	6	4	5	3
HB2	312	106	300	235	1667	3072	4672	1427	8	11	11	12
HB3	298	467	858	385	5414	2708	7022	2325	8	11	11	12
HB4	180	338	415	248	1066	1254	2014	906	8	11	11	11
HB6	243	242	310	219	1145	3268	2060	1277	8	11	11	12
HB7	266	202	957	238	6268	570	3936	2899	8	11	11	12
HB8*				183				951				12
HB9*				215				2978				11
MB2	99	38	101	55	2294	252	1364	460	8	11	11	12
MB3*				69				976				12

* Monitoring at this site began in 2011.

3.3.3 Summary

The surface water quality in rivers in Huron County reflect its rural nature. Non-point sources of nitrogen, phosphorus and bacteria contribute to poor water quality conditions. More urban contaminates such as chloride and copper are not present in concentrations above the PWQO. There are differences in water chemistry amongst the rivers in Huron County. Rivers in the northern part of the County seem to have lower concentrations of nutrients and sediment than rivers in the southern part.

Nitrogen, in the form of nitrate, is an issue throughout the area with an exception of the Nine Mile River. Nitrate-nitrogen concentrations seem to be higher in watercourses in the southern part of Huron County, potentially reflecting the shift from more groundwater fed systems in the northern part of the County. Nitrate concentrations have also increased in County streams over the past 50 years. Phosphorus concentrations are high in the southern tributaries (i.e., Parkhill Creek, Ausable and Bayfield Rivers). Phosphorus concentrations seem to be declining in watercourses throughout the County.

Water samples for *E.coli* concentrations are not collected in a systematic manner in the watersheds of Huron County. Except for sites in the ABCA watershed, they are not collected as a part of the PWQMN. From the limited information collected by community groups at sites within the ABCA watershed, it is apparent that *E.coli* concentrations are spatially and temporally variable. There appears to be high concentrations of E coli in rivers and tributaries, and lower concentrations in Lake Huron. Typical *E.coli* concentrations for local watercourses are between 200 and 300 fecal colony forming units per 100 mL. In some locations and in some years the concentrations are higher.

A report prepared by the Ministry of Environment and Climate Change (Howell *et al.* 2005) analyzed the Huron County Health Unit beach water data collected between 1993 and 2003. Over this period, the median *E.coli* concentration at the beaches sampled was between 50 and 100 cfu/100 mL. The recreational water quality guideline of 100 cfu/100 mL was exceeded approximately 25% of the sampling opportunity. The results of this summary correspond with findings from the BSRA lake shore sampling. Further examination of the sources and conveyance of nutrients and bacteria in watercourses with different physical features and land use will inform stewardship efforts to improve the water for all users.

3.4 Biology

3.4.1 Benthic Macroinvertebrates

3.4.1.1 Background

Benthic macroinvertebrates are a group of larger, visible invertebrates (200-500 µm in length) that live on the bottom of watercourses. They include several types, such as insects, crustaceans, and mollusks. Since each species has a different level of tolerance for environmental stressors and pollutants that may be present in their local environment, benthic macroinvertebrates are often used as indicators of water quality. The presence of species that are intolerant to pollution generally indicates good water quality conditions.

Advantages of using benthic macroinvertebrates as water quality indicators include:

1. they are easy to identify to a reasonably fine taxonomic level;
2. they reflect local conditions due to their lack of mobility (relative to fish); and
3. longer-lived taxa can be used to detect past changes in water quality.

The ABCA, MVCA, SVCA, and UTRCA have each monitored water quality with benthic macroinvertebrates in Huron County watercourses, at approximately 150 sites total (Figure 3.11, Table 3.7). The ABCA's benthic monitoring program began in 2000 and has continued annually. Monitoring also took place in the Pergel Gully watershed between 1998 and 2000 for a special project. The MVCA monitored benthic macroinvertebrates in 1994, 1995, 1997, 2008, 2010, and 2011. The approximately ninety sites monitored by the MVCA in 1994, 1995, or 1997 are displayed in Figure 3.11, but do not appear in Table 3.6 because they lacked unique identifiers that would indicate on which watercourse they were located and during what year they were sampled. The SVCA has sampled two locations in Huron County for benthic macroinvertebrates, one in 2006 and the other in 2007. The UTRCA has also sampled two locations in the County, one in each of 1997 and 2003. Since the years of benthic macroinvertebrate monitoring by the four Conservation Authorities do not generally overlap, data from only 2010, during which the ABCA and MVCA both monitored benthic macroinvertebrates, were used for this assessment of Huron County water quality.

3.4.1.2 Methods

Sample Collection and Identification

Benthic macroinvertebrate samples were collected from a total of 18 sites in Huron County (ABCA – 13 sites; MVCA – 5 sites) during the autumn of 2010 (Table 3.7). This does not include sites that were sampled as part of special projects within ABCA's and MVCA's jurisdiction.

The ABCA collected benthic macroinvertebrate samples with a D-frame net that had a mesh size of 500 µm. A three-minute walking-kick technique was employed to ensure that all microhabitats (i.e., riffles, runs, pools) were sampled. Samples were initially preserved in 10% buffered formalin and, within a few weeks, were transferred to 70% ethanol. Benthic macroinvertebrates were sorted and identified by John Schwindt of the UTRCA. The samples were placed in a tray that was divided into equally-sized cells. Random cells were chosen for sequential removal of subsamples for sorting and identification until at least 300 macroinvertebrates had been identified. The macroinvertebrates were identified to family level.

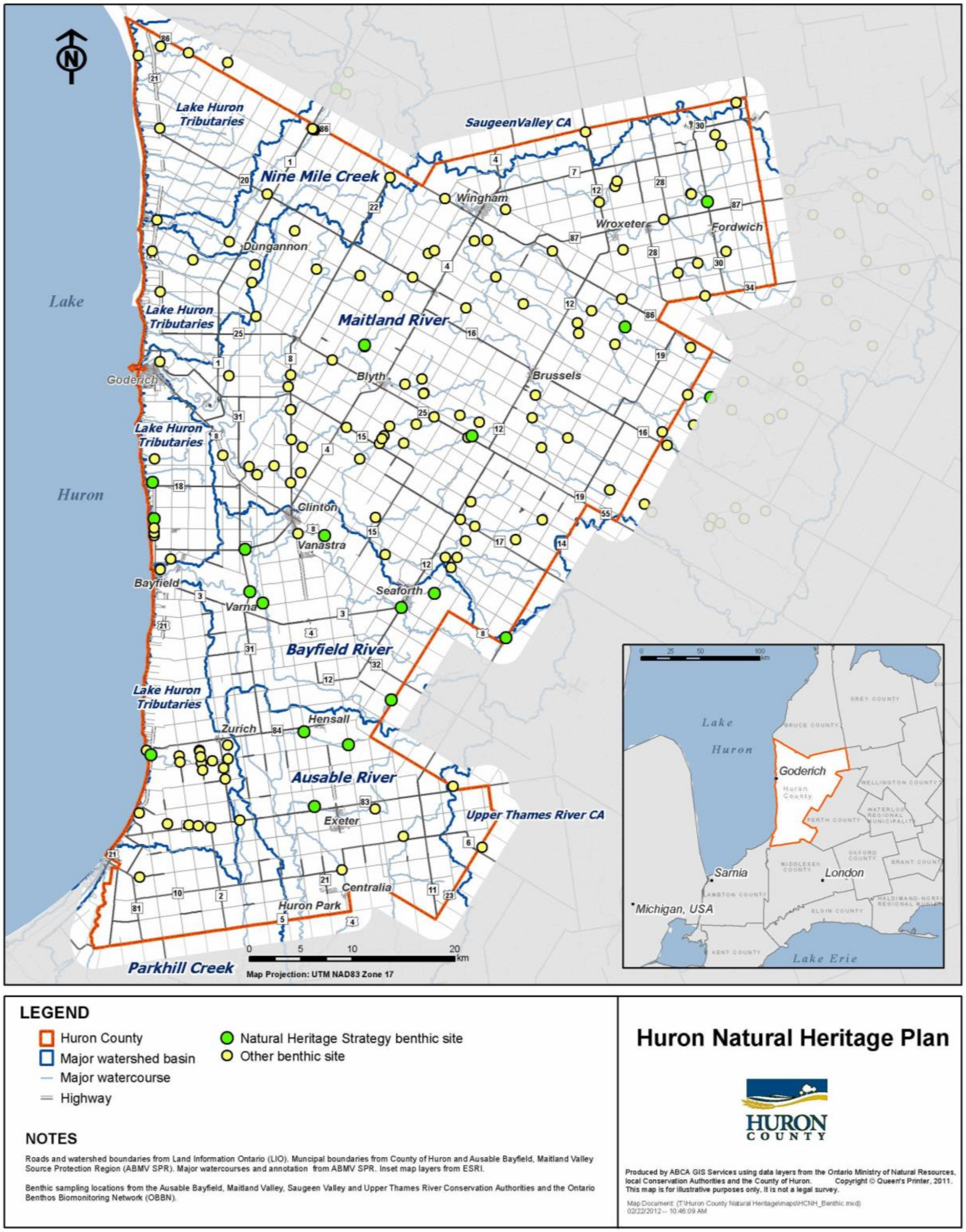

Figure 3.11 Locations in Huron County at which water quality has been monitored with benthic macroinvertebrates.

Table 3.7 Sites in Huron County where water quality has been monitored with benthic macroinvertebrates.

Site	Watercourse	Major Basin	Year(s) Sampled
Ausable Bayfield Conservation Authority			
GULGO361*	Fiddlehead Creek	Lake Huron Tributaries	2010
GULGO371*	Weston Creek	Lake Huron Tributaries	2010
GULGO37N1*	Cuttlefish Creek	Lake Huron Tributaries	2010
GULGO79N1*	DeJong Creek	Lake Huron Tributaries	2010
GULGUL1	Gully Creek	Lake Huron Tributaries	2001, 2003, 2005
GULGUL2	Gully Creek	Lake Huron Tributaries	2007, 2009-2011
GULRW3*	Kading Drain	Lake Huron Tributaries	2010
GULRW4*	Kading Drain	Lake Huron Tributaries	2010
GULRW5*	Kading Drain	Lake Huron Tributaries	2010
GULRW6*	Haugh Extension	Lake Huron Tributaries	2010
GULRW7*	Kading Drain	Lake Huron Tributaries	2010
GULZUR1*	Zurich Drain South	Lake Huron Tributaries	2010
GULZUR2*	Truemner Drain	Lake Huron Tributaries	1998, 2006
GULZUR3*	Truemner Drain	Lake Huron Tributaries	1998
GULZUR4*	Truemner Drain	Lake Huron Tributaries	1999, 2000, 2006
GULZUR5*	Masse Drain	Lake Huron Tributaries	1999
GULZUR6*	Geiger Drain	Lake Huron Tributaries	1999, 2000, 2006
GULZUR7*	Truemner Drain	Lake Huron Tributaries	1999
GULZUR8	Pergel Gully	Lake Huron Tributaries	1998, 2000, 2001, 2003, 2005-2011
GULZUR9*	Pergel Gully	Lake Huron Tributaries	1999
GULZUR11*	Geiger Drain	Lake Huron Tributaries	2006, 2010
GULZUR12*	McAdams-Dietrich Drain Branch	Lake Huron Tributaries	2006, 2010
GULZUR13*	McAdams-Dietrich Drain Tributary	Lake Huron Tributaries	2006, 2010
GULZUR14*	Masse Drain	Lake Huron Tributaries	2006, 2010
GULZUR16*	Zurich Drain South	Lake Huron Tributaries	2010
HABLA1	Black Creek (Headwaters)	Ausable River	2000, 2002, 2004, 2006, 2008, 2010
HACENT1	Centralia Drain	Ausable River	2002, 2004, 2006, 2008, 2011
HAELIM1	Elimville Drain	Ausable River	2000, 2002, 2004-2006, 2008, 2011
HBBAN1	Bannockburn River (Headwaters)	Bayfield River	2000, 2002, 2004, 2006, 2008, 2010
HBHEL1	Helgrammite Creek	Bayfield River	2000, 2002-2006, 2008-2011
HBLIF1	Liffy Drain	Bayfield River	2000, 2002, 2004, 2006, 2008, 2010, 2011
HBSIL1	Silver Creek	Bayfield River	2000, 2002, 2004, 2006, 2008, 2010
HBSTEEN1	Steenstra Drain	Bayfield River	2003, 2005-2008, 2010

Site	Watercourse	Major Basin	Year(s) Sampled
HPDESJ1	Desjardine Drain	Parkhill Creek	2006, 2008, 2011
HPPARK1	Mud Creek	Parkhill Creek	2000
MABLA2	Black Creek	Ausable River	2001, 2003, 2005, 2007, 2009, 2010, 2011
MAEXE1	Ausable River (Upper)	Ausable River	2010, 2011
MAMOR1	Ausable River (Upper)	Ausable River	2001, 2003, 2005, 2008, 2009, 2011
MBBAN1	Bannockburn River	Bayfield River	2001, 2003, 2005-2007, 2009-2011
MBBAY1	Bayfield River (Lower)	Bayfield River	2001
MBCLI1	Bayfield River (Lower)	Bayfield River	2001
MBSEA1	Bayfield River (Upper)	Bayfield River	2002, 2003, 2005, 2007, 2009, 2010
MBVAR1	Bayfield River (Lower)	Bayfield River	2002, 2003, 2005, 2007, 2009-2011
Maitland Valley Conservation Authority			
Beauchamps	Middle Maitland River	Maitland River	2008
Blyth	Blyth Brook	Maitland River	2008
Jamestown	Little Maitland River	Maitland River	2008
LM1	Little Maitland River	Maitland River	2010
LWM1	Lower Maitland River	Maitland River	2010
NM1	North Maitland River	Maitland River	2010
Quarter Line	Little Maitland River	Maitland River	2008
Salem	North Maitland River	Maitland River	2008
SL1	Shoreline	Lake Huron Tributaries	2010
SM1	South Maitland River	Maitland River	2010
Summerhill	South Maitland River	Maitland River	2008
Saugeen Valley Conservation Authority			
2176	South Saugeen River Tributary	Saugeen Valley CA	2007
2648	Teeswater River Tributary	Saugeen Valley CA	2006
Upper Thames River Conservation Authority			
—	Fish Creek Tributary	Upper Thames River CA	1997
—	Watson Drain	Upper Thames River CA	2003

* This site was sampled as part of a special project by the Ausable Bayfield Conservation Authority.

The MVCA followed the Ontario Benthos Biomonitoring Network (OBBN) protocol to collect benthic macroinvertebrate samples with a D-frame net that had a mesh size of 500 µm (Jones *et al.* 2007). Three samples were collected per site: two from riffle habitats and one from a pool habitat. Each sample was collected with a three-minute traveling kick-and-sweep technique. Benthic macroinvertebrates were sorted and identified immediately by MVCA staff. The samples were stirred to randomize the organisms and sub-samples of known volume were extracted until at least 100 macroinvertebrates had been identified. A hand lens was used as an aid in identifying macroinvertebrates to the minimum OBBN level of 27 taxonomic groups.

3.4.1.3 Data Analysis

Each site was classified with a Hilsenhoff Index, following the Stream Assessment Protocol for Southern Ontario (Stanfield *et al.* 1999). This index was modified from Hilsenhoff's Family Biotic Index (Hilsenhoff 1988). The Hilsenhoff Index works by assigning a weighting to each of 23 taxonomic groups based on its tolerance of organic pollution (Table 3.8). The index for each site is calculated from the abundance data and the tolerance values for each of the 23 taxa with the following equation:

$$HI = (\Sigma x_i t_i)/n$$

where HI is the value of the Hilsenhoff Index, which is the sum of the abundance (x_i) multiplied by the tolerance value (t_i) for all taxa, then divided by the total abundance of all taxa (n).

Table 3.8 Hilsenhoff Index weightings for each of 23 taxonomic groups based on their tolerance of organic pollution (modified from Stanfield *et al*. 1999).

Benthic Macroinvertebrate Taxon	**Hilsenhoff Index Weighting**
Acarina (Water Mites)	6
Oligochaeta (Segmented Worms)	8
Hirudinea (Leeches)	8
Amphipoda (Scuds)	6
Isopoda (Aquatic Sowbugs)	8
Chironomidae (Blood Worms)	7
Simuliidae (Black Flies)	6
Tipulidae (Crane Flies)	3
Other *Diptera*	5
Ephemeroptera (Mayflies)	5
Plecoptera (Stoneflies)	1
Hemiptera (True Bugs)	5
Coleoptera (Beetles)	4
Megaloptera (Helgrammites)	4
Anisoptera (Dragonflies)	5
Zygoptera (Damselflies)	7
Trichoptera (Caddisflies)	4
Gastropoda (Snails)	8
Pelecypoda (Clams)	6
Ostracoda (Seed Shrimp)	7
Decapoda (Crayfish)	0
Coelenterata (Hydra)	5
Turbellaria (Flatworms)	6

The Hilsenhoff Index for each site provided an indication of water quality and the degree of organic pollution according to the interpretations in Table 3.9.

Table 3.9. Interpretation of Hilsenhoff Index with respect to water quality and the degree of organic pollution (from Stanfield *et al*. 1999).

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 – 6.50	Fairly Poor	Substantial organic pollution likely
6.51 – 7.25	Poor	Very substantial organic pollution likely
7.26 – 10.0	Very Poor	Severe organic pollution likely

3.4.1.4 Results

Hilsenhoff Index values calculated for each Huron County site sampled in 2010 are presented in Table 3.10. The best water quality (Very Good) was found in the South Maitland River, while the worst water quality (Very Poor) was found in the Steenstra Drain, a tributary of the lower Bayfield River. Of the remaining sites, three were classified as having Good water quality, six as Fair, four as Fairly Poor, and three as Poor (Figure 3.12). The average Hilsenhoff Index of all eighteen sites in 2010 was 5.82. This indicated that, overall, stream water quality in Huron County was Fairly Poor.

Table 3.10 Hilsenhoff Index values and corresponding water quality conditions for Huron County sites sampled by the Ausable Bayfield Conservation Authority and Maitland Valley Conservation Authority in the Autumn of 2010.

Site	Watercourse	Hilsenhoff Index	Water Quality
Ausable Bayfield Conservation Authority			
GULGUL2	Gully Creek	4.93	Good
GULZUR8	Zurich Drain	5.69	Fair
HABLA1	Black Creek (Headwaters)	6.47	Fairly Poor
HBBAN1	Bannockburn River (Headwaters)	5.12	Fair
HBHEL1	Helgrammite Creek	6.35	Fairly Poor
HBLIF1	Liffy Drain	6.76	Poor
HBSIL1	Silver Creek	6.53	Poor
HBSTEEN1	Steenstra Drain	7.58	Very Poor
MABLA2	Black Creek	6.05	Fairly Poor
MAEXE1	Ausable River (Upper)	5.66	Fair
MBBAN1	Bannockburn River	5.40	Fair
MBSEA1	Bayfield River (Upper)	4.96	Good
MBVAR1	Bayfield River (Lower)	5.17	Fair
Maitland Valley Conservation Authority			
LM1	Little Maitland River	5.62	Fair
LWM1	Lower Maitland River	7.02	Poor
NM1	North Maitland River	4.89	Good
SL1	Shoreline	6.47	Fairly Poor
SM1	South Maitland River	4.11	Very Good

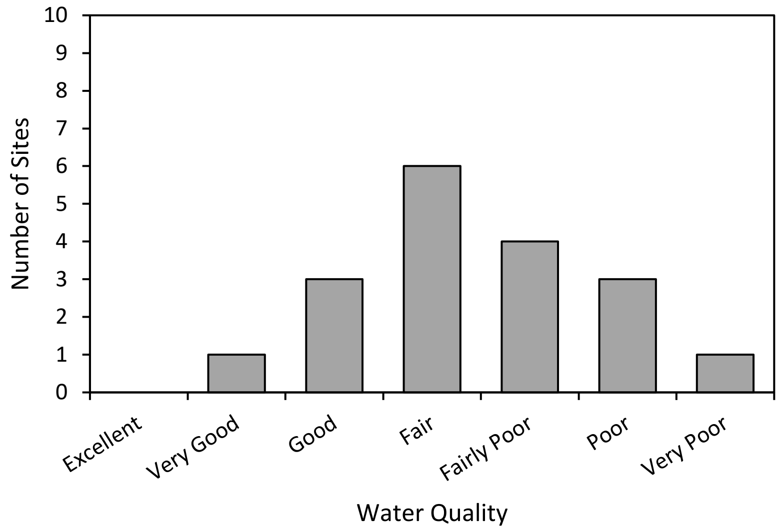

Figure 3.12 Number of Huron County sites with various water quality conditions in 2010 based on the Hilsenhoff Index for benthic invertebrates.

3.4.2 Fish

The *Fisheries Act* defines fish as “shellfish, crustaceans, marine animals and any parts of these”. It defines fish habitat as “spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes”. The quality of aquatic habitat depends on water quantity (i.e., water depth and velocity), water quality (most specifically water temperature, dissolved oxygen concentrations, to some extent turbidity, and nitrogen (N) and phosphorus (P) concentrations), aquatic plants, in-stream substrate type and structure, and benthic invertebrates (an important fish food source). Activities that alter these characteristics may potentially alter fish habitat. Fish habitat is a natural feature identified under section 2.1 of the PPS (OMMAH 2014), and must be protected. Watercourses are also protected under the *Fisheries Act*.

The Ausable River supports one of the most diverse and unique assemblages of aquatic fauna for a watershed of its size in Canada. At least 26 species of freshwater mussels and 85 species of fish have been documented (Kari Jean pers. comm. February 12, 2015; Table 3.11). Thus, in this agricultural landscape the diversity of fish species is impressive, although not uncommon. The Grand River basin, another watershed dominated by agricultural activity, is home to 80 confirmed species (OMNR and GRCA 1998). Similar numbers of fish species are also found for the Upper Thames and the St. Clair Region. However, species diversity at any one site is typically less than 10. In 1999/2000, ABCA surveyed 40 watercourses in the southern part of the watershed. Most sites (34) had less than 10 species. Low species diversity may indicate poor habitat conditions. Furthermore, the distribution of some of the more sensitive fish species (i.e., warm water intolerant species, such as salmonids, or sediment intolerant species, such as percids) may be limited by land use practices that affect water quality and the physical stream environment and thus, limit the abundance and distribution of sensitive species.

Fish abundance data has been used as a biological monitoring assessment tool in select streams but not as a diagnostic tool for area watercourses. However, information regarding the presence/absence of fish species has helped determine the classification of municipal drains.

Table 3.11 Confirmed fish species in the Maitland, Bayfield, Ausable, Saugeen and Thames River Basins

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*	Largemouth Bass	*Micropterus salmoides*
American Brook Lamprey	*Lampetra appendix*	Least Darter	*Etheostoma microperca*
Atlantic Salmon	*Salmon salar*	Logperch	*Percina caprodes*
Banded Killifish	*Fundulus diaphanus*	Longear Sunfish	*Lepomis megalotis*
Black Bullhead	*Ameiurus melas*	Longnose Dace	*Rhynichthys cataractae*
Black Crappie	*Pomoxis nigromaculatus*	Mimic Shiner	*Notropis volucellus*
Black Redhorse	*Moxostoma duquesnei*	Mottled Sculpin	*Cottus bairdi*
Blackchin Shiner	*Notropis heterodon*	Muskellunge	*Esox masquinongy*
Blacknose Dace	*Rhinichthys atratulus*	Northern Brook Lamprey	*Ichthyomyzon fossor*
Blacknose Shiner	*Notrops heterolepis*	Northern Hog Sucker	*Hypentelium nigricans*
Blackside Darter	*Percina maculata*	Northern Pearl Dace	*Margariscus nachtriebi*
Bluegill	*Lepomis macrochirus*	Northern Pike	*Esox lucius*
Bluntnose Minnow	*Pimephales notatus*	Northern Redbelly Dace	*Phoxinus eos*
Bowfin	*Amia calva*	Northern Redhorse	*Moxostoma carinatum*
Brassy Minnow	*Hybognathus hankinsoni*	Pearl Dace	*Margariscus margarita*
Brook Stickleback	*Culaea inconstans*	Pickerel/Walleye	*Stizostedion vitreum*
Brook Trout	*Salvelinus fontinalis*	Pink Salmon	*Oncorhynchus gorbuscha*
Brown Bullhead	*Ameiurus nebulosus*	Pugnose Shiner	*Notropis anogenus*
Brown Trout	*Salmo trutta*	Pumpkinseed	*Lepomis gibbosus*
Catfish	*Ictalurus punctatus*	Quillback	*Carpiodes cyprinus*
Central Mudminnow	*Umbra limi*	Rainbow Darter	*Etheostoma caeruleum*
Central Stoneroller	*Campostoma anomalum*	Rainbow Smelt	*Osemerus mordax*
Channel Catfish	*Ictalurus punctatus*	Rainbow Trout	*Oncorhynchus mykiss*
Chinook Salmon	*Oncorhynchus tshawytscha*	Redfin Shiner	*Lythrurus umbratilis*
Coho Salmon	*Oncorhynchus kisutch*	Redside Dace	*Clinostomus elongates*
Common Carp	*Cyprinus carpio*	River Chub	*Nocomis micropogon*
Common Shiner	*Luxilus cornutus*	River Redhorse	*Moxostoma carinatum*
Creek Chub	*Semotilus atromaculatus*	Rock Bass	*Ambloplites rupestris*
Emerald Shiner	*Notropis atherinoides*	Rosyface Shiner	*Notropis rubellus*
Fantail Darter	*Etheostoma flabellare*	Sand Shiner	*Notropis stramineus*
Fathead Minnow	*Pimephales promelas*	Shorthead Redhorse	*Moxostoma macrolepidotum*
Ghost Shiner	*Notropis buchanani*	Silver Shiner	*Notropis photogenis*
Gizzard Shad	*Dorosoma cepedianum*	Smallmouth Bass	*Micropterus dolomieui*
Golden Redhorse	*Moxostoma erythrurum*	Spotfin Shiner	*Cyprinella spiloptera*
Golden Shiner	*Notemigonus crysoleucas*	Stonecat	*Notorus flavus*
Grass Pickerel	*Esox americanus vermiculatum*	Striped Shiner	*Notropis chrysoocephalus*
Greater Redhorse	*Moxostoma valenciennesi*	Tadpole Madtom	*Notorus gyrinus*
Green Sunfish	*Lepomis cyanellus*	Trout-perch	*Percopsis omiscomaycus*
Greenside Darter	*Etheostoma blennioides*	White Crappie	*Pomoxis annularis*
Hornyhead Chub	*Nocomis biguttatus*	White Sucker	*Catostomus commersoni*
Iowa Darter	*Etheostoma exile*	Yellow Bullhead	*Ameiurus natalis*
Johnny Darter	*Etheostoma nigrum*	Yellow Perch	*Perca flavescens*
Lake Chubsucker	*Erimyzon sucetta*		

3.5 Drain Classifications

In rural Ontario many watercourses are Municipal Drains. These drains are either modified naturally occurring creeks or have been constructed. Drains have been constructed to provide an outlet for subsurface drainage or improve drainage from wet areas on farm properties. Periodically, deposited sediment and brush need to be cleaned out of the drain to help improve their function. As these drains provide potential fish habitat they are protected under the *Fisheries Act*. The Act is comprised of three main areas of focus: management and monitoring of fisheries, conservation and protection of fish and fish habitat, and pollution prevention. The Act states in Section 35 that “no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery” without receiving authorization by the Minister of Fisheries and Oceans Canada.

To help determine the level of protection required for each drain, a Municipal Drain Classification system was created. This classification system is comprised of six drain types (A, B, C, D, E, and F), each type varying in the combination of flow, temperature, species present, and time since last clean out. The class authorization required for work done within a drain is dependent on the drain type. For example, Drain Type A has permanent flow, cold to cool water temperatures, no sensitive species present, and requires a Class A authorization. For each drain type their associated drain maintenance activities and typical terms and conditions for work are outlined in Table 3.12. Drain types A, B, and C can be authorized by the Conservation Authority in cooperation with the Department of Fisheries and Oceans (DFO), depending on the level of agreement in place. While drain types D and E require project specific authorization directly through the DFO. Drain type F is the only type that does not require authorization but does have specific terms and conditions for potential work being done. If Species at Risk are identified in a drain, a site specific review is required. Within Huron County, all the Municipal Drains have been classified (Table 3.12). Approximately 49% of watercourses in Huron County are Municipal Drains (Table 3.13).

Table 3.12 Municipal Drain classification and Ontario's Class Authorization System

Drain Type	Flow	Temperature	Drain Classification Table Species	Time Since Last clean-out	Authorization	Associated Drain Maintenance Activities	Typical Terms and Conditions for Work
A	Permanent	Cold/cool	No sensitive species and/or communities present	Not applicable	Class A	Brushing of side slope, bottom clean-out (bed of drain only) and debris clean-out	• Re-establish riparian/bank vegetation if removed: timing restrictions (to protect fish during critical or sensitive life stages) • Finished channel to be as narrow and deep as possible • Sediment and erosion control measures • Riparian vegetation to be left in unaltered state on shade producing side (i.e., maintaining vegetation along the south or west side of drain) • Bends in channel stabilized • Work in-water only when flows are not elevated
B	Permanent	Warm	Sensitive species and/or communities present	Less than 10 years	Class B	Brushing of side slope, bottom clean-out (bed of drain only) and debris clean-out	• Finished channel to be as narrow and deep as possible • Riparian vegetation can be removed from either bank (not both) • Riparian and bank vegetation to be re-established if removed • Timing restrictions (to protect fish during critical or sensitive life stages) • Sediment and erosion control measures • Bends in channel stabilized • Work in-water only when flows are not elevated
C	Permanent	Warm	No sensitive species and/or communities present	Not applicable	Class C	Brushing of side slope, bottom clean-out (bed of drain) and full clean-out	• Finished channel to be as narrow and deep as possible • Riparian vegetation can be removed from either bank (not both) • Timing restrictions (to protect fish during critical or sensitive life stages) • Sediment and erosion control measures • Bends in channel stabilized • Work in-water only when flows are not elevated
D	Permanent	Cold/cool	Sensitive species and/or communities present	Not applicable	Project specific	Projects in type D or E drains are reviewed on a project-by-project basis. If the harm to fish cannot be fully mitigated, a project specific authorization is needed	• Project specific
E	Permanent	Warm	Sensitive species and/or communities present	Greater than 10 years	Project specific		• Project specific
F	Intermittent or ephemeral (dry for more than two consecutive months)	Not applicable	Not applicable	Not applicable	Not required (if work is done in dry)	Bottom or full clean-out and vegetation removal	• Work is done in dry • All disturbed soil is stabilized upon completion of work *Note: If the drain is wet at the time of clean out and it has been classified as an F, the drain will be treated as type A,B or C with requirement to follow respective Class Authorization terms & conditions*

Table 3.13 Percentages of municipal drains separated by class within Huron County

Municipal Class	Length (km)	Percent
A	661.7	12.0 %
B	138.4	2.5 %
C	1,030.6	18.8 %
D	522.1	9.5 %
E	566.4	10.3 %
F - Intermittent	905.9	16.5 %
T - Tiled	1,175.3	21.4 %
U - Unclassified	493.8	9.0 %
Total	**5,494.2**	**100 %**

3.6 Sensitivity of Watercourses

3.6.1 Background

Watercourses offer Huron County diverse and considerable benefits for the natural environment as well as the economy. They provide habitat for plant and animal species, including Species at Risk. Wetlands in conjunction with watercourses can act as a natural filtration system to improve the quality of water flowing into Lake Huron. For the agricultural community, watercourses are vital to their livelihood (e.g. for irrigation, livestock watering). The presence of a watercourse can increase property value and provide recreational opportunities such as fishing, boating and swimming.

Another way of considering water quality in Huron County is an analysis of the sensitivity of watercourses. The sensitivity analysis groups watercourses into five systems (Table 3.14). This analysis helps to summarize areas within Huron County that have more sensitive watercourses. Note that the water quality indicators were not included in the sensitivity analysis.

Table 3.14 Description of the grouping of watercourses with Huron County, and the percentages of watercourses within each sensitivity group.

Group	Description	Length of Watercourse System (km)	Percent of Total Watercourse System
System 1	Natural watercourses, Ontario Municipal Drain Type A, B, D, E, and watercourses containing Species at Risk (SAR)	2,435.6	44.3
System 2	Ontario Municipal Drain Type C	872.7	15.9
System 3	Ontario Municipal Drain Type F	588.6	10.7
Closed	Watercourse that has been tiled and brought underground	1,175.3	21.4
Unclassified	Intermittent or small watercourses that have not yet been formally classified	422.1	7.7
	Total	5,494.2	100

System 1 is comprised of natural watercourses, Ontario Municipal Drain Type A, B, D, E, and watercourses containing Species at Risk (SAR) (aquatic SAR and at-risk reptiles). See Section 3.5 for a description of the Ontario Municipal Drain Classification System and how the assessments were completed.

System 1 has permanent flow, cold or warm water habitat and/or sensitive aquatic species. System 1 provides the majority of habitat for aquatic species including Species at Risk (SAR) and contributes to the base flow within Huron County. This mapping exercise has estimated 44.3% are System 1, which is the highest percentage for each of the system types (Table 3.14 and Figure 3.13).

System 2 is comprised of Ontario Municipal Drain Type C, which is a permanent watercourse with warm water and no sensitive aquatic species or communities present.

System 1 and System 2 define watercourses that have flowing waters in the summer.

System 3 is comprised of Ontario Municipal Drain Type F, which has intermittent flow and is dry for more than two consecutive months. The closed systems are watercourses that have been tiled underground. The amount of closed watercourses within Huron County is underestimated, since not all closed watercourses have been identified within the mapping system.

Lastly the Unclassified grouping includes watercourses which as of yet have not been formally classified. They most likely include intermittent or small watercourses which may be located on private properties or alternatively may not be watercourses at all.

From this mapping exercise, approximately 21.4% of watercourses are closed within Huron County, which is a higher percentage than either System 2 or System 3 watercourses, which are 15.9% and 10.7% respectively. These closed watercourses potentially short circuit the soil-water interface reactions that occur in smaller watercourses, which help reduce downstream nutrient and sediment concentrations.

3.6.2 Results

Watercourse sensitivity was calculated for each municipality in Huron County (Table 3.15). This information can be used to determine which areas within Huron County contain the most sensitive watercourses. Maps for each Municipality within Huron County (Figure 3.14 to Figure 3.21) were also created to view watercourses categorized by each of the five system types (Table 3.14).

Most municipalities have the highest percentage of System 1 watercourses (by watercourse length). System 1 watercourses can be cold or warm, and provide the majority of habitat for aquatic species, including Species at Risk (SAR), and contribute to the base flow within Huron County. These systems are considered the most sensitive watercourses.

The Municipality of Howick had the highest percentage of System 1 watercourses (60.9%) compared to South Huron, which had the lowest (23.6%). Both Huron East and Huron South municipalities have the highest percentage of System 2 watercourses (43.6% and 34.6% respectively). System 2 watercourses are drains with warm water, but have no sensitive aquatic species or communities present.

Several municipalities (Ashfield-Colborne-Wawanosh, Central Huron/Goderich, Morris-Turnberry, and North Huron) within Huron County have closed systems as their second highest categorized watercourses. These watercourses have been tiled and brought underground and are no longer providing aquatic habitat.

Table 3.15 Length of watercourses within each Municipality in Huron County grouped by watercourse sensitivity.

Municipality	Watercourse Sensitivity Information		
	Watercourse Groups	***Length (m)***	***Percentage (%)***
Ashfield-Colborne-Wawanosh	1	544,968	43.6
	2	80,590	6.5
	3	76,884	6.2
	Closed	475,184	38.1
	Unknown	70,893	5.7
	Total	1,248,518	100
Bluewater	1	234,586	42.6
	2	116,365	21.1
	3	134,975	24.5
	Closed	37,216	6.8
	Unknown	27,184	4.9
	Total	55,0326	100
Central Huron / Goderich*	1	440,230	57.3
	2	51,640	6.7
	3	37,719	4.9
	Closed	187,932	24.5
	Unknown	51,099	6.6
	Total	768,620	100
Howick	1	225,188	60.9
	2	4,800	1.3
	3	40,891	11.1
	Closed	37,593	10.2
	Unknown	61,432	16.6
	Total	369,903	100
Huron East	1	267,169	35.7
	2	326,752	43.6
	3	59,904	8.0
	Closed	78,648	10.5
	Unknown	16,938	2.3
	Total	749,411	100
Morris -Turnberry	1	300,154	50.5
	2	36,292	6.1
	3	11,760	2.0
	Closed	180,759	30.4
	Unknown	65,761	11.1
	Total	594,726	100
North Huron	1	182,815	61.2
	2	1,643	0.5
	3	9,896	3.3
	Closed	91,738	30.7
	Unknown	12,787	4.3
	Total	298,878	100

Municipality	Watercourse Sensitivity Information		
	Watercourse Groups	***Length (m)***	***Percentage (%)***
South Huron	1	105,649	23.6
	2	154,980	34.6
	3	146,897	32.8
	Closed	24,333	5.4
	Unknown	15,647	3.5
	Total	447,506	100

*For the purposes of this study, any watercourses within Goderich are included within Central Huron (Figure 3.16).

3.7 Summary

The aquatic resource information that was collected will help support future decisions regarding development, land use changes, habitat protection and remediation, irrigation, water supply, dilution of contaminants and recreation within Huron County.

Overall, the aquatic resource information analyzed for this report shows the northern portions of the Ausable, Bayfield and Maitland Rivers as having the most sensitive watercourses (Figure 3.13). A significant base flow contribution is also prevalent in the northern portions of the Ausable, Bayfield and Maitland Rivers, and is positively influencing the high sensitivity values found within this headwater region. The Ausable Bayfield Conservation Authority is reviewing approaches to incorporate the results from the Aquatic Resources Study more completely into a Natural Heritage Systems Study. In the future this information could be incorporated into a review of this Technical Document.

These sensitive headwater regions within Huron County are important to consider. The geology in these areas suggests that there is natural potential to support valuable habitat and improve water quality and quantity. However, the aquatic resources information (water quality and biology) suggests that land use changes in Huron County have potentially impaired the resources in these regions, and ways to mitigate these changes should be reviewed. Drawing from the findings of the Aquatic Resources Study, the following recommendations are proposed to work toward a healthier aquatic ecosystem.

The collection of *E. coli* data is completed by different agencies to meet different objectives. The summarized information that is readily available is from programs that community groups have fostered. Monitoring fecal contamination is important, as this is one of the top three pollutants that the United States Environmental Protection Agency has listed that is impairing US water bodies. Locally, the abundance of this indicator in area beaches has very important economic repercussions as found by Dodds (2010). It is recommended that local agencies find more effective ways of collecting and reporting on the abundance and distribution of this water quality indicator.

Further examination of the sources and conveyance of nutrients and bacteria in watercourses with different physical features and land use will inform stewardship efforts to help to improve the water for all users.

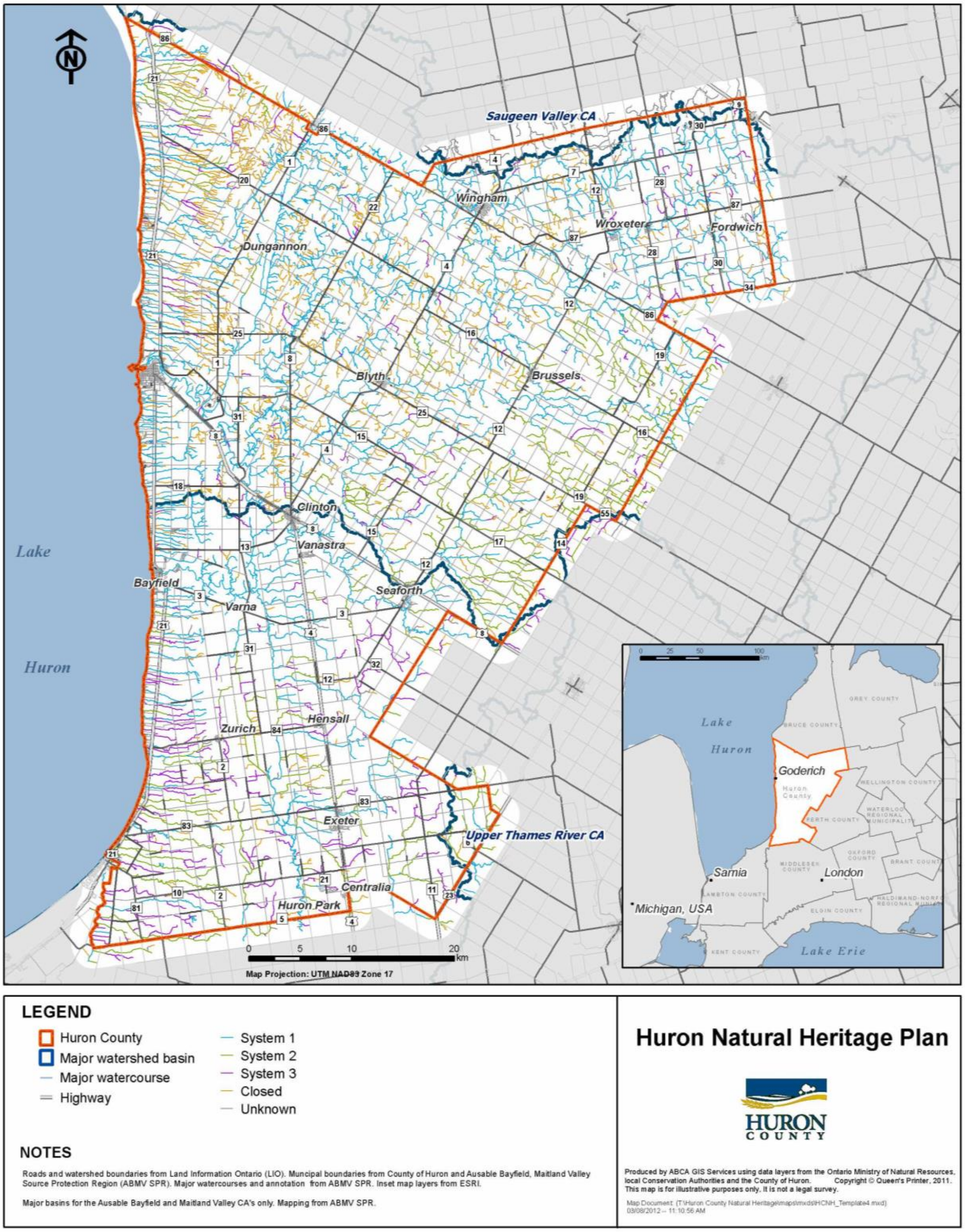

Figure 3.13 Watercourses categorized as system types in Huron County

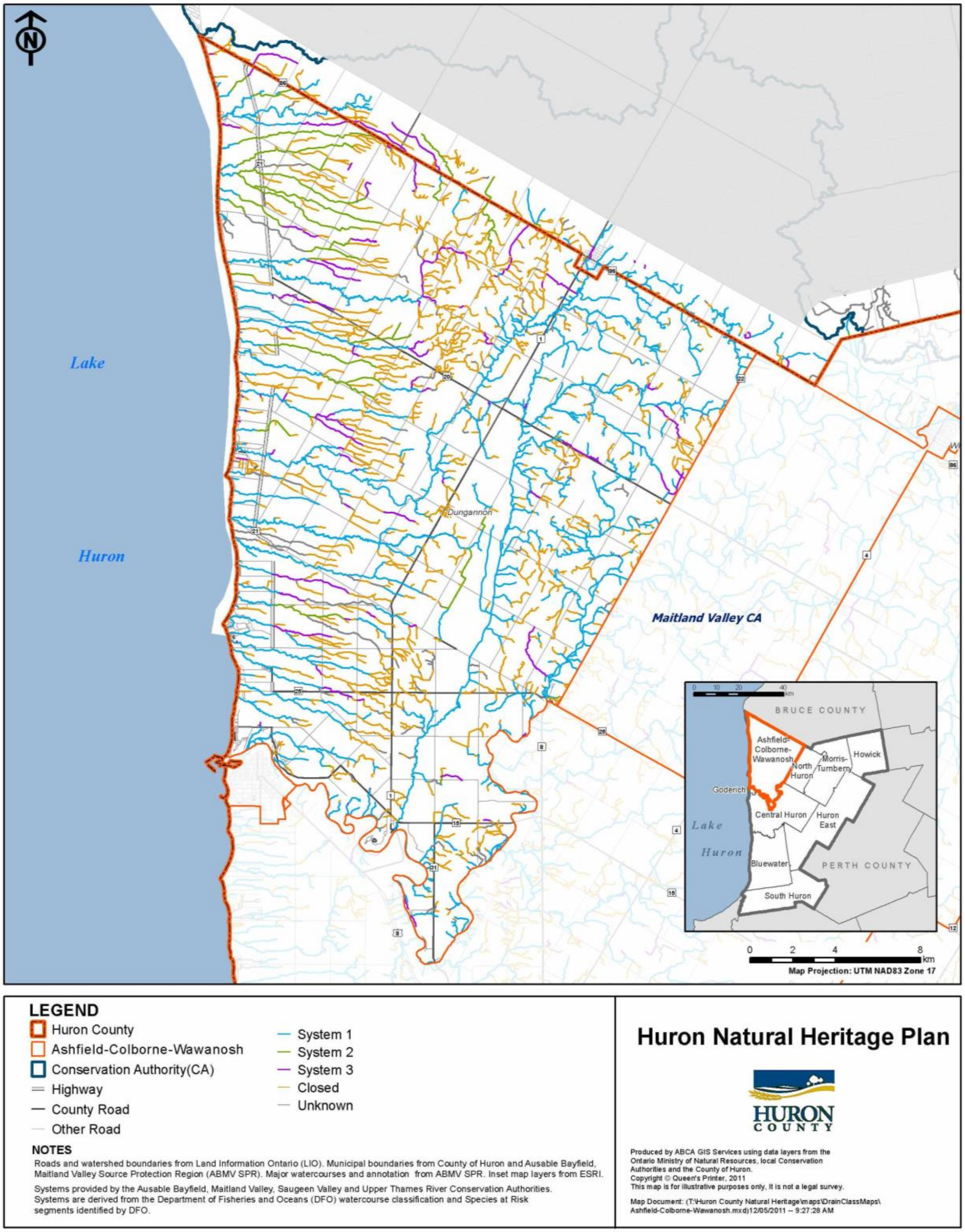

Figure 3.14 Watercourses categorized as system types in Ashfield-Colborne-Wawanosh.

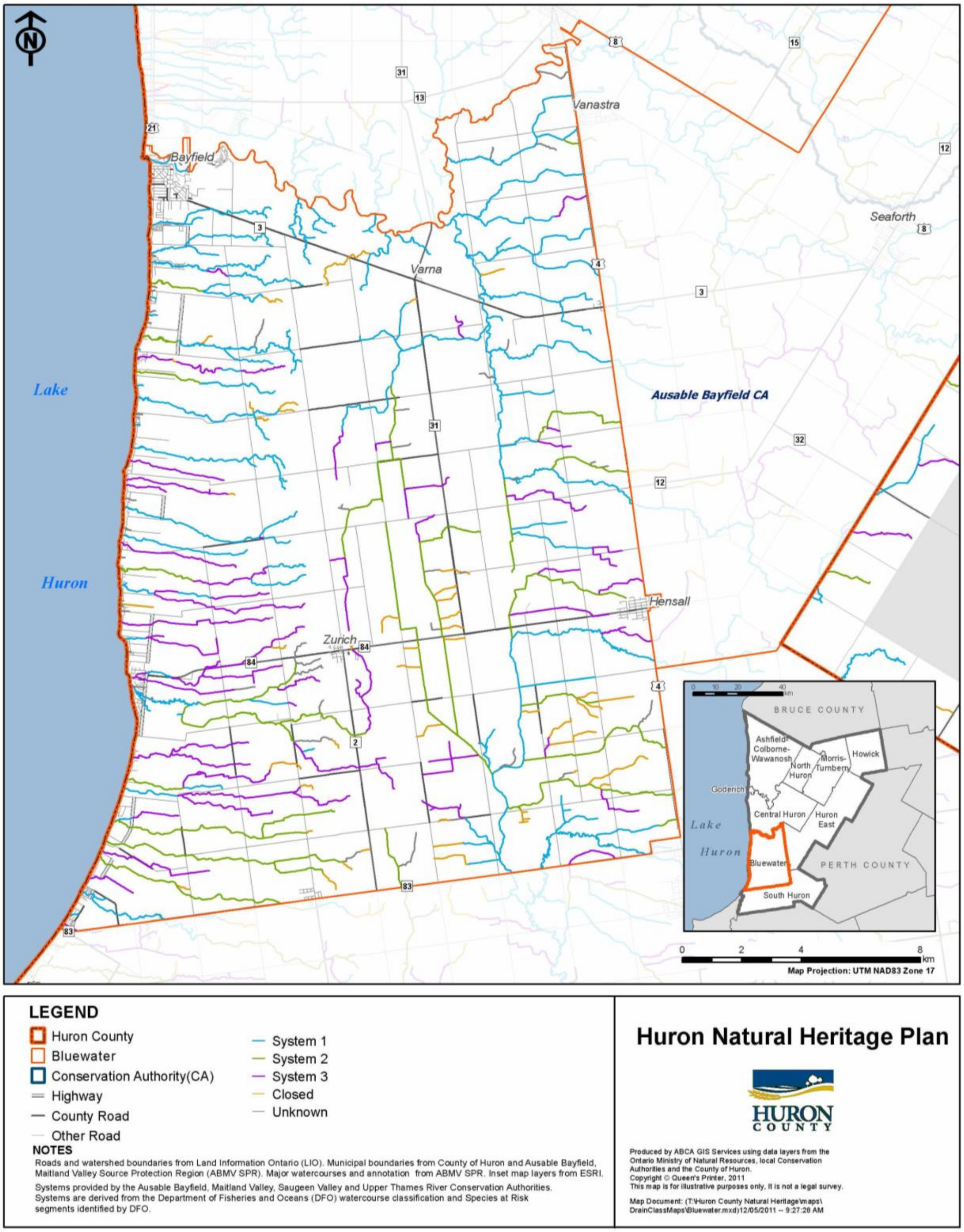

Figure 3.15 Watercourses categorized as system types in Bluewater.

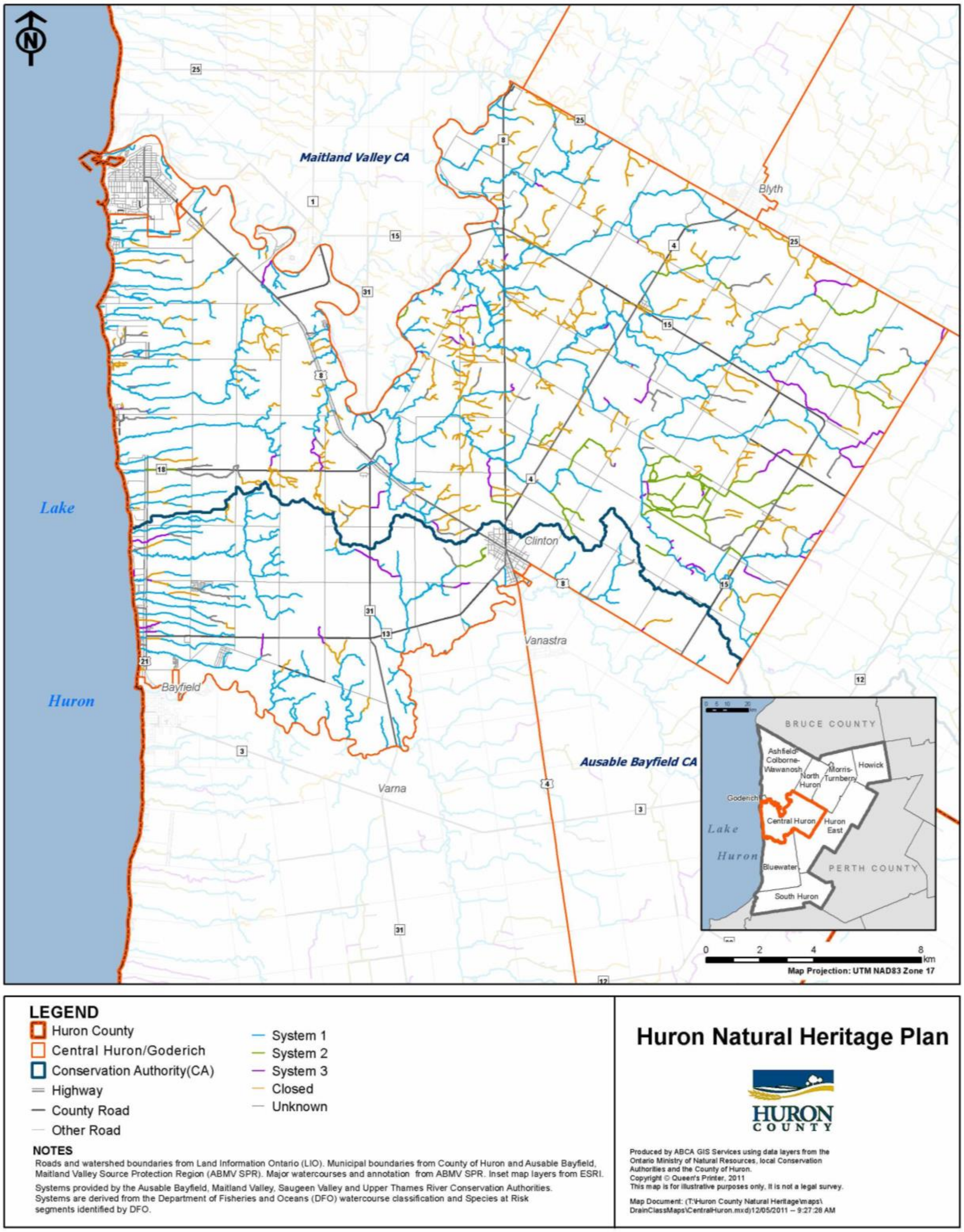

Figure 3.16 Watercourses categorized as system types in Central Huron / Goderich.

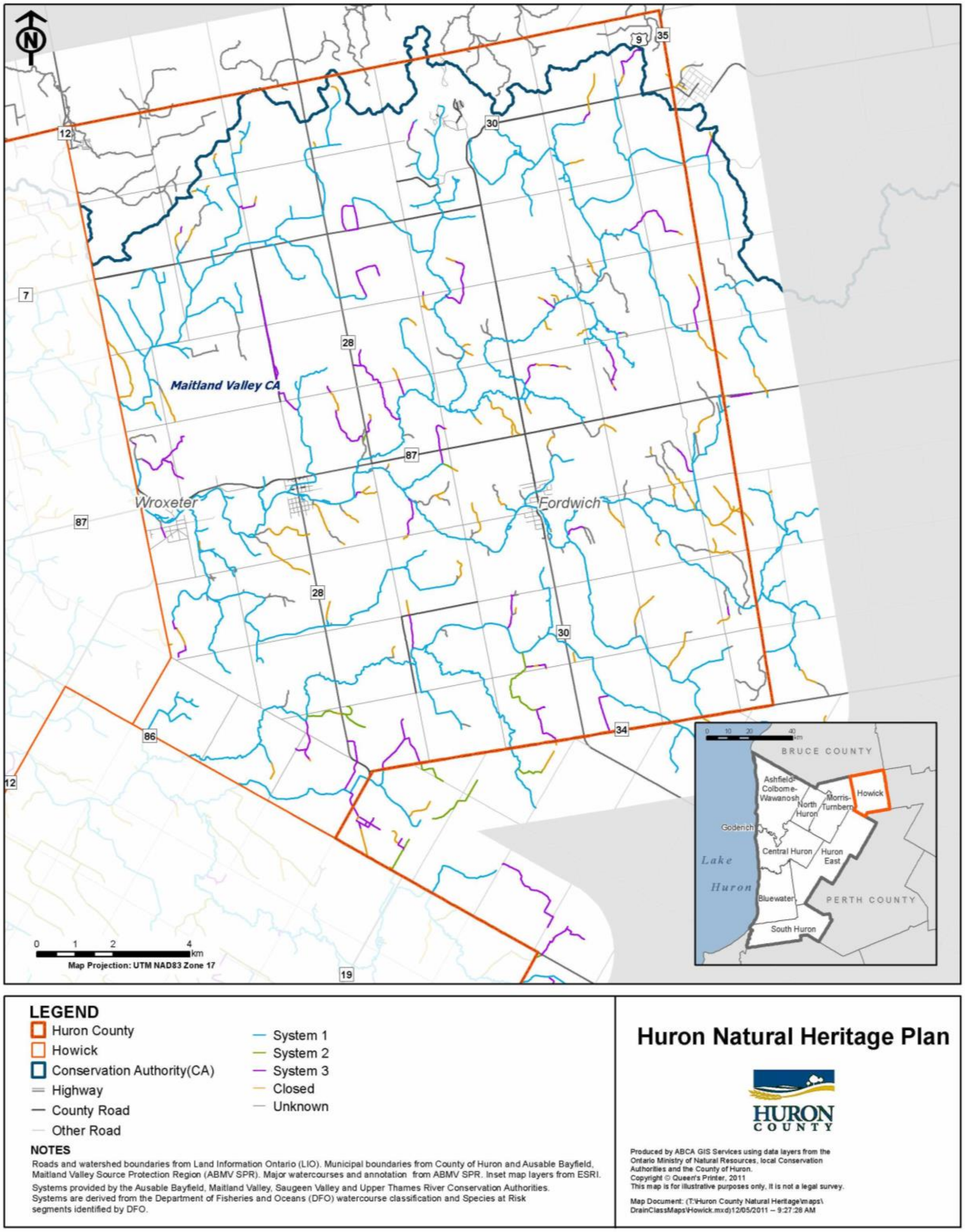

Figure 3.17 Watercourses categorized as system types in Howick.

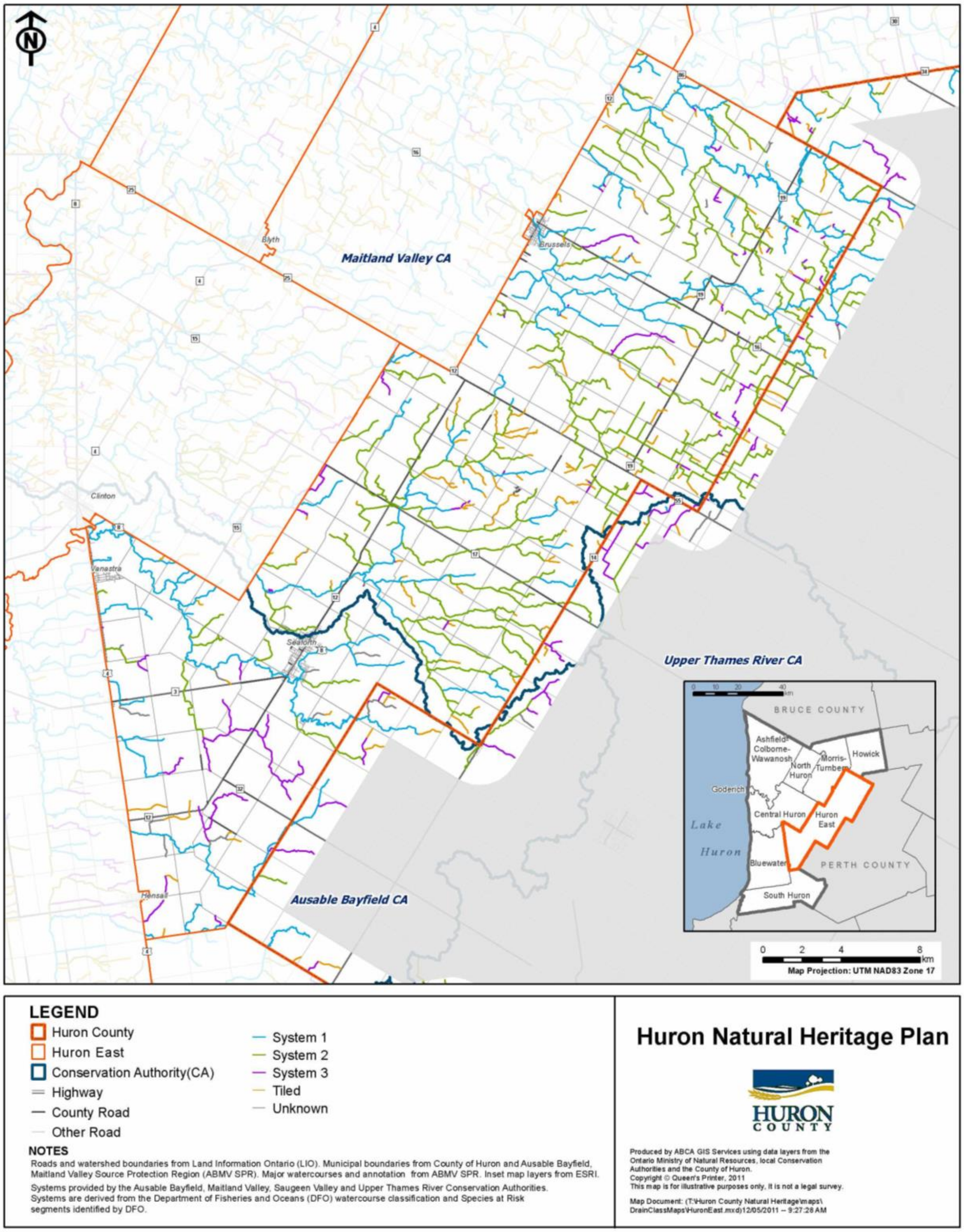

Figure 3.18 Watercourses categorized as system types in Huron East.

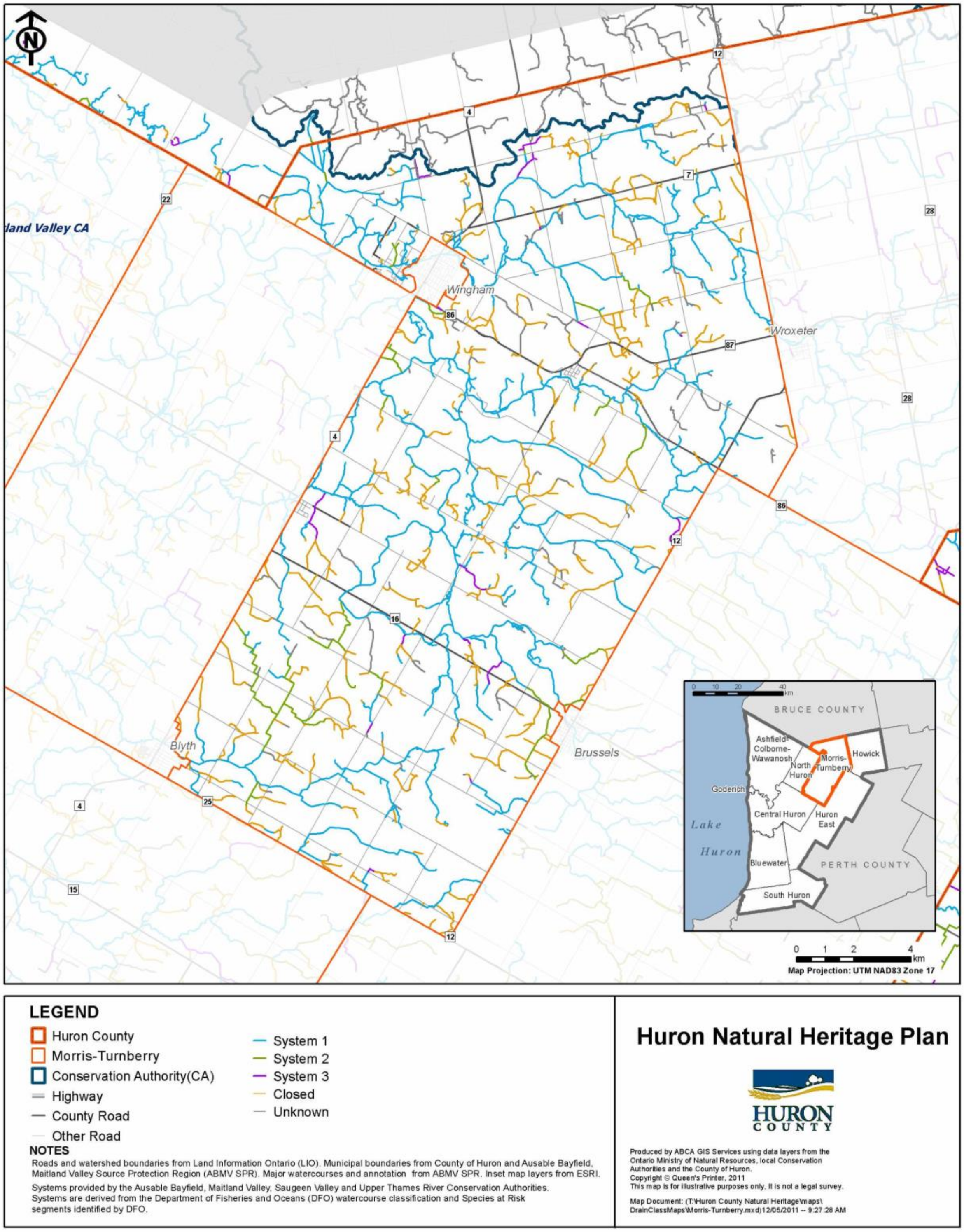

Figure 3.19 Watercourses categorized as system types in Morris-Turnberry.

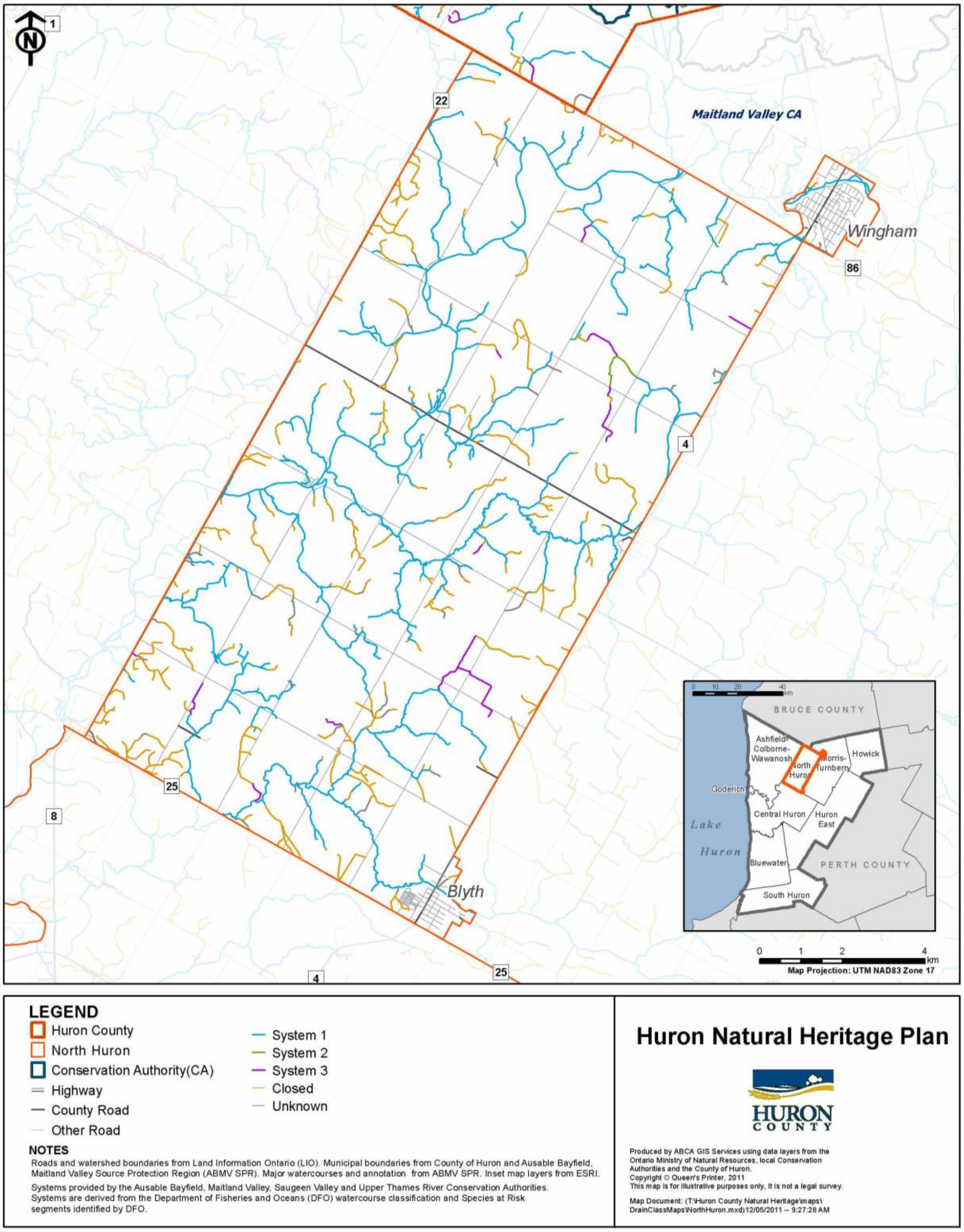

Figure 3.20 Watercourses categorized as system types in North Huron.

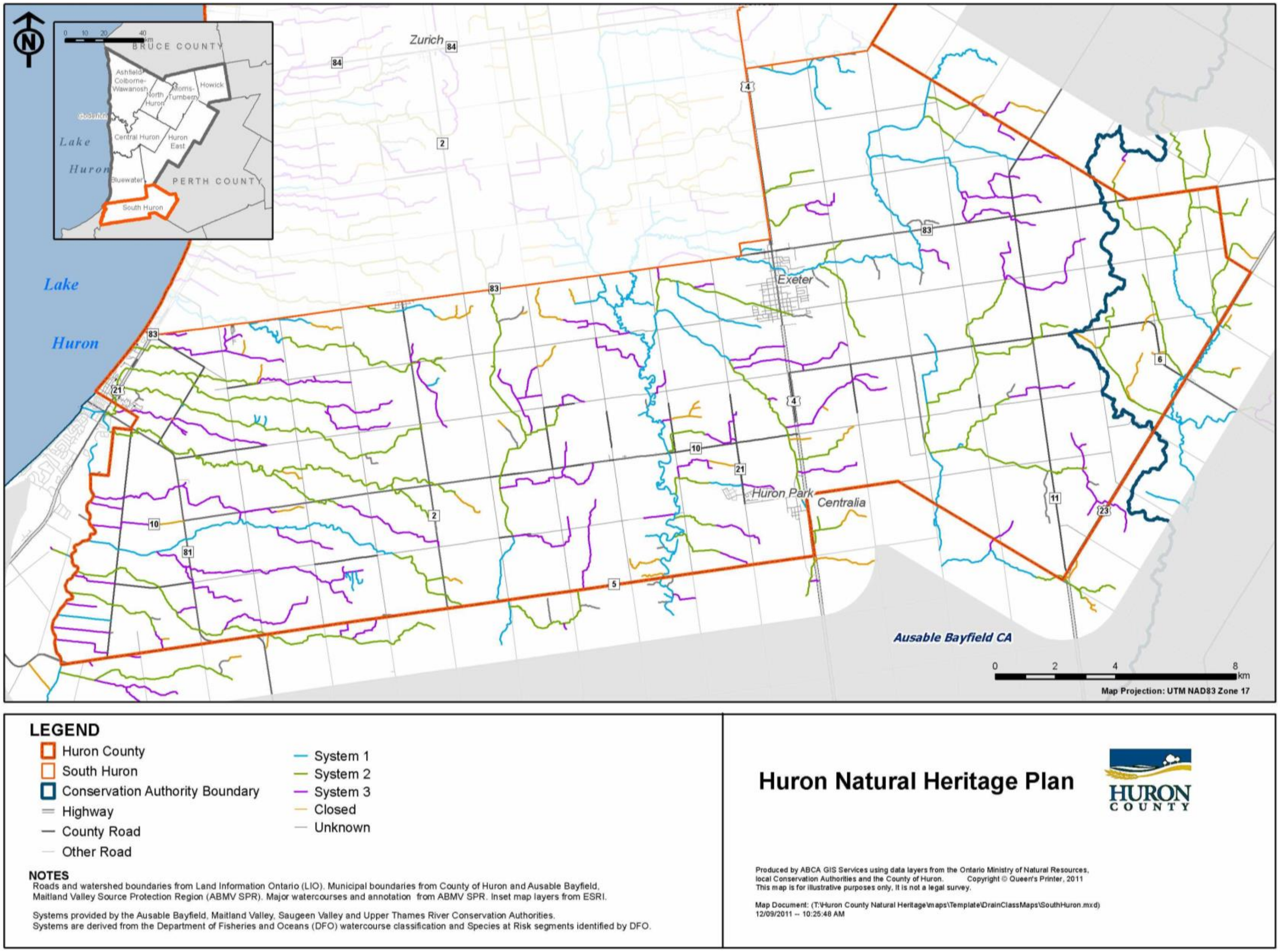

Figure 3.21 Watercourses categorized as system types in South Huron.

3.8 References

Brock, H., Upsdell, B., and Veliz M. 2010. Ravine & Lake Water Quality Monitoring 2010, BSRA-ABCA. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Bluewater Shoreline Residents' Association (BSRA). 2009. Water Quality Test Results 2006. Retrieved 10 November 2009 from BSRA website: http://www.bsra.ca/Water_Quality/wq_results.htm

Canadian Council of Ministers of the Environment (CCME). 2002. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Total Particulate Matter. In CCME, 1999 (updated 2002), Canadian Environmental Quality Guidelines.

Dodds, R. 2010. Determining the Economic Impact of Beaches: Lake Huron Shoreline from Sarnia to Tobermory. Ryerson University, Toronto Ontario.

Environmental Defence. 2012. Water Quality Measurement Requirements 2012 – Ontario. Retrieved 12 August 2014 from Environmental Defence website: http://environmentaldefence.ca/sites/default/files/pdf/Ontario_Water_Quality_Guidelines_2012.pdf

Gutteridge, A., and M. Veliz. 2008. Ravine & Lake Water Quality Monitoring 2008, BSRA-ABCA. Ausable Bayfield Conservation Authority. Exeter, Ontario

Gutteridge, A., and M. Veliz. 2012. Ravine and Lake Water Quality Monitoring 2011, BSRA-ABCA Ausable Bayfield Conservation Authority. Exeter, Ontario.

Hendry, G. and K. Lynch. 2010. Summer 2010 Baseflow Study. Ausable Bayfield Conservation Authority and Maitland Valley Conservation Authority. 80 pp.

Hilsenhoff, W. L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. Journal of the North American Benthological Society 7(1):65-68.

Howell, T., S. Abernethy, M. Charlton, A. Crowe, T. Edge, H. House, C. Lofranco, J. Milne, P.Scharfe, R. Steele, S. Sweeney, S. Watson, S. Weir, A. Weselan, and M. Veliz. 2005. Sources and mechanisms of delivery of *E. coli* (bacteria) pollution to the Lake Huron shoreline of Huron County. 270p.

Jones, C., Somers, K. M., Craig, B., and Reynoldson, T. B. 2007. Ontario Benthos Biomonitoring Network: Protocol Manual. Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment, Dorset, Ontario.

Kerr, S. J. 1995. Silt, turbidity and suspended sediments in the aquatic environment: an annotated bibliography and literature review. Ontario Ministry of Natural Resources, Southern Region Science and Technology Transfer Unit Technical Report TR-008.

Luinstra, B., Snell, L., Steele, R., Walker, M. and M. Veliz. 2007. Ausable Bayfield & Maitland Valley Source Protection Region – Watershed Characterization. Ministry of the Environment. 97 pp. http://www.sourcewaterinfo.on.ca/images/uploaded/uploadedDownloads/WC_Chap2_Mar_08.pdf

Ministry of Environment and Energy (MOEE). 1994. Water Management Policies, Guidelines, and Provincial Water Quality Objectives of the Ministry of Environment and Energy. Government of Ontario Publication No. 3303E.

Ontario Ministry of Municipal Affairs and Housing (OMMAH). 2014. Provincial Policy Statement, 2014. 50pp.

Ontario Ministry of Natural Resources (OMNR) and Grand River Conservation Authority (GRCA). 1998. Grand River Fisheries Management Plan. 105 pp.

Stanfield, L., Jones, M., Stoneman, M., Kilgour, B., Parish, J., and Wichert, G. 1999. Stream Assessment Protocol for Southern Ontario, version 3.1. Great Lakes Salmonid Unit, Ontario Ministry of Natural Resources.

United States Environmental Protection Agency (USEPA). 2014. Data accessed February 2015 at: http://iaspub.epa.gov/waters10/attains_nation_cy.control

Upsdell, B., and M. Veliz. 2009a. Ravine & Lake Water Quality Monitoring 2009, BSRA-ABCA. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Upsdell, B., and M. Veliz. 2009b. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2008. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Upsdell, B., and M. Veliz. 2009c. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2009. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Upsdell, B., and M. Veliz. 2011. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2010. Ausable Bayfield Conservation Authority. Exeter, Ontario

Upsdell, B., and M. Veliz, 2012. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2011. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Veliz, M., and H. Brock. 2006. Water Quality and Wetland Feasibility in the St. Joseph and Adjacent Ravines along Lake Huron. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Veliz, M., and H. Brock. 2007. Ravine & Lake Water Quality Monitoring 2007, BSRA-ABCA. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Chapter 4

Rare Species

Snapping Turtles are a species of special concern in Ontario. Photo by Jory Mullen.

4 Rare Species

4.1 Introduction

The diversity of our ecosystems plays a significant role in determining the environmental health and resiliency of Huron County's natural areas. The unique habitat requirements of each species can make them vulnerable to land use changes or modifications within the environment. A number of species within Huron County are at risk of extinction and must be protected to ensure the continued health of the ecosystem.

In the Natural Heritage Systems Study (Chapter 2), the occurrence of a designated Species at Risk (SAR) in a natural heritage patch resulted in the patch being designated significant. The results indicated that Species at Risk are rarely found in a patch that does not meet another criteria for significance (7 patches are significant for SAR criteria only out of 132 patches in total that are significant for containing SAR). This indicates that the model effectively identified the habitat of many SAR based on a suite of significance criteria developed to measure many aspects of the natural heritage system. Due to the sensitive nature of SAR, their precise location cannot be shared.

4.2 Committees and Legislation

Species at Risk (SAR) are identified at both the federal and provincial levels by committees of independent experts. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses species to ascertain if they are 'at risk' in Canada. Similarly, the Committee on the Status of Species at Risk in Ontario (COSSARO) determines if a particular species is at risk in Ontario. Species status categories are listed in Table 4.1 with their COSEWIC and COSSARO definitions.

Table 4.1 Species statuses with definitions from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; COSEWIC 2010) and the Committee on the Status of Species at Risk in Ontario (COSSARO; OMNR 2010b).

Status	COSEWIC Definition	COSSARO Definition
Extinct	• A wildlife species that no longer exists.	• A native species that no longer exists anywhere in the world.
Extirpated	• A wildlife species that no longer exists in the wild in Canada, but exists elsewhere.	• A native species that no longer exists in the wild in Ontario, but still exists elsewhere.
Endangered	• A wildlife species facing imminent extirpation or extinction.	• A native species facing extinction or extirpation.
Threatened	• A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.	• A native species at risk of becoming endangered in Ontario.
Special Concern	• A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.	• A native species that is sensitive to human activities or natural events that may cause it to become endangered or threatened.
Data Deficient	• A category that applies when the available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction.	
Not At Risk	• A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.	

Species at Risk are protected at both the federal and provincial levels. Canada's *Species at Risk Act* (SARA) was created to prevent species from becoming extinct and to ensure that actions are taken to recover SAR (Government of Canada 2008). The SARA applies to all species listed on Schedule 1 that are on federal lands, are an aquatic species, or are a species of migratory bird protected by the *Migratory Birds Convention Act*, 1994 (Government of Canada 2009). Huron County does not contain any large tracts of federal lands. Schedule 1 is the official list of wildlife SAR within Canada. Once a species is listed on Schedule 1, it benefits from all the legal protection afforded, and the mandatory recovery planning required, under the SARA. Species listed on Schedules 2 and 3 are species that have to be reassessed and are not protected by the SARA. Ontario's *Endangered Species Act* (ESA; 2007) provides legal protection for species that are listed provincially as extirpated, endangered, or threatened (OMNR 2010a). Species designated as threatened or endangered receive legal protection under the ESA (2007) and their habitats are protected under the Act (OMNR 2010a). Proponents must have regard for species protected under the ESA and their habitats, regardless of whether or not they are protected through the Huron Natural Heritage Plan.

The Natural Heritage Information Centre (NHIC) is a branch of the provincial government that collects, reviews, manages, and distributes information about SAR in Ontario. The NHIC is part of an international network of Conservation Data Centres (CDCs) that assigns a Rarity Rank to species or ecological communities to reflect their rarity on a global, national or sub-national (provincial) level. These ranks are denoted as GRANK, NRANK and SRANK, respectively. In general, the NHIC maintains data for those species that are provincially rare. Also, the initiative known as the General Status of Species in Canada (CESCC 2011) provides a general conservation status for each species within the various taxonomic groups (such as mammals, birds, freshwater fish, vascular plants) for each Canadian province or territory, and within all of Canada. The conservation ranks associated with these two institutions are not legal designations; however, they do assist groups such as COSEWIC and COSSARO in evaluating species status for consideration of legal protection under legislation such as the SARA and ESA.

Observation data on species listed under the SARA, the ESA, and provincially rare species (SRANK) was used in the Natural Heritage Systems Study model (Chapter 2). A complete list of SAR is not provided in this report since federal and provincial SAR lists are constantly changing, with species becoming 'listed' or 'delisted' as the result of review and classification by COSEWIC or COSSARO.

4.3 Terrestrial Species at Risk

Huron County is home to many terrestrial SAR. For simplicity, this section focuses on only one class of species: reptiles. These are particularly sensitive to changes in the environment. Four at-risk turtle species are located in Huron County (Table 4.2). The Lake Huron Tributaries and Maitland River basins each support three of these species, while the Ausable River and Bayfield River basins each support two rare turtle species. Snapping Turtle (ranked special concern) is the only SAR that has been detected in every major basin of the County.

Five snake SAR inhabit Huron County (Table 4.2). The Bayfield River, Lake Huron Tributaries, and Maitland River basins are each home to three of these species, while two snake SAR are found in each of the Nine Mile Creek and Parkhill Creek basins. The Parkhill Creek basin is the only basin in Huron County that supports the species Blue Racer. Only one snake SAR, Milksnake (special concern), inhabits the Ausable River basin within Huron County. Snake SAR inhabit six of the major basins.

Table 4.2 Reptile Species at Risk in Huron County and the Major Basins in which they are found. Species statuses from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Committee on the Status of Species at Risk in Ontario (COSSARO) are listed.

	Common Name	Scientific Name	Species Status		Major Basin(s)*
			COSEWIC	COSSARO	
Snakes	Blue Racer	*Coluber constrictor foxii*	E	END	PC
	Eastern Hog-nosed Snake	*Heterodon platirhinos*	T	THR	NMC, PC
	Eastern Ribbonsnake	*Thamnophis sauritus*	SC	SC	BR, LHT, MR
	Milksnake	*Lampropeltis triangulum*	SC	SC	AR, BR, LHT, MR, NMC
	Queensnake	*Regina septemvittata*	E	END	BR, LHT, MR
Turtles	Blanding's Turtle	*Emydoidea blandingii*	T	THR	AR, LHT
	Snapping Turtle	*Chelydra serpentine*	SC	SC	AR, BR, LHT, MR, NMC, PC, SVCA, UTRCA
	Spotted Turtle	*Clemmys guttata*	E	END	MR
	Wood Turtle	*Glyptemys insculpta*	T	END	BR, LHT, MR

* AR – Ausable River; BR – Bayfield River; LHT – Lake Huron Tributaries; MR – Maitland River; NMC – Nine Mile Creek; PC – Parkhill Creek; SVCA – Saugeen Valley Conservation Authority; UTRCA – Upper Thames River Conservation Authority

4.4 Aquatic Species at Risk

Countless species rely on healthy watercourses directly or indirectly as part of their continued survival. Aquatic species are studied as indicators of environmental degradation. Maintaining healthy watercourses is essential to ensure the health and resiliency of Huron County's natural areas. Aquatic species can provide an indication of the health of watercourses.

Aquatic SAR that have been detected in Huron County include three fishes and four mussels (Table 4.3). Fish SAR (including Redside Dace; Figure 4.1) have only been detected in three of the major basins: Bayfield River, Lake Huron Tributaries, and Maitland River. Mussel SAR have been found in basins of larger river systems (Ausable, Bayfield, and Maitland Rivers).

Figure 4.1. Redside Dace (*Clinostomus elongates*) Captured in Lake Huron Tributary Inventory, June 2011.

Table 4.3 Fish and Mussel Species at Risk in Huron County and the Major Basins in which they are found. Species statuses from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Committee on the Status of Species at Risk in Ontario (COSSARO) are listed.

	Common Name	Scientific Name	Species Status		Major Basin(s)*
			COSEWIC	COSSARO	
Fish	Black Redhorse	*Moxostoma duquesnei*	T	THR	BR, LHT, MR
	Northern Brook Lamprey	*Ichthyomyzon fossor*	SC	SC	BR
	Redside Dace	*Clinostomus elongatus*	E	END	LHT
Mussels	Kidneyshell	*Ptychobranchus fasciolaris*	E	END	AR
	Mapleleaf Mussel	*Quadrula quadrula*	T	THR	BR
	Rainbow Mussel	*Villosa iris*	E	THR	BR
	Wavy-rayed Lampmussel	*Lampsilis fasciola*	SC	THR	AR, MR

* AR – Ausable River; BR – Bayfield River; LHT – Lake Huron Tributaries; MR – Maitland River

4.5 Summary

Species at Risk (SAR) contribute to the overall biodiversity of the landscape and are important indicators of environmental health. There are no major SAR monitoring programs in Huron County. Species at Risk survey programs have been targeted towards specific areas of the County. The target SAR may be present outside these specific study locations. Other SAR may be present in the County, but remain undetected. Proponents must have regard for species protected under the Endangered Species Act and their habitats, regardless of whether or not they are protected through the Natural Environment Update.

Bird and fish SAR observation data was not incorporated into the Natural Heritage Systems Study (NHSS). Due to the transitory nature of birds and fish, observations of these SAR are not necessarily indicators of critical habitat. For example, many bird observations are along roadways or in agricultural fields. Even so, the habitat of all rare species should be protected for the long term. The landscape model in the NHSS effectively identified the habitat of many SAR using a suite of significance criteria that covered multiple aspects of the natural heritage system.

Each rare species plays an important role in the overall health of the ecosystem, and knowledge of their population dynamics aids in making educated decisions regarding their protection. This, in turn, helps to focus resources and inspire action that will support future habitat improvements. Given appropriate habitat protection and enhancement, the abundance of SAR (number of species, as well as individuals within a species) could be improved.

4.6 References

Canadian Endangered Species Conservation Council (CESCC). 2011. Wild Species 2010: The General Status of Species in Canada. National General Status Working Group. 302 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2010. COSEWIC's Assessment Process and Criteria. Retrieved 9 January 2012 from COSEWIC website: http://www.cosewic.gc.ca/pdf/assessment_process_e.pdf

Government of Canada. 2008. *Species at Risk Act* Background. Retrieved 9 January 2012 from Species at Risk Public Registry website: http://www.sararegistry.gc.ca/approach/strategy/background/default_e.cfm

Government of Canada. 2009. *Species at Risk Act* Purpose. Retrieved 9 January 2012 from Species at Risk Public Registry website: http://www.sararegistry.gc.ca/approach/act/purpose_e.cfm

Ontario Ministry of Natural Resources (OMNR). 2010a. The *Endangered Species Act* 2007. Retrieved 9 January 2012 from OMNR website: http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/STEL01_131232.html

Ontario Ministry of Natural Resources (OMNR). 2010b. What Species are at Risk in Ontario. Retrieved 9 January 2012 from OMNR website: http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/STEL01_131230.html

5 Conclusions and Recommendations

5.1 Conclusions

The natural heritage systems mapping described in the Technical Document identified the location of natural features and defined the natural heritage system in Huron County. The NHSS determined 98% of the natural features identified are significant based on methodology supported by current science. The NHSS is a background scientific document to inform the sustainable management, protection and enhancement of natural heritage features in Huron County.

A healthy landscape is an important societal outcome of conserving natural heritage. If we wish to *improve* the health of the natural environment, and in turn build healthier communities and contribute to a prosperous economy, preserving the existing natural environment is only the first step. Enhancing or expanding natural features, prioritizing stewardship, improving connections between natural areas, promoting sustainable agricultural practices and forest management would all contribute to a healthier environment in Huron County.

The following recommendations describe how the Technical Document can be used to promote the enhancement of the natural heritage system in Huron County.

5.2 Recommendations

1. **Any natural heritage patch that met at least one significance criterion in the Natural Heritage Systems Study contributes to an ecological landscape function and should be protected.**

Each criterion reflects some aspect of habitat value and complexity. Significance criteria must not be valued differently, since all criteria measure different aspects of ecological integrity. Patches that do not meet a significance criterion are considered candidate patches.

2. **All natural heritage features in Huron County should be maintained, restored, or enhanced.**

Each natural feature provides habitat for wildlife and contributes to the diversity of the County. Candidate patches are habitat patches that did not meet any criteria of significance, and require further on-the-ground field study to verify significance with respect to significant wildlife habitat, habitat for Species at Risk, and other criteria that are difficult to assess at a County-wide scale. Although detailed, site-specific analysis is not feasible at a County level, local municipalities are strongly encouraged to conduct more in-depth studies and evaluate their natural heritage features at the site level.

3. **Targets for natural cover in Huron County should be based on sound ecological principles.**

The mapping results of the Natural Heritage Systems Study, based on 2006 air photos, showed that there is 20% natural cover, including 16.6% woodland cover, 6.5% wetland cover, and 3.5% forest interior in Huron County. Targets for Huron County could be drawn from resources such as "*How Much Habitat is Enough?*" (Environment Canada 2013). The following guidelines (from Environment Canada 2013) are intended to be minimum ecological requirements for natural cover with the objective of maintaining wildlife populations at a level that would prevent extirpations (local extinctions) of species.

- Minimum of 30% forest cover
- Minimum of 10% wetland cover and 6% of each subwatershed, or 40% of historical watershed wetland coverage (whichever is greater)
- Less than 10% impervious cover
- Minimum of 10% forest interior (> 100m from forest edge)

The targets on the previous page are proposed for Huron County as a whole, recognizing that some areas will fall below the targets, while others will surpass them. This is a voluntary stewardship effort and does not require property owners to plant trees. Municipalities and local agencies should work collaboratively with landowners to achieve local targets. Targets will be different for each subwatershed/municipality, depending on its geographical location and current natural cover. The Watershed Report Card can be used as an indicator of the effectiveness of stewardship efforts and conserving natural features.

4. **Watershed Report Cards as a future reference**

In Conservation Ontario watersheds, Watershed Report Cards are completed every five years. Watershed Report Cards are a province-wide grading system that has been established for reporting forest cover, forest interior, total phosphorus and *E.coli* concentrations, as well as benthic invertebrates. The Ausable Bayfield Conservation Authority, Maitland Valley Conservation Authority and Upper Thames River Conservation Authority Watershed Report Cards can be a valuable future reference for monitoring change of the Huron County natural heritage systems.

5. **When a development application requires an Environmental Impact Study (EIS), the Terms of Reference must have regard for the Huron Natural Heritage Plan's Natural Heritage Systems Study.**

Any new development applications must have regard for the results of the Natural Heritage Systems Study (Chapter 2), in addition to the in-depth analysis that is typically required for an EIS. The EIS should include confirmation of the patch boundary and the attributes or functions for which the patch was identified, with consideration of the linkage components of the natural heritage system (whether or not the components are part of the natural heritage patch). Vegetation communities should be characterized and mapped using the Ecological Land Classification for Southern Ontario (Lee *et al*. 1998) and updated to the revised community codes (Lee 2008). As more detailed studies are completed on natural heritage features, significant wildlife habitat, fish habitat, and Species at Risk should be assessed and identified where appropriate.

6. **Conduct periodic updates to the Huron Natural Heritage Plan Technical Document.**

The status of natural heritage features in Huron County should be reviewed as new information (such as new aerial imagery) becomes available. The suggested timeframe for review is 10 years. A status report will evaluate any changes to the vegetation patch in terms of vegetation coverage, fragmentation, or restoration. A status report will also help highlight the effectiveness of the implementation tools.

The science of landscape ecology as it applies to Huron County should also be reviewed to ensure that new landscape techniques or theories are considered and incorporated. This should be done every 5 years.

These timeframes reflect the likelihood of updated mapping and ability to detect changes. At the time of a future update, consideration may be given to update the criteria for aquatic features. The updated mapping should be appended to the Technical Document upon completion.

Gathering new information in preparation of a model update and sharing the results of the Natural Heritage Systems Study will help fill knowledge gaps. For example, data generated by this study could be shared with the Ontario Ministry of Natural Resources and Forestry to assist with delineation and evaluation of wetlands. This would contribute to the preservation of wetlands in Huron County.

7. **Adopt a Sustainable Huron approach to Forest Conservation**

Work collaboratively with the landowner community and local forestry industry to sustainably manage forests and forest resources, recognizing the economic potential of good forest management. This approach is outlined in the County's Forest Management Plan – "Forests for our Future" (2014).

8. **Local stewardship**

Stewardship efforts and management decisions by private landowners are central to the management and enhancement of natural heritage features on the landscape. The Huron Clean Water Project, launched in 2004, is testament to the collaborative approach developed amongst Huron County, the local Conservation Authorities and the private landowner community. The long-term protection of natural heritage features in Huron County depends of the success of this collaborative approach to land stewardship.

Appendices