ATTACHMENT 1

Perth Natural Heritage Systems Study

(includes City of Stratford and Town of St. Marys)

2018

Prepared by

Upper Thames River Conservation Authority

in cooperation with Perth County Conservation Authorities

ATTACHMENT 1

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Oblique aerial photograph of rural Perth County. *Photo by UTRCA*

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Executive Summary

The 2018 Perth Natural Heritage Systems Study (PNHSS) evaluates the existing ecologically important terrestrial (land) resources of the county using scientific methods and Geographic Information Systems (GIS) modeling.

Chapter 1 introduces the importance of the natural heritage systems planning, including policy rationale and a history of natural heritage planning in Perth County and other nearby counties. The study scope is discussed, including the study area, project governance, and general limitations of the study. The distinction between "significant" features, as defined in the PPS, and "ecologically important", as defined in this study, is explained.

Chapter 2 describes how the various components of the county's natural heritage system were defined and mapped. Using a variety of base mapping layers developed by the Upper Thames River, Ausable Bayfield and Grand River Conservation Authorities the first step was to identify and delineate the smallest unit of vegetation, the *Vegetation Community*. Eighteen types of *Vegetation Communities* were delineated. The *Vegetation Communities* were then lumped into seven broader categories called *Vegetation Groups*: woodlands, thickets, meadows, water features, connected vegetation features and watercourse bluffs and depositional areas. Three *Vegetation Ecosystems* were defined: terrestrial, wetland and aquatic. The final step consisted of delineating *Vegetation Patches*, which are a mosaic of one or more abutting *Vegetation Groups*.

Chapter 2 concludes with a summary of mapping results for the Perth Study Area (Corporate Perth plus a 1 km buffer). In the Perth Study Area there is 10.01% woodland cover, 0.33% thicket cover, 1.40% meadow cover, 0.31% water feature cover, and 0.01% connected vegetation feature cover. Wetland cover (comprised of woodland, thicket and meadow groups) is 3.75%. Environment Canada (2013) sets guidelines for sustainability of at least 30% vegetation cover and at least 10% wetland cover at the watershed (or county) scale.

Chapter 3 describes the 15 criteria used to identify ecologically important natural heritage features and functions. Two types of criteria were developed: criteria for *Vegetation Groups* and criteria for *Vegetation Patches*. Three criteria are difficult to map and will have to be evaluated as part of the site specific field work needed for an Environmental Impact Study (EIS) if a landuse change is proposed. Each criterion is described, providing rationale, application/mapping rules and modeling results in terms of how many *vegetation groups* or *patches* meet each criterion.

Chapter 4 summarizes the overall results of the criteria modeling at the *vegetation group* and *patch* levels. The woodland group criteria for ecological importance also establishes significance for woodlands consistent with the PPS. Patches meeting one or more criteria are deemed ecologically important in this study. Maps showing the patches that meet one or more criteria for ecological importance are provided for Perth County and for each local municipality in Appendix K. Approximately 11.87% of the Perth Study Area is in ecologically important natural vegetation cover (patch cover). Approximately 92% of vegetation patches meet at least one criteria, representing 99.4% of the patch area.

Chapter 5 provides recommendations for the implementation of this science-based study. A number of land use planning related recommendations are provided along with additional stewardship and education recommendations.

The appendices provide additional information on methodology, rationale, metadata, and maps showing patches that meet each criterion and maps showing patches that meet at least one criterion in each municipality and for the county.

Table of Contents

Executive Summary i
List of Figures vi
List of Tables vii
1.0 Background 1
1.1 Purpose of the Perth County Natural Heritage Systems Study 1
1.2 Natural Heritage Systems Studies 5
1.2.1 Natural Heritage Studies (2003 to 2006) 5
1.2.2 Natural Heritage Systems Studies (2014 to present) 5
1.3 Study Area 6
1.4 Project Governance 6
1.5 Significant versus Ecologically Important 8
1.6 Statement of Limitations (Scope) 10
1.6.1 Mapping Limitations 10
1.6.2 Watercourse Layer 10
1.6.3 Connectivity and System Linkages 11
1.6.4 Features Identified through EISs 12
2.0 Mapping Guidelines 13
2.1 Assemble Digital Vegetation Layers (Base Mapping Layers) 13
2.2 Delineation of Digital Vegetation Layers 14
2.3 *Vegetation Communities* 16
2.4 *Vegetation Groups* 20
2.4.1 Wetland *Vegetation Group* 22
2.4.2 Woodland *Vegetation Group* 23
2.4.3 Thicket *Vegetation Group* 23
2.4.4 Meadow *Vegetation Group* 24
2.4.5 Water Feature *Vegetation Group* 24
2.4.6 Connected Vegetation Feature *Vegetation Group* 24
2.4.7 Watercourse Bluff and Depositional Area (Bar or Beach) Vegetation Group 25
2.4.8 Clustering around Narrow Breaks (Roads, Railroads, Rivers) 26
2.5 *Vegetation Patches* 27
2.6 *Vegetation Ecosystems* 29
2.7 Results of Mapping the Vegetation Layers 31
3.0 Criteria for Ecological Importance 35

3.1 Background 35
3.2 Ecologically Important Criteria 35
3.2.1 Fifteen Ecologically Important Criteria 36
3.2.2 Significant Woodlands 38
3.3 Criteria Applied to all *Vegetation Groups* and *Ecosystems* 39
3.3.1 Criterion 1 – *Vegetation Group* within or touching a SignificantValleyland 39
3.3.2 Criterion 2 − *Vegetation Group* within or touching any Life Science ANSI 43
3.3.3 Criterion 3 – *Vegetation Group* within 30 m of an Open Watercourse 46
3.4 Size Criteria Applied to Specific *Vegetation Groups* 49
3.4.1 Criterion 4 – All Wetland *Vegetation Groups* ≥ 0.5 ha 49
3.4.2 Criterion 5 – Woodland *Vegetation Group* ≥ 1 ha 51
3.4.3 Criterion 6 – Woodland *Vegetation Groups* within 100 m of a Woodland *Vegetation Group* ≥ 1 ha 54
3.4.4 Criterion 7 – Thicket *Vegetation Group* ≥ 2 ha 56
3.4.5 Criterion 8 – Meadow *Vegetation Group* ≥ 5 ha 58
3.4.6 Criterion 9 – Meadow *Vegetation Group* within 100 m of a ≥ 1ha Woodland or ≥2 ha Thicket *Vegetation Group* 60
3.5 Criteria Applied to All *Vegetation Patches* 62
3.5.1 Criterion 10 – *Vegetation Patches* containing a *Vegetation Group* that meets a Group Criterion 62
3.5.2 Criterion 11 – *Vegetation Patch* Containing a Diversity of Vegetation Ecosystems, Groups or Communities 63
3.5.3 Criterion 12 − *Vegetation Patches* that don't meet any criteria that are within 100 m of a *Vegetation Patch* that meets other Patch Criteria 66
3.6 Criteria Applied to *Vegetation Groups* Not Currently Mapped 68
3.6.1 Criterion 13 − Significant Wildlife Habitat (SWH) 68
3.6.2 Criterion 14 − Groundwater Dependent Wetlands (GDW) 69
3.6.3 Criterion 15 – Watercourse Bluff and Deposition Areas 71
3.7 Additional Information – Criteria that did not pick up any patches not already picked up by other criteria 72
3.7.1 *Vegetation Patches* ≥ 100 ha 72
3.7.2 Woodland Interior Habitat 73
3.8 Criteria Reviewed but Not Included 75
4.0 Results of Running the Ecologically Important Criteria 76
4.1 *Vegetation Groups* that meet Criteria 77

4.2 *Vegetation Patches* that meet Criteria 78
4.3 Woodlands: Significant, Ecologically Important, and Other 81
5.0 Recommendations 82
5.1 Land Use Planning 83
5.2 Other Implementation Measures 85
References 87
List of Acronyms 96
Appendices 97
Appendix A-1. Ecological Land Classification (ELC) Code Descriptions 98
Appendix A-2. The similarities and differences between the ELC *Vegetation Community* Series and the PNHSS *Vegetation Groups* 99
Appendix B. Wetland Layer Methodology and Sources 100
Appendix C. Groundwater Dependent Wetlands and a possible procedure for landscape scale study 104
Appendix D-1. Summary of Ecologically Important Criteria and Rationale, Criteria 1 to 5 105
Appendix D-2. Summary of Criteria and Rationale, Criteria 6 to 10 106
Appendix D-3. Summary of Criteria and Rationale, Criteria 11 to 15 107
Appendix E. Summary of rationale for 19 criteria NOT used 108
Appendix F. Metadata: Patch and Group Criteria Mapping and Field Description 113
Appendix G. Metadata for Vegetation Communities and Vegetation Groups 117
Appendix H-1. Criterion 1 Map, Significant Valleylands 123
Appendix H-1-1. Criterion 1 Map, Vegetation Group within or touching a Significant Valleyland 124
Appendix H-2. Criterion 2 Map, ANSIs 125
Appendix H-3. Criterion 3 Map, *Vegetation Groups* within 30 m of an open watercourse 126
Appendix H-4. Criterion 4 Map, Wetlands 127
Appendix H-5. Criterion 5 Map, Woodland Size ≥ 1 ha 128
Appendix H-6. Criterion 6 Map, Woodland Proximity 129
Appendix H-7. Criterion 7 Map, Thicket Size ≥ 2 ha 130
Appendix H-8. Criterion 8 Map, Meadow Size ≥ 5 ha 131
Appendix H-9. Criterion 9 Map, Meadow Proximity 132
Appendix H-10. Criterion 10 Map, Patches that meet a Group Criteria 133
Appendix H-11. Criterion 11 Map, Diversity 134
Appendix H-12. Criterion 12 Map, Patch Proximity 135
Appendix I-1. Map showing patches ≥100 ha 136

Appendix I-2. Map showing Woodlands that contain Woodland Interior..... 137

Appendix I-3. Map showing the watercourse layer (open and tiled)..... 138

Appendix J-1. Valley in relation to Significant Groundwater Recharge 139

Appendix J-2. Valley in relation to Geological Features..... 140

Appendix J-3. Valley in relation to vegetation patch cover..... 141

Appendix K-1. Woodland Groups that meet one or more criteria for Ecological Importance in Perth 142

Appendix K-2. Meadow Groups that meet one or more criteria for Ecological Importance in Perth 143

Appendix K-3. Patches that meet one or more criteria for Ecological Importance in Perth..... 144

Appendix K-4. Patches that meet one or more criteria for Ecological Importance in Perth South 145

Appendix K-5. Patches that meet one or more criteria for Ecological Importance in Perth East 146

Appendix K-6. Patches that meet one or more criteria for Ecological Importance in North Perth 147

Appendix K-7. Patches that meet one or more criteria for Ecological Importance in West Perth 148

Appendix K-8. Patches that meet one or more criteria for Ecological Importance in St. Marys 149

Appendix K-9. Patches that meet one or more criteria for Ecological Importance in Stratford 150

Appendix L-1. Woodlands: Significant, Ecologically Important and Other in Perth County .. 151

Appendix M. 2006 Oxford Natural Heritage Study - Recommendations..... 152

List of Figures

Figure 1	County of Perth showing member municipalities and Conservation Authority Watersheds …… ……...……	7
Figure 2	Illustration of two Woodland *Vegetation Communities* (deciduous woodland and deciduous swamp) forming a *Woodland Group* …….	20
Figure 3	Illustration of how small and large *Vegetation Communities* are combined into *Vegetation Groups* and *Patches*……..	21
Figure 4	Illustration of clustering *Vegetation Groups* around narrow roads into one Woodland Cluster ……..	26
Figure 5	Illustration of the composition of a *Vegetation Patch* comprised of different *Vegetation Communities, Groups* and *Ecosystems* ……..	28
Figure 6	Criterion 1, illustration of Significant Valleyland boundary delineation using flood limit, steep slope and 100 m from watercourse edge ……..	40
Figure 7	Criterion 1, illustration showing *Vegetation Groups* on or touching the Significant Valley System ……...	41
Figure 8	Criterion 2, illustration showing *Vegetation Groups* within or touching a Life Science ANSI ……	45
Figure 9	Criterion 3, illustration showing *Vegetation Groups* within 30 m of Open Watercourses (small and large) ……	48
Figure 10	Criterion 6, illustration of 100 m proximity between Woodland Groups ≥ 1ha ..	55
Figure 11	Criterion 11, illustration of patches containing many different *Vegetation Ecosystems, Groups* and *Communities* ……..	65
Figure 12	Criterion 12, illustration of a small patch that does not meet any criteria but is within 100 m of a patch that meets one or more criteria ……...	67
Figure 13	Illustration of how interior woodland area is calculated ……...	74

List of Tables

Table 1	Significant versus Ecologically Important Natural Heritage Features and Areas ..	9
Table 2	Digital mapping layer development for the 2017 PNHSS……..	13
Table 3	Relationship between *Vegetation Communities, Groups* and *Ecosystems* …….....	15
Table 4	Definition and attributes of the 18 *Vegetation Communities* …….....	18
Table 5	Relationship between *Vegetation Communities*, *Groups* and *Ecosystems* …….	30
Table 6	Number of Vegetation Communities, Groups and Patches in the Study Area …...	31
Table 7	Number and area of the 18 *Vegetation Community* Types in the Study Area ……	32
Table 8	*Vegetation Community* types sorted by Area in the Study Area ……...	33
Table 9	Area of *Vegetation Groups* as a percentage of Perth Study Area ……..…	34
Table 10	Summary of the 15 Ecologically Important Criteria …….	37
Table 11	PNHSS Criteria for Ecologically Important Woodlands that meet PPS Criteria for Significance ……..……	38
Table 12	Criterion 1 Results – *Vegetation Groups* located on or touching Significant Valleylands in the Study Area ……	42
Table 13	Criterion 2 Results – *Vegetation Groups* within or touching a Life Science ANSI in the Study Area ……..……...	44
Table 14	Criterion 3 Results – *Vegetation Groups* containing or within 30 m of an Open Watercourse in the Study Area …….	47
Table 15a	Criterion 4 Results -- *Vegetation Groups* that contain Wetland Vegetation Communities …….	50
Table 15b	Wetland Cover by Member Municipality and Perth Study Area …….	50
Table 16	Criterion 5 Results – Woodland *Vegetation Groups* ≥ 1 ha in the Study Area ….	53
Table 17	Criterion 6 Results – Woodland *Vegetation Groups* within 100 m of a Woodland *Vegetation Group* ≥ 4 ha in the Study Area ……...	54
Table 18	Criterion 7 Results – Thicket *Vegetation Groups* ≥2 ha in the Study Area ……..	57
Table 19	Criterion 8 Results – Meadow *Vegetation Groups* ≥ 5 ha in the Study Area …...	59
Table 20	Criterion 9 Results – Meadow *Vegetation Groups* within 100 m of a ≥1 ha woodland or ≥2 ha thicket *Vegetation Group* in the Study Area …….	61
Table 21	Criterion 10 Results – *Vegetation Patches* that contain a *Vegetation Groups* that meets a Group Criteria in the Study Area …….....	62
Table 22	Criterion 11 Results – *Vegetation Patches* that contain a diversity of *Vegetation Ecosystems, Groups* or *Communities* in the Study Area ……	64
Table 23	Criterion 12 Results – *Vegetation Patches* that do not meet any criteria but are within 100 m of a *Vegetation Patch* that meets other patch criteria in the Study Area……	66

Table 24	Vegetation Patches ≥ 100 ha …….	72
Table 25	Woodland Groups with Woodland Interior Habitat ……..	73
Table 26	Vegetation Group Results for Perth Study Area ……..……...	77
Table 27	The number of *Vegetation Patches* versus the number of criteria met in the Perth Study Area……...	78
Table 28a	Number of Vegetation Patches that are Ecologically Important by Municipality ……...	80
Table 28b	Area of Vegetation Patches that is Ecologically Important by Municipality ……	80
Table 29	Woodland Category Results for Perth Study Area ……..……	81

American Goldfinch. *Photo by Ron Ridout*

1.0 Background

1.1 Purpose of the Perth County Natural Heritage Systems Study

The Perth Natural Heritage Systems Study (PNHSS) addresses the need for information on the state of the county's natural areas and systems. The study provides a landscape level assessment of natural heritage features and functions.

The identification of natural features and areas in southwestern Ontario is an important undertaking. Environment Canada (2013) identified that human activities, such as agriculture, urban development and associated infrastructure, have resulted in the loss or degradation of over 70% of the naturally vegetated areas in Southern Ontario. In some areas this reduction is greater. The remaining naturally vegetated areas tend to be in unconnected patches across the landscape. Intensive land use activities have also been found to contribute to degraded water quality conditions in many streams and lakes.

The Province of Ontario provides policy guidance to municipalities on matters of provincial interest in the Provincial Policy Statement (PPS). The PPS (2014) includes the following general directives for municipalities related to planning for natural heritage:

> ***Excerpt from the 2014 PPS (page 22)***
>
> **2.0 Wise Use and Management of Resources**
> Ontario's long-term prosperity, environmental health, and social well-being depend on conserving biodiversity, protecting the health of the Great Lakes, and protecting natural heritage, water, agricultural, mineral and cultural heritage and archaeological resources for their economic, environmental and social benefits.
> Accordingly:
>
> **2.1 Natural Heritage**
> 2.1.1 Natural features and areas shall be protected for the long term.
> 2.1.2 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 *ground water features*.
> 2.1.3 *Natural heritage systems* shall be identified in Ecoregions 6E & 7E1, recognizing that *natural heritage systems* will vary in size and form in *settlement areas*, *rural areas*, and *prime agricultural areas*.

Note: Perth County is fully within Ecoregion 6E.

The PNHSS (2017) is a science based study that uses high quality ortho-imagery and Geographic Information System (GIS) modeling to identify natural vegetation patches that are considered to be ecologically important at the County level. Many of the ecologically important features also are significant in the context of the PPS (see text box below).

Excerpt from the 2014 PPS (pages 48, 49)

Significant means

a) in regard to wetlands, coastal wetlands and areas of natural and scientific interest, an area identified as provincially significant by the Ontario Ministry of Natural Resources using evaluation procedures established by the Province, as amended from time to time;
b) in regard to woodlands, an area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history. These are to be identified using criteria established by the Ontario Ministry of Natural Resources;
c) in regard to other features and areas in policy 2.1, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system;

Criteria for determining significance for the resources identified in sections (c)-(e) are recommended by the Province, but municipal approaches that achieve or exceed the same objective may also be used.

While some significant resources may already be identified and inventoried by official sources, the significance of others can only be determined after evaluation.

The PNHSS (2017) methodology is intended to establish the local approach for identifying the terrestrial Natural Heritage System (Fish Habitat and other aquatic habitat features are not identified in the study), as required by the natural heritage policies of the PPS. The PNHSS incorporates the most current information available from the Ministry of Natural Resources and Forestry (MNRF) to identify the Natural Heritage Features and Areas that they are responsible for identifying as per a) of the PPS definition of significant in the above text box and related policies (e.g., provincially significant wetlands and Areas of Natural and Scientific Interest).

The study also includes the identification of significant woodlands and valleylands, in accordance with the Natural Heritage Reference Manual (MNR, 2010), and sets outs a recommended approach for identifying significant wildlife habitat, to address the PPS requirement for planning authorities to identify such Natural Heritage Features and Areas as per b) and c) of the PPS definition in the text box above. The complete list of Natural Heritage Features and Areas as set out in the PPS is shown in the text box below.

NOTE: In the case of valleylands, the identification and evaluation of Significant Valleylands is based on the recommended criteria outlined in section 8.3.1 of the Natural Heritage Reference Manual (MNR, 2010). It is the responsibility of planning authorities to identify these features.

Excerpt from the 2014 PPS (page 22)

2.1.4 *Development* and *site alteration* shall not be permitted in:
- a) *significant wetlands* in Ecoregions 5E, 6E and 7E1; and
- b) *significant coastal wetlands*.

2.1.5 *Development* and *site alteration* shall not be permitted in:
- a) *significant wetlands* in the Canadian Shield north of Ecoregions 5E, 6E and 7E[1];
- b) *significant woodlands* in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River)[1];
- c) *significant valleylands* in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River)[1];
- d) *significant wildlife habitat*;
- e) *significant areas of natural and scientific interest*; and
- f) *coastal wetlands* in Ecoregions 5E, 6E and 7E1 that are not subject to policy 2.1.4(b)

unless it has been demonstrated that there will be no *negative impacts* on the natural features or their *ecological functions*.

2.1.6 *Development* and *site alteration* shall not be permitted in *fish habitat* except in accordance with *provincial and federal requirements*.

2.1.7 *Development* and *site alteration* shall not be permitted in *habitat of endangered species and threatened species*, except in accordance with *provincial and federal requirements*.

2.1.8 *Development* and *site alteration* shall not be permitted on *adjacent lands* to the *natural heritage features and areas* identified in policies 2.1.4, 2.1.5, and 2.1.6 unless the *ecological function* of the *adjacent lands* has been evaluated and it has been demonstrated that there will be no *negative impacts* on the natural features or on their *ecological functions*.

This study also identifies various other Natural Features and Areas that comprise the Natural Heritage System that are not considered "significant" as defined in the PPS. These other features and areas are described in more detail in Section 1.5.

The PNHSS provides mapping of the Natural Heritage Systems for the Corporate County of Perth, including the City of Stratford and the Town of St. Marys, North Perth, West Perth, Perth East and Perth South.

The PPS (2014) defines the natural heritage system as follows:

> ***Excerpt from the 2014 PPS (page 45)***
>
> ***Natural heritage system:*** means 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 processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include *natural heritage features and areas*, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue. The Province has a recommended approach for identifying *natural heritage systems*, but municipal approaches that achieve or exceed the same objective may also be used.

The Natural Heritage System includes: woodlands, wetlands, thickets, young plantations, meadows, waterbodies and watercourses and connected vegetation features.

Agriculture is the dominant land use in the County of Perth. The working agricultural fields can provide linkages between natural features and areas and these linkages may be utilized in different ways depending on the cropping patterns or the time of year. The PNHSS does not attempt to map all of these potential system linkages but rather acknowledges that the agricultural landscape (i.e., crop fields, pastures, etc.) can provide some linkage functions. Given the size of the study area, the predominantly agricultural land use and that land use change is anticipated to be limited, the PNHSS maps the Natural Heritage System at the county level of scale.

In cases where land use change is anticipated, the potential impact of the land use change on system linkages must be considered. For example, if agricultural land is proposed to be converted to urban development or other non-agricultural uses, the system linkages that would have been provided in the working agricultural landscape may be disrupted or eliminated by the post development urban landscape. In such cases it is necessary that Natural Heritage System linkages be studied at an appropriate level of detail and that system linkages be provided as part of the planning approval process.

1.2 Natural Heritage Systems Studies

The UTRCA has led Natural Heritage Systems Studies in Oxford (County of Oxford, 2016), Middlesex (County of Middlesex, 2014) and Huron (County of Huron, 2014 draft). These studies evolved from earlier Natural Heritage Studies (County of Oxford 2006 and County of Middlesex 2003).

1.2.1 Natural Heritage Studies (2003 to 2006)

The first study, the 2003 Middlesex Natural Heritage Study (County of Middlesex and UTRCA 2003), was a pilot project for the Carolinian Canada Big Picture Project and the Ministry of Natural Resources Ecological Land Classification System. The Middlesex Natural Heritage Study (MNHS) involved analysis of existing information along with new botanical information for private property that was collected as part of the study. This information, combined with a detailed review of the ecological literature, led to the development of a set of landscape criteria that were then modelled using Geographic Information System (GIS) technology. The study focused on the identification of significant woodland patches only.

Building upon the Middlesex study, the 2006 Oxford Natural Heritage Study (ONHS) (County of Oxford 2006) was led by the UTRCA in collaboration with other county Conservation Authorities and completed for the County of Oxford. Various partners participated in the project. The 2006 ONHS had the following goals:

1. To increase understanding of the County's natural heritage features and systems (e.g. woodlands, wetlands, aquatic systems such as streams and rivers, etc.).
2. To develop land use planning information and establish the scientific and provincial policy basis, to identify, protect and enhance the natural heritage features and systems, at both the County and local municipal levels.
3. To encourage and facilitate private stewardship and public education.
4. To strengthen links between natural areas and protect the relationships between plant and animal communities.

The ONHS broadened the approach beyond wooded areas to include flood plain meadows and other elements of the natural heritage system, including an aquatic resources analysis. The ONHS was subjected to a third party peer review. The basic approach was validated through the peer review and minor adjustments were made to some criteria.

1.2.2 Natural Heritage Systems Studies (2014 to present)

Since the 2014 PPS Section 2.1.3 requires that natural heritage systems be identified in ecoregions 6E and 7E, new iterations of natural heritage studies are using a systems approach. The system expands from the previous studies that primarily focused on identifying significant woodlands. Current system studies now include other habitat types such as meadows, thickets, hedgerows, riparian buffers, etc.

Recent studies using this approach were completed by the UTRCA for Middlesex (County of Middlesex, 2014), Huron (County of Huron, 2014 draft) and Oxford (County of Oxford, 2016). These studies provide the basis for this Perth study.

1.3 Study Area

A map of the Perth County is shown in Figure 1. The County of Perth has four member municipalities, the Municipality of North Perth, the Township of Perth East, the Township of Perth South and the Municipality of West Perth. Stratford and the town of St. Marys operate under their own municipal governments that are independent from the County's government. However, this study treats the entire county as a whole for the purposes of natural heritage mapping. The county is under the jurisdiction of four Conservation Authorities: Maitland Valley, Grand River, Ausable Bayfield and Upper Thames River.

A 1 km buffer was placed around the county boundary when modelling the criteria to avoid cutting off woodlands and other natural heritage features that spanned both sides of the boundary. This larger area is termed the Study Area. The Natural Heritage Reference Manual (page 156) recommends that the natural heritage system adequately and appropriately connect features to other natural heritage systems beyond the study area. After modelling, this buffer was clipped back to the county corporate border to calculate final areas and percent vegetation cover. The Perth County corporate area is 222,233 ha and the study area with the buffer is 247,324 ha.

1.4 Project Governance

Since this study follows the methodology of the 2014 MNHSS and 2016 ONHSS, the project governance was streamlined. The project was guided by a partnership of the following agencies which provided comments at the onset of the study at a joint natural heritage working group meeting of Oxford and Perth Counties. Representatives from the following agencies participated:

- County of Perth, Planning & GIS staff
- Upper Thames River Conservation Authority
- Grand River Conservation Authority
- Maitland Valley Conservation Authority
- Ausable Bayfield Conservation Authority
- Ministry of Natural Resources and Forestry (Planning Dept, Guelph and Aylmer Office)

The County of Perth approved the final project proposal and oversaw the fulfillment of project time lines and deliverables. The Upper Thames River Conservation Authority (UTRCA) oversaw project coordination.

Peer Review

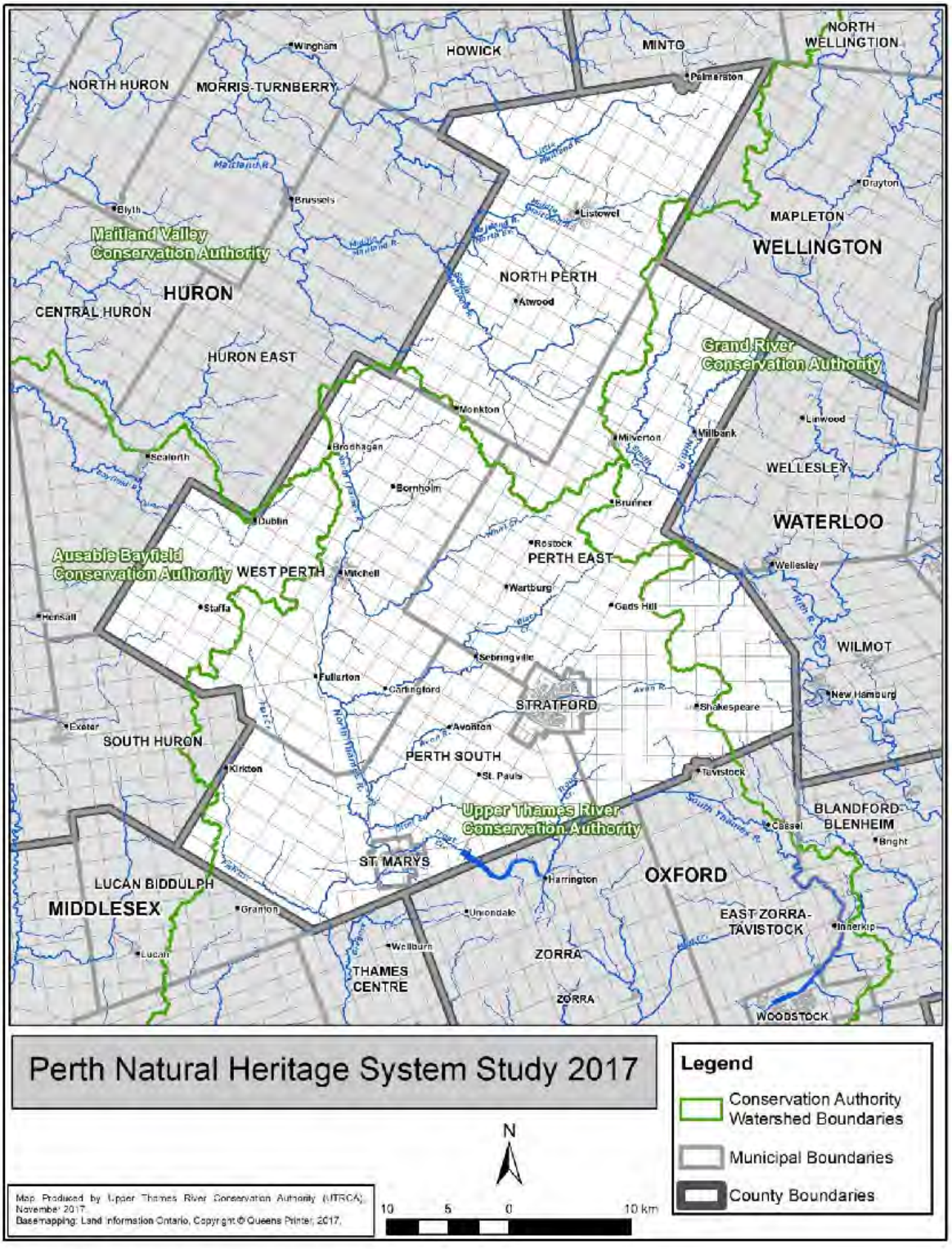
The 2006 Oxford Natural Heritage Study (ONHS) and the 2014 Middlesex Natural Heritage Systems Study (MNHSS) were both peer-reviewed. In the case of the MNHSS, a technical peer review was completed by a qualified third party expert at two stages in the process. Thus, the Terms of Reference for the PNHSS concluded that this PNHSS did not require a peer review as it followed the same methodology as the 2017 ONHSS and 2014 MNHSS. The 2017 Oxford Natural Heritage Systems Study was extensively reviewed by county planning staff.

Changes from the 2014 MNHSS and the 2016 ONHSS methodologies to this Perth NHSS:

- woodland size criterion cut-off was reduced from ≥4 ha in the MNHSS and ONHSS, to ≥1 ha in the PNHSS. The rational is included in section 3.4.2, and
- meadow size criterion cut-off was reduced from ≥ 10 ha in the MNHSS to ≥ 5 ha in the ONHSS. The rational is included in section 3.4.2.

The methodology used to identify the valleyland systems in the MNHSS 2014 and ONHSS 2016 was reviewed by the MNRF who agreed that the methodology met evaluation criteria and standards as per the NHRM requirements to identify Significant Valleylands.

Figure 1. County of Perth showing Member Municipalities and Conservation Authority Watersheds



1.5 Significant versus Ecologically Important

As outlined in Section 1.1., this study maps and evaluates the natural heritage system of Perth County and its component features and areas, to provide the scientific basis for their identification by the County, as required to be consistent with the applicable natural heritage policies of the PPS.

The term/phrase "ecologically important" is used to identify the features of the natural heritage system that meet the ecologically based criteria established in this study. These features include:

- vegetation groups and patches that are "significant" as per the definitions of significant in the PPS and MNRF criteria, including significant woodlands, significant valleylands, fish habitat, provincially significant wetlands, and provincially significant ANSIs, and

- various other vegetation groups that are ecologically important from a natural heritage system analysis perspective, including additional features and areas such as meadows, thickets, regionally significant ANSIs, evaluated and unevaluated wetlands, and connected vegetation features. These latter features are not significant as per the PPS definition and the MNRF criteria (unless they are determined to be Significant Wildlife Habitat). Table 1 summarizes the differences.

The valleyland layer developed in this study meets the requirements of Significant Valleylands as noted in the previous section.

Natural Heritage Systems Studies identify "ecologically important" features using a series of ecologically based criteria and GIS modeling. Each criterion measures a unique aspect of the ecological services that a natural feature provides. Thus, any patch that meets at least one criterion is considered "ecologically important" in Perth, with some of these ecologically important features also being significant as per the PPS.

This one-criterion approach has been utilized in many other studies including the 2016 Oxford Natural Heritage Systems Study, 2014 Middlesex Natural Heritage Systems Study and the 2014 Huron Natural Heritage Study. In these other studies, the criteria were called "significance criteria", but in this study the word "significant" has been replaced with "ecologically important". This change was made to distinguish the use of the word significant in the Provincial Policy Statement for features such as Provincially Significant Wetlands and Provincially Significant ANSIs.

Table 1. Significant versus Ecologically Important Natural Heritage Features and Areas

Natural Heritage Features	Significant (as per the PPS)	Ecologically Important (as per the PNHSS 2017)
Significant Woodlands that Meet PPS Criteria (Table 7-2 NHRM)	Yes	Yes (see Section 3.2.2 of this study)
Significant Valleylands	Yes	Yes (only the NHFs within or touching them)
Fish Habitat	Yes	No (not a criteria in this terrestrial study)
Provincially Significant Wetlands	Yes	Yes
Provincial Life Science ANSIs	Yes	Yes
Provincial Earth Science ANSIs	Yes	No (some NHF&A on them may be if they meet other PNHSS criteria)
Regional Life Science ANSIs	No	Yes
Evaluated Wetlands	No	Yes
Unevaluated Wetlands	No	Yes
Meadows	No	Yes (if meet PNHSS group or patch criteria)
Thickets	No	Yes (if meet PNHSS group or patch criteria)
Connected Vegetation Features	No	Yes (if meet PNHSS group or patch criteria)
Non-significant Woodlands that do not meet PPS criteria	No	Yes (if they meet PNHSS patch criteria)
Water bodies and Major Watercourses	Yes (If they contain Fish Habitat)	Yes (if part of a group or patch that meets PNHSS criteria)
Habitat of Endangered, Threatened species	Yes (where identified, but not mapped currently)	No (not a criteria in the PNHSS; already protected under the SAR Act)
Significant Wildlife Habitat	Yes (where identified, but not currently mapped)	Yes (if identified in an EIS)
Groundwater Dependent Wetlands/Ecosystems	No (not as a natural heritage feature)	Yes (if identified in an EIS)
Watercourse Bluffs and Depositional Areas	Yes (if they contain Fish Habitat)	Yes (if identified in an EIS)

1.6 Statement of Limitations (Scope)

The methodology for this study involves using the best available vegetation information from digital mapping layers and current landscape ecology literature to develop landscape criteria for local importance (e.g., size, proximity). Several limitations are noted in this section.

1.6.1 Mapping Limitations

The base mapping layer is based on spring colour 2010 aerial photography (ortho-imagery). The boundaries of the natural features are accurate for that point in time only. 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. 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. The 2010 photography was flow prior to leaf-out and is an excellent product for discerning natural heritage features.

Although the boundary of some natural heritage features will have changed from 2010 to present, 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. If needed, the Environmental Impact Study will verify any changes to the boundaries of the natural features.

Another limitation with mapping features that are developed and maintained by dynamic processes (e.g., old field succession) 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 of the ecosystem functions and derived services, 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.).

1.6.2 Watercourse Layer

Although digital data for watercourses exists for southern Ontario, this data is not current and was not updated as part of this study. Recognizing time and resource constraints, a method was developed that eliminated the need to update the entire watercourse layer when running the criteria. Using spring 2010 aerial photography (SWOOP – Southwestern Ontario Orthoimagery Project), an on-screen interpretation of the edge (i.e., the bank-full width) of open watercourses was completed in tandem with the interpretation of Vegetation Community boundaries. Section 3.3.3 provides more details.

Notwithstanding the state of the water course layer, it should be understood that all open watercourses are still considered to be potential fish habitat and should be screened for at the site level as part of any development application. All open watercourses are considered part of the aquatic system, however, this study focuses on the terrestrial system. Best available watercourse mapping is shown in Appendix I-3.

1.6.3 Connectivity and System Linkages

Ecological connectivity is a fundamental conservation biology principle that is scientifically defensible, yet difficult to identify given the dynamic nature of the landscape and the species within it (Rodewald 2003). In urban areas, roads, hard surfaces and dense human populations are an obvious barrier to many native plant and animal species. As a result, remaining wildlife linkages in existing developed urban areas are often limited to waterways, valleys and protected parkland/natural areas.

However, in agricultural landscapes, it is difficult to define linkages outside of the defined natural heritage system (woodlands, hedgerows, wetlands, major watercourses, etc.) where it could be argued that many farm fields can be part of the system. Ontario Nature (2014) recognizes the natural heritage / agricultural matrix interactions in southwestern Ontario. Crop fields and pastures do not present as much of a barrier to animal/seed movement as dense urban landuses, though they do not replace NHFA and formal linkages. Thus the PNHSS does not attempt to identify current or future linkages between patches or across agricultural fields or along unvegetated stretches of watercourses (drains) in rural areas, as the concern over loss of connectivity is not as great as it is for urban areas.

Identifying and planning for a NHS ideally should include both the identification of patch and linkage/corridor attributes. This is supported in the policies/definition for natural heritage studies under the PPS 2014, and the technical guidance under the 2010 Natural Heritage Reference Manual.

This study identifies Significant Valleylands *as per* the methods established in the 2016 Oxford Natural Heritage Systems Study, which MNRF recommended form the backbone of the linkages/corridors of the Natural Heritage System. Chapter 5 outlines recommendations for identifying and evaluating natural linkages as part of the review of proposals to develop land for uses that could affect the ability for species to move between natural features. The recommendations consider the site as a part of the overall system and the need to demonstrate that there is no impact on the loss of connectivity and linkages between the features defined in this study. The analysis of proposed development of agricultural and future development lands for other uses must characterize and prioritize these linkages according to factors such as the presence of threatened and endangered species, proximity to other features, application of the Carolinian Canada Big Picture corridor rules, etc. As well, several criteria deal with proximity between Vegetation Communities and Patches.

This study evaluates what is significant, but does not attempt to analyze whether the natural heritage features are in the best location, nor does it build an ecologically sustainable ecosystem. Through the submissions of an Environmental Impact Study, opportunities to improve linkages should be provided.

1.6.4 Features Identified through EISs

There are three natural features that could not be mapped in this study, but are part of the 15 ecologically important criteria for identifying the Natural Heritage System (see Table 9):

- Significant Wildlife Habitat,
- Groundwater Dependent Wetlands/Ecosystems and
- Watercourse Bluffs and Depositional Areas.

Where there is a change in land use within any feature on the landscape, an EIS may be required to determine if any of these three features are present and ensure no negative impact on the features or their ecological function. Planners need to be aware that some features can only be identified through site inventory and ensure that the EIS considers all such features, whether mapped or not. Section 3.6 provides more detail.

Trees planted along a watercourse in Perth County. UTRCA photo.

2.0 Mapping Guidelines

2.1 Assemble Digital Vegetation Layers (Base Mapping Layers)

Before evaluation criteria can be applied to the natural heritage features of the County, it is necessary to develop a method to define and delineate these natural heritage features and systems. Photo interpretation techniques using 2010 South Western Ontario Orthoimagery Project (SWOOP) as a backdrop were used to prepare a detailed and comprehensive mapping product of the natural heritage features in Perth County. Air photo interpretation enables coarse level identification of vegetation communities without a site visit.

The natural heritage features were defined using a minimum scale of 1:2,000. The work was completed primarily by the UTRCA and Ausable Bayfield Conservation Authority (ABCA), with wetland work completed by the Grand River CA (GRCA). Table 2 summarizes the work that each conservation authority undertook.

Table 2. Digital mapping layer development for the 2017 PNHSS

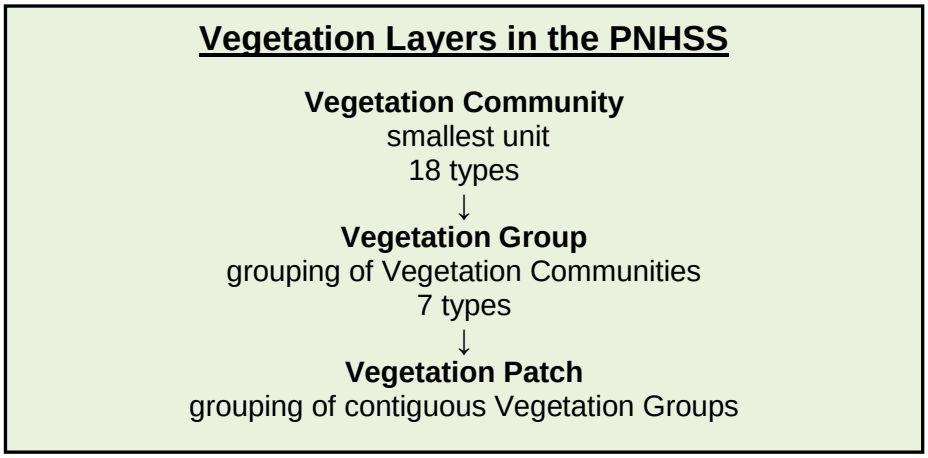
Watershed within Perth County	Agency that provided the mapping update and elements of the vegetation layers
Upper Thames River	UTRCA – All (woodlands, wetlands, watercourses, waterbodies, thickets and meadows)
Grand River	UTRCA – All but wetlands GRCA – Wetlands
Ausable Bayfield	ABCA – All
Maitland	UTRCA - All

Note: wetlands include both evaluated and unevaluated wetlands

2.2 Delineation of Digital Vegetation Layers

Natural heritage in Perth County is comprised of a hierarchy of four vegetation layers or components described in detail in this chapter and shown in the schematic below. The smallest unit of delineation is the *Vegetation Community*. *Vegetation Communities* are lumped by type into *Vegetation Groups* and contiguous *Vegetation Groups* are then lumped into *Vegetation Patches* (see Table 3). *Vegetation Communities* are also lumped by type into *Vegetation Ecosystems*. The graphic below illustrates how the layers are put together. Land ownership boundaries do not impact the creation of *Vegetation Communities*, *Groups*, *Ecosystems* and *Patches*. For example, any given *Vegetation Patch* could be under the jurisdiction of many landowners.

The metadata for *Vegetation Patch* and *Group* is included in Appendix F. The metadata for *Vegetation Community* is included in Appendix G.



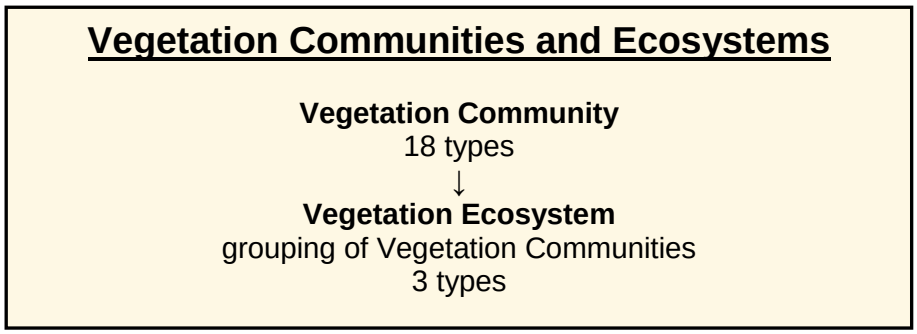


Table 3. Relationship between *Vegetation Communities*, *Groups* and *Ecosystems*

Vegetation Community **(18 types)**	***Vegetation Group*** **(7 types)**	***Vegetation Ecosystem*** **(3 types)**
Deciduous Woodland	Woodland	Terrestrial
Mixed Woodland	Woodland	Terrestrial
Coniferous Woodland	Woodland	Terrestrial
Mature Plantation	Woodland	Terrestrial
Deciduous Swamp	Woodland, Wetland	Wetland
Mixed Swamp	Woodland, Wetland	Wetland
Coniferous Swamp	Woodland, Wetland	Wetland
Plantation Swamp	Woodland, Wetland	Wetland
Upland Thicket	Thicket	Terrestrial
Young Plantation	Thicket	Terrestrial
Young Plantation Swamp	Thicket, Wetland	Wetland
Wetland Thicket	Thicket, Wetland	Wetland
Meadow Marsh	Meadow, Wetland	Wetland
Upland Meadow	Meadow	Terrestrial
Connected Vegetation Feature	Connected Vegetation Feature	Terrestrial
Watercourse Bluff and Depositional Areas	Watercourse Bluff, Bar or Beach	Terrestrial
Water bodies	Water Feature	Aquatic
Major Watercourses	Water Feature	Aquatic

2.3 *Vegetation Communities*

The smallest unit mapped in this study is the *Vegetation Community*. The *Vegetation Community* is a unit of vegetation that is normally visible and consistently interpreted on remotely sensed images. *Vegetation Communities* are internally homogenous and distinguishable at a 1:2,000 scale by the dominant types of plant forms that characterize the *Vegetation Community*. The *Vegetation Communities* must be at least 0.5 ha in area and 30 m wide to be included (length is the longer direction and width is the shorter). This minimum width was chosen to ensure the protection of the roots of some of the tree species. Tree roots often extend out from the core of the tree to a distance of at least the height of the tree, and the average height of a mature tree in Perth County is 30 m. The Natural Heritage Reference Manual (section 7.3.2) suggests 0.5 ha in size and 40 m width, but the width was reduced to 30 m in the Middlesex, Oxford and Perth NHSSs for the reasons mentioned above.

Vegetated areas 20 to 30 m wide and connected to two or more *Vegetation Communities* are considered connecting features (e.g., hedgerows), not woodlands. Unconnected vegetated areas of the same width are not mapped or included in this study. Linear treed areas <20 m wide are considered windbreaks and are not mapped or included in this study, though it is understood that windbreaks do provide many benefits to the environment including protection from soil erosion. For consistency, the 30 m width was chosen as the minimum width for thickets and meadows as well as woodlands.

A Minimum Mapping Unit (MMU) of 0.5 ha was used as the minimum size of an isolated *Vegetation Community*. The Ecological Land Classification (ELC) (Lee *et al.* 1998) uses 0.5 ha and that is one of the standards referenced as being acceptable for woodland delineation in the PPS definition. Land cover classifications commonly use a MMU of 0.5 to 1.0 ha for large scale county level maps, and 10 to 100 ha for very small scale regional maps.

Exceptions to the 0.5 ha MMU rule in this study include:

- **Connected Vegetation Features.** These features do not have a minimal area associated with them, but they do have to be > 20 m in length and 20 to 30 m in width and connected to two or more *Vegetation Communities.*

- **Provincially Significant Wetlands.** Some evaluated wetland communities are smaller than 0.5 ha and are retained as part of the natural heritage system.

- **Artifacts of Mapping**. *Vegetation Communities* smaller than 0.5 ha in size are identified if they are either: 1) surrounded by *Vegetation Communities* or 2) connect two or more *Vegetation Communities* that are greater than 0.5 ha. A *Vegetation Community* < 0.5 ha does not, by itself, become a *Vegetation Group*, but it is included in the *Vegetation Patch* to maintain shape and size of the *Vegetation Patch* (see Figure 3).

Vegetation Communities in Perth County were mapped and updated guided by the manual on-screen digitizing procedures outlined in the Southern Ontario Land Resources Information System (SOLRIS) Image Interpretation Manual (MNR 2004), with the following notes:

- **Small Intrusions** – Existing buildings, structures, gardens, manicured areas and waterbodies that are < 20 m in width are considered part of the surrounding natural feature (i.e., they do not cause a break in the *Vegetation Community*), as per the SOLRIS manual.

- **Roads, Railroads, Watercourses** − All municipal roads, railroads and watercourses separate *Vegetation Communities* regardless of their width. However, later, when

Vegetation Communities are put into *Vegetation Groups*, clustering rules apply when these features are < 20 m wide (see Section 2.4 and 2.4.8).

Eighteen types of *Vegetation Communities* were delineated in Perth County. Table 4 provides a description of each *Vegetation Community* including how they are identified and the ELC (Ecological Land Classification) equivalent. The ELC code name descriptions are provided in Appendix A1 and A2.

Wildflowers flourish in a woodlot near the mouth of the Avon River in Perth South. Photo by Cathy Quinlan

Table 4. Definition and attributes of the 18 *Vegetation Communities*

Vegetation Community	**Description and Methods uses for Identification on Imagery**	**ELC Equivalent** (Appendix A)
1. Deciduous Woodland (Forest)	- Contains ≥60% tree cover. Comprised of tree species that lose their leaves at the end of the growing season and are capable of reaching heights of several metres (typically 20-30 m). - Individual deciduous trees have a billowy texture on air photography. If the image is taken when trees are not in leaf, individual trees have a translucent appearance such that tree trunks can be seen through the branching canopy.	FOD
2. Mixed Woodland	- Contains ≥60% tree cover. Comprised of a combination of coniferous and deciduous tree types scattered throughout. - Each tree type comprises >25% but <75% of the canopy.	FOM
3. Coniferous Woodland	- Contains ≥60% tree cover. Comprised of >60% coniferous (cone-bearing) tree species capable of reaching heights of several metres. - Individual trees are dark in colour as most are evergreen, and have a conical shape with a pointed top.	FOC
4. Mature Plantation	- Contains ≥60% tree cover. Comprised of deciduous and/or coniferous tree species. - In the past, most plantations start as planted rows of conifers, but in time deciduous trees filled in. - Boundary distinguishable by at least one edge with a straight line. - At maturity, individual trees or rows of trees are not clearly discernible at 1:2,000.	CUP
5. Deciduous Swamp	- Contains ≥60% tree cover. Deciduous woodland with a more open canopy (indicating lower tree vigor) located in a wetland as identified by MNRF or CAs. - Common in Perth. - The standing water, common in spring, appears dark in colour.	SWD
6. Mixed Swamp	- Contains ≥60% tree cover. Mixed woodland (coniferous and deciduous) with a more open canopy (indicating lower tree vigor) located in an MNRF or CA identified wetland area.	SWM
7. Coniferous Swamp	- Contains ≥60% tree cover. Coniferous woodland with a more open canopy (indicating lower tree vigor) located in a MNRF or CA identified wetland area. - Treed bogs, a type of coniferous wetland, are uncommon and often have a pond or low open thicket at the centre.	SWC
8. Plantation Swamp	- Contains ≥60% tree cover. A mature plantation with a more open canopy (indicating lower tree vigor) located in a MNRF or CA identified wetland area. - Not common in Perth. - Trees are usually conifers (planted).	CUP
9. Upland Thicket	- Comprised of 25 to 60% tree or shrub cover. Shrubs are woody plants that are not capable of reaching heights of several metres. - < 20% standing water.	TPW, CUT, CUW

10. Wetland Thicket	- A thicket *Vegetation Community* that is found either along a watercourse, has ≥20% standing water, or is located in a MNRF or CA identified wetland area. - Has either 10-25% tree cover or, <10% tree cover and >25% shrub cover. - Dark water tones interspersed throughout demarking standing water.	SWT, FET, FES, BOT, BOS
11. Young Plantation	- Comprised of coniferous (usually) or deciduous trees planted in rows that are discernable at 1:2,000 scale. Trees short, not mature. - Boundary distinguishable by at least one edge with a straight line - Does NOT include fruit/nut orchards or Christmas tree farms and these may need to be verified at the site level if in question.	CUT, CUW
12. Young Plantation Wetland	- A young plantation *Vegetation Community* located in a MNRF or CA identified wetland area where individual trees or rows of trees are discernible at 1:2,000. Trees are usually young conifers.	CUT
13. Upland Meadow	- Comprised of grasses or forbs where less than 25% of the canopy is comprised of woody plants. Trees or shrubs often widely scattered.	TPO, CUM
14. Meadow Marsh	- A meadow marsh *Vegetation Community* located in a wetland identified by the MNRF or CA, comprised of cattails, wetland grasses and other wetland forbs (non-treed). - Fens and open bogs may not be distinguished in the wetland mapping layer, but these habitats are uncommon in Perth County. They should be distinguished when conducting EIS surveys.	FEO, BOO, MAM, MAS, SAS, SAM, SAF
15. Water Bodies	- Comprised of a body of standing water ≥ 20 m wide <u>adjacent</u> to another *Vegetation Community*. Can include a: • man-made pond associated with construction or extraction (e.g., aggregate pit), • reservoir created by a dam or barrier, • natural pond within a wetland or a natural water feature such as a kettle lake, or • sewage lagoon found in/on the outskirts of an urban area. - Appears as a flat plain surface on air photos; may show patterns of wind disturbance, floating aquatic vegetation, or cloud reflections.	OAO
16. Major Watercourse	- A linear feature >1 km long and mostly >20 m wide and containing flowing water at least for part of the year. - Delineated as a polygon using bank-full width as seen on aerial photography flown in the spring. - See Section 2.4.5 for more details.	OAO
17. Connected Vegetation Feature	- A linear feature comprised of woody plants (trees, shrubs) that connects two or more *Vegetation Communities*, often called a buffer, hedgerow or shelterbelt. - Length is >20 m and width is >20 m but <30 m. See Section 2.4.6 - Considered one feature as long as there are no gaps >20 m. - Often located between farm fields.	--
18. Watercourse Bluff and Depositional Areas (Bars, Beaches)	- Bluffs: Areas of mostly bare soil along the outside meander of a watercourse or on steep slopes not being actively cultivated. - Bars, Beaches: Appears as a sediment/stone depositional area along inside bends of watercourses. - Currently not mapped.	BBO, BBS, BBT, BLO, BLS, BLT, CLO, CLS, CLT, TAO, TAS, TAT

2.4 *Vegetation Groups*

Each *Vegetation Community* is assigned to broader *Vegetation Groups*. Seven types of *Vegetation Groups* were delineated in Perth County:

1) Wetland (contains woodland, thicket and meadow)
2) Woodland
3) Thicket
4) Meadow
5) Water Feature
6) Connected Vegetation Feature, and
7) Watercourse Bluff and Depositional Area.

Vegetation Groups are comprised of a mosaic of one or more *Vegetation Communities* within 20 m of each other, as illustrated in Figure 2. Figure 3 also illustrates *Vegetation Group* formation as well as *Vegetation Patch* formation.

Figure 2. Illustration of two Woodland *Vegetation Communities* (Deciduous Woodland and Deciduous Swamp) forming a *Woodland Group*

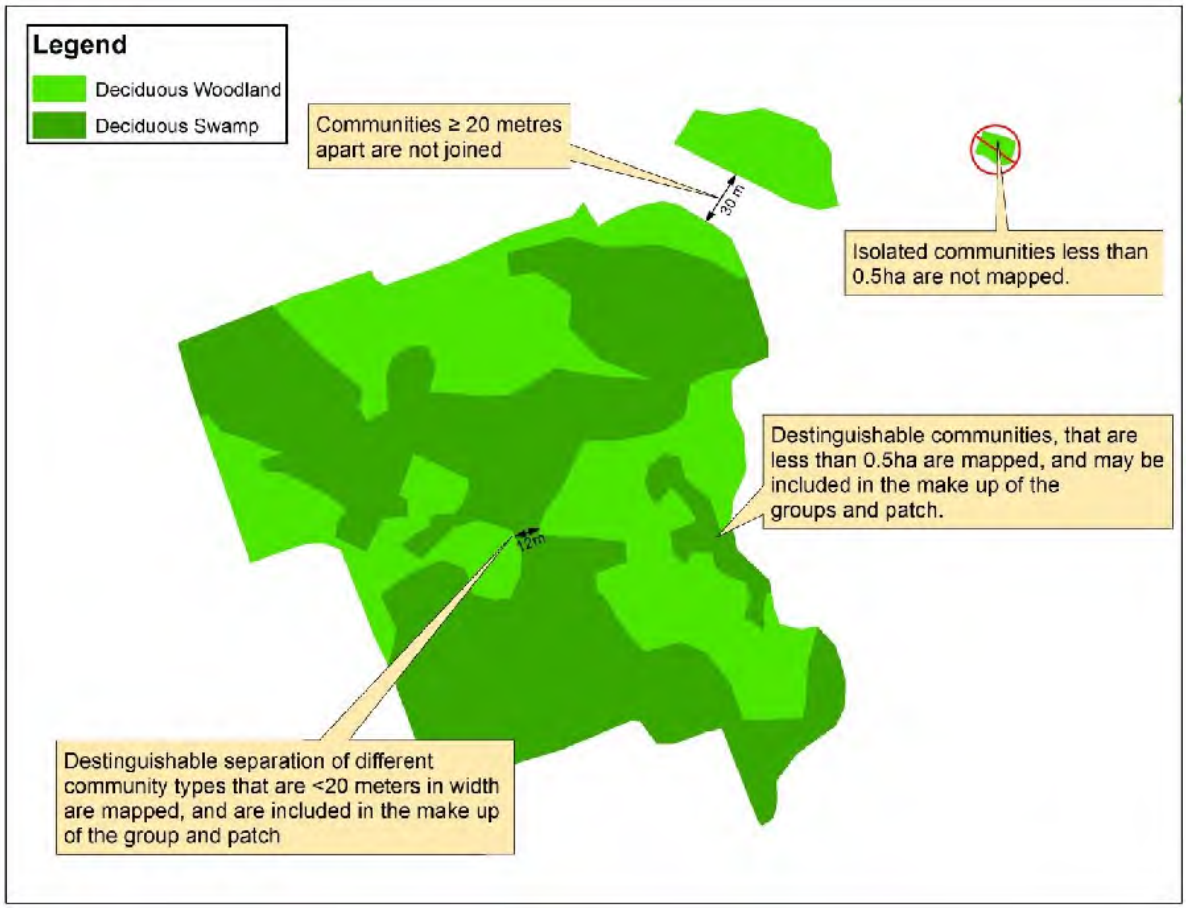
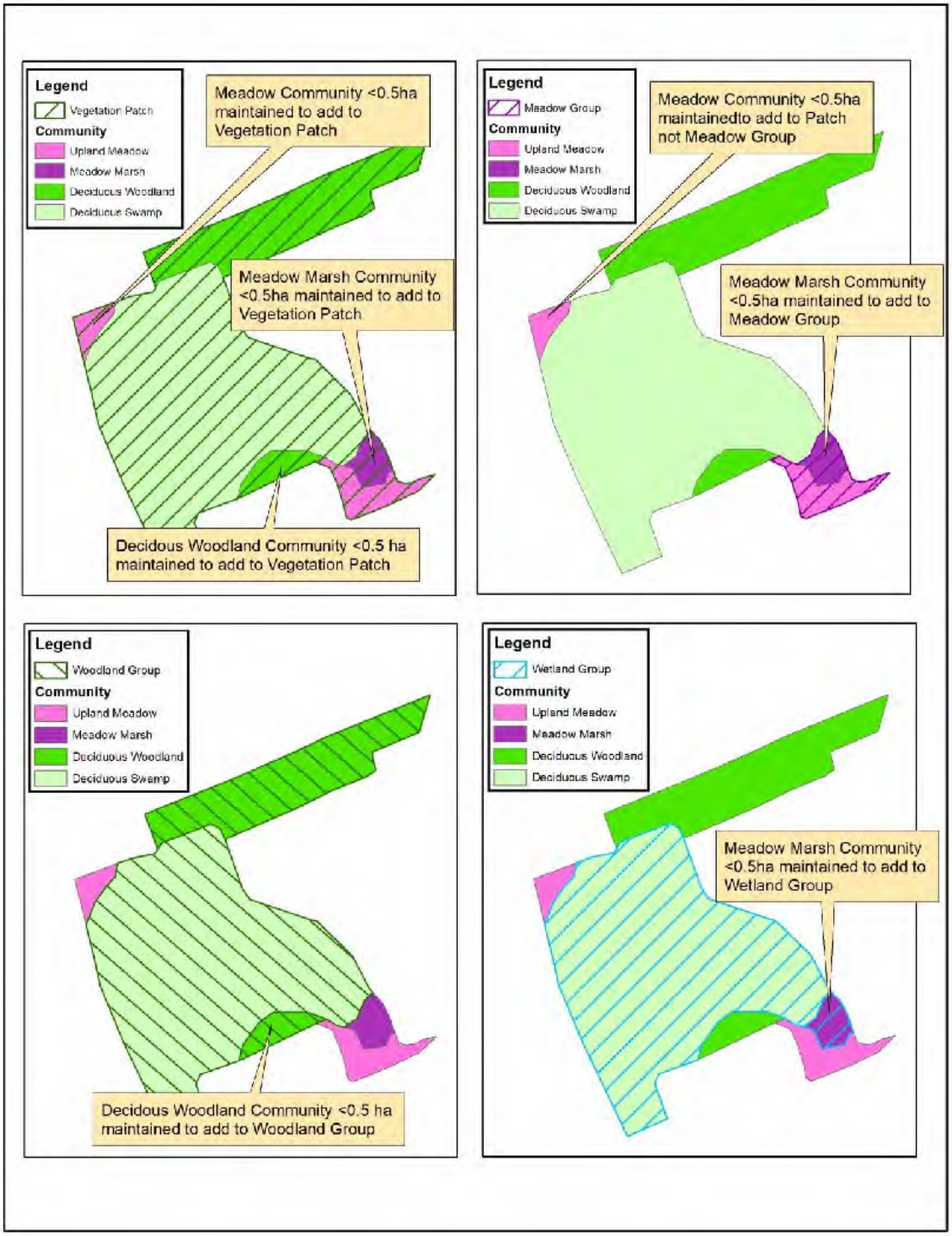


Figure 3. Illustration of how small and large *Vegetation Communities* are combined into *Vegetation Groups* and *Patches*



Note: Small *Vegetation Communities* <0.5 ha become part of *Vegetation Groups* if they are adjacent to (or <20 m from) a *Vegetation Community* of the same group (e.g., Deciduous Woodland and Deciduous Swamp are both in the Woodland Group). Small *Vegetation Communities* <0.5 ha become part of a *Vegetation Patch* if they are adjacent to any *Vegetation Community* within the patch.

Table 4, shown earlier, presents a comparison between the *Vegetation Groups* identified in this study to the ELC *Vegetation Community* Series level (Lee *et al.* 1998). Appendix A contains more details on the similarities and differences between the ELC Vegetation Community Series and the *Vegetation Groups* defined in this study. There are four main differences outlined below.

- The ELC distinguishes whether the vegetation is the result of an anthropogenic (cultural) process or a natural process. However, it should not be assumed that a cultural feature is not significant. Cultural, disturbed or successional natural features can have significant ecological functions and could be identified as Significant Wildlife Habitat (SWH). Therefore, it is important to consider any ELC communities classified as cultural for their potential to provide important ecological functions by comparing the community description with criteria in the Significant Wildlife Habitat Technical Guide. Thus, there is no distinction in the PNHSS 2017 as to whether the vegetation was influenced by natural or anthropogenic (cultural) processes.

- The ELC defines Open Water bodies as > 2 m depth and Shallow Water bodies as <2 m depth. Since depth of water bodies cannot be determined from aerial photos or remotely sensed data, these two features are combined into a single open water feature.

- The key factor in distinguishing wetlands from water bodies and other aquatic components in the ELC is the presence of > 25% emergent or woody vegetation cover. For this study, water bodies did not contain any water tolerant herbaceous or woody plants.

- The ELC distinguishes thickets, woodlands and forests. The ELC lists two types of woodlands (Tallgrass Woodland TPW and Cultural Woodland CUW), with a tree cover of 35% to ≤60%. Both these woodland types are rare in Perth. For the PNHSS, these ELC woodlands were lumped in the thicket *Vegetation Community* because of the low tree cover. As well, the ELC defines forests as habitats with > 60% tree cover. The PNHSS calls them woodlands to be consistent with the PPS wording. See Appendix A for more details.

2.4.1 Wetland *Vegetation Group*

The wetland *Vegetation Group* is comprised of seven wetland *Vegetation Communities* of which four are treed and three are untreed:

1) coniferous swamp (treed)
2) deciduous swamp (treed)
3) mixed swamp (treed)
4) plantation swamp (treed)
5) wetland thicket (untreed)
6) meadow marsh (untreed)
7) young plantation wetland (untreed)

The wetland information for Perth was derived from the MNRF Evaluated Wetlands layer (2015) and the Unevaluated Wetland layers from UTRCA and GRCA. The UTRCA identified unevaluated wetlands for the remainder of the county. A description of the methods used is included in Appendix B.

2.4.2 Woodland *Vegetation Group*

The Woodland *Vegetation Group* is comprised of eight *Vegetation Communities*, of which four are terrestrial/upland and four are wetland:

1) coniferous woodland (terrestrial/upland),
2) deciduous woodland (terrestrial/upland),
3) mixed woodland (terrestrial/upland),
4) mature plantation (terrestrial/upland),
5) coniferous swamp (wetland),
6) deciduous swamp (wetland),
7) mixed swamp (wetland) and
8) plantation swamp (wetland).

Because this is a GIS exercise, the SOLRIS (Southern Ontario Land Resources Information System) definition for woodland is used: Woodland describes areas with more than 60% tree cover. The ELC uses the word *forest* for this same definition, but to be consistent with the PPS, the word woodland is used in this study. In the NHRF (OMNR 2010), woodland means a treed area, woodlot or forested area, other than a cultivated fruit or nut orchard or a plantation established for the purpose of producing Christmas trees, that is located south and east of the Canadian Shield.

Mature plantations and plantation swamps are included as part of the woodland *Vegetation Group* as they are important components in the ecosystem. Mature plantations are old enough that the original tree rows (usually conifers) are not very visible on the ortho-imagery because a variety of other tree species (usually deciduous) have moved in. Plantation swamps are communities where trees have been planted in an area recognized as a wetland (evaluated or unevaluated) and the trees are full size or taller than shrub height.

Similar to natural forests and woodlands, plantations contribute to the net removal of carbon dioxide from the atmosphere, produce oxygen, modify wind and temperature, remediate soil pollution and structure and provide wildlife habitat. Often, landowners plant trees into a plantation or block planting to retire a parcel of land from agriculture and begin the process of natural succession towards mature forest/woodland. Narrow plantings of trees < 30 m wide and < 0.5 ha in size are not included in this group as they fall into the category of windbreaks, screen trees or visual barriers.

2.4.3 Thicket *Vegetation Group*

The Thicket *Vegetation Group* is comprised of four *Vegetation Communities*, two terrestrial and two wetland:

1) upland thicket (terrestrial/upland),
2) young plantation (terrestrial/upland),
3) wetland thicket (wetland), and
4) young plantation wetland (wetland).

Thickets are usually early successional communities dominated by shrubs, young trees or stunted mature trees. Upland thickets that develop on abandoned farm fields succeed to woodland much more quickly than wetland thickets which tend to be found in areas too wet for trees. Wetland thickets may also succeed to swamp if the wetland slowly fills in. Thickets along watercourses may be maintained even longer as flooding and ice scour knock back trees. Young tree plantations are called thickets when the trees are still short (e.g., shrub height).

Table 4 provides definitions for each thicket *Vegetation Community*. To be included, thicket *Vegetation Communities* must be ≥ 30 m wide and ≥ 0.5 ha.

2.4.4 Meadow *Vegetation Group*

The Meadow *Vegetation Group* is comprised of two *Vegetation Communities*, one terrestrial/upland and one wetland:

1) upland meadow (terrestrial/upland), and
2) meadow marsh (wetland).

Table 4 provides a description of the defining meadow habitat features. Meadows are short, open *Vegetation Communities* dominated by grasses and broad-leaved herbaceous plants and a scattering of shrubs and trees. Many meadows in Perth County are old fields of cultural origin (e.g., abandoned or retired farmland, future development land) and may, in time, succeed to thicket and then forest/woodland if left in a natural state. Meadows are often transitional communities, as in the examples given. However, meadows along watercourses may be more permanent habitats as the frequent flooding and ice scour keeps trees and shrubs from becoming established.

Meadows must be ≥ 30 m wide and ≥ 0.5 ha to be included. Pastures are not included in meadows as they are often heavily grazed and are part of the farm cycle.

2.4.5 Water Feature *Vegetation Group*

The Water Feature *Vegetation Group* is comprised of two *Vegetation Communities*:

1) permanent water bodies and
2) major watercourses.

Permanent water bodies include natural and man-made ponds ≥ 20 m wide and ≥ 0.5 ha in size without any vegetation cover or emergent vegetation.

Major watercourses are defined as watercourses ≥ 20 wide and ≥ 1 km long. Short stretches of major watercourses that are < 20 m wide are included as part of the major watercourse to maintain continuity. However, when a watercourse is < 20 m wide for 1 km or longer, it no longer becomes a major watercourse and becomes part of the surrounding *Vegetation Group*. However, all open watercourses are used to inform the proximity criteria as described in Section 3.3.3.

2.4.6 Connected Vegetation Feature *Vegetation Group*

The Connected Vegetation Feature *Vegetation Group* is comprised only of the Connected Vegetation Features *Vegetation Community*. Connected Vegetation Features are narrow *Vegetation Communities* consisting of trees and/or shrubs that connect two or more *Vegetation Communities*. They must be >20 m long and 20-30 m wide. They are sometimes called buffers, hedgerows, shelterbelts or natural fencerows. For example, a connected vegetation feature can connect two deciduous woodlands, or it can connect a deciduous woodland and a major watercourse, or a water body and a meadow marsh and a mixed woodland.

They are an important component of the natural heritage system because they provide corridors for wildlife movement as well as wildlife habitat, and may include remnants of vegetation present prior to disturbance (e.g., forest remnants). More common in the past, many of these features have been or are being removed in the agricultural landscape to increase field size. This is despite the fact that these features have many advantages to agriculture including protecting crops from wind damage, protecting soil from wind erosion, increasing crop yields, conserving water and controlling snow accumulation (Agriculture Canada and Ministry of Agriculture and Food 1992). Hedgerows provide a barrier that can slow water flow and trap soil particles especially along waterways (Hobbs and McGrath, 1998).

Section 7.3.2 of the Natural Heritage Reference Manual (NHRM) (MNR 2010) recommends establishing a minimum width to Woodland *Vegetation Groups* to exclude these relatively narrow linear treed areas (e.g., windbreaks). Recognizing that breaks < 20 m are too small to separate Woodland *Vegetation Groups*, the width of a connected vegetation feature was defined as being >20 m but < 30 m in width.

Farm fields, windbreaks and woodlots are part of a balanced farm. *Photo by Cathy Quinlan*

2.4.7 Watercourse Bluff and Depositional Area (Bar or Beach) Vegetation Group

This Watercourse Bluff and Depositional Area *Vegetation Group* is part of the terrestrial/upland *Vegetation Ecosystem* and consists of very open and generally active geomorphic sites including beach bars, cliffs and talus slopes, all of which represent unique and significant habitats for animals and plants. These areas are often associated with Significant Wildlife Habitats as defined in the PPS.

Watercourse bluffs usually occur on steep slopes on an outside meander where active erosion takes place preventing the long-term establishment of vegetation. Bluffs are used by Bank Swallows and burrowing animals.

Depositional areas are often found on an inside river meander or on the downstream tip of river islands where sediment is deposited in slower moving water. Beach-like areas of sand and cobble result. They are generally open or unvegetated because of fluctuating water levels and water action. Their shape and even their presence changes from year to year, depending on flow conditions. Depositional Areas are used by wildlife such as snakes and turtles for basking and, in the case of Spiny Softshell turtles, for nesting.

The dynamic nature of watercourses means these features are constantly being altered and recreated. These features are generally quite small and because of the vertical nature of Bluffs, they not very visible on ortho-imagery. Thus, most watercourse bluffs and depositional areas are not mapped currently and will need to be identified through field studies as part of the Environmental Impact Study (EIS), where required (see Chapter 5). These features do not have to meet a minimum size for mapping standards.

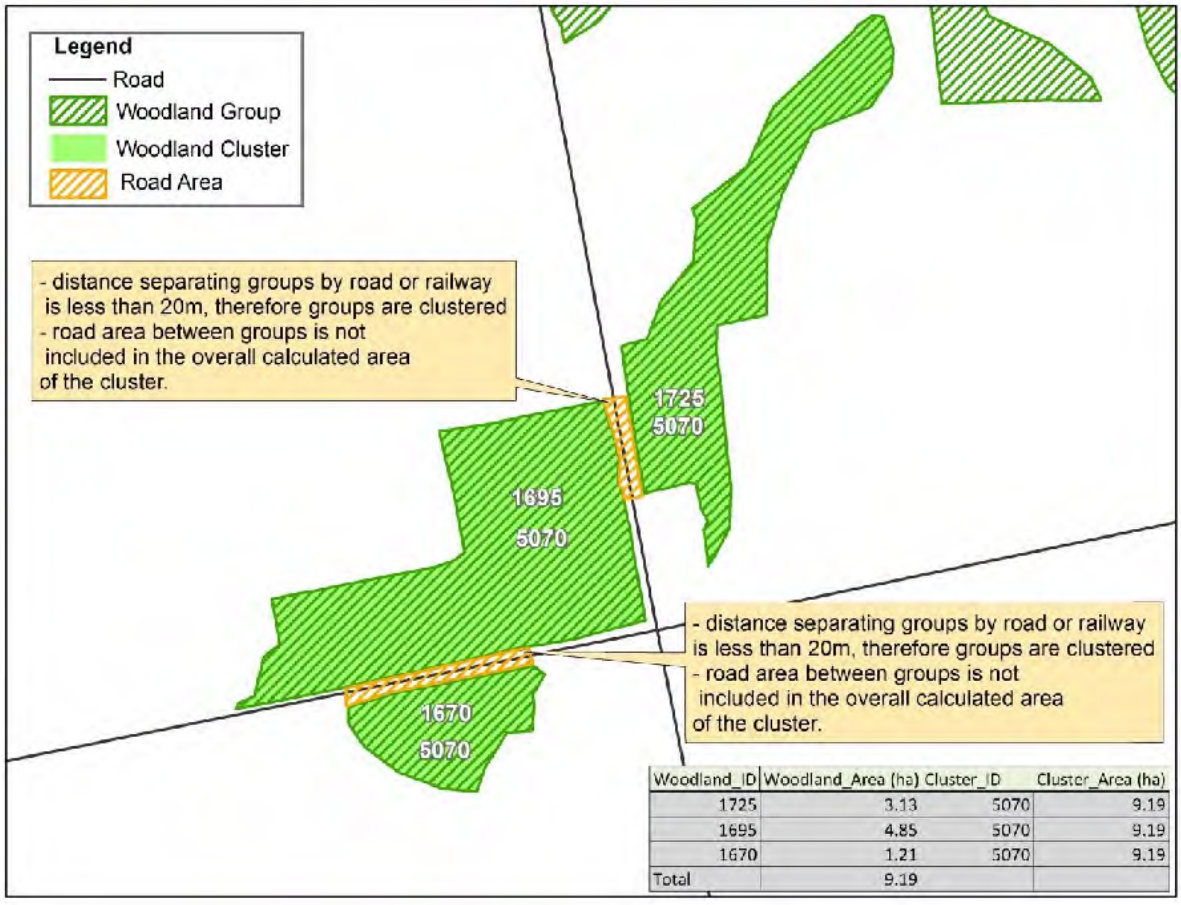
2.4.8 Clustering around Narrow Breaks (Roads, Railroads, Rivers)

As stated in Section 2.3, roads, railroads and watercourses ≥ 20 m separate *Vegetation Communities* and *Vegetation Groups*. Where roads, railroads and watercourses are < 20 m wide, the vegetation is not broken, but an extra step in the mapping is needed so that the area of the road/railroad/ watercourse is not included when vegetation area measurements are calculated, as per section 7.3.2 of the Natural Heritage Reference Manual (MNR 2010). This step is called clustering and is applied to woodlands, thickets and meadow groups.

Clustering methodology is as follows (see Figure 4 example):

- A unique identification number is assigned to each *Vegetation Group* (in Figure 4: 1725, 1695, 1670).
- A unique cluster identification number is assigned to each clustered *Vegetation Group* (5070).
- Clustering was applied to the *Vegetation Groups* before modeling the criteria (see Chapter 3).
- Criteria that measure area were applied to the entire clustered *Vegetation Group* (5070), and then the area of the road was subtracted.
- The remaining criteria were applied to the clustered *Vegetation Groups* (5070).

Figure 4. Illustration of clustering *Vegetation Groups* (1725, 1695, 1670) around narrow roads into one Woodland Cluster (5070)



Woodland_ID	Woodland_Area (ha)	Cluster_ID	Cluster_Area (ha)
1725	3.13	5070	9.19
1695	4.85	5070	9.19
1670	1.21	5070	9.19
Total	9.19		

2.5 *Vegetation Patches*

A *Vegetation Patch* is a mosaic of one or many different abutting (or < 20 m apart) *Vegetation Groups* (see Figure 5).

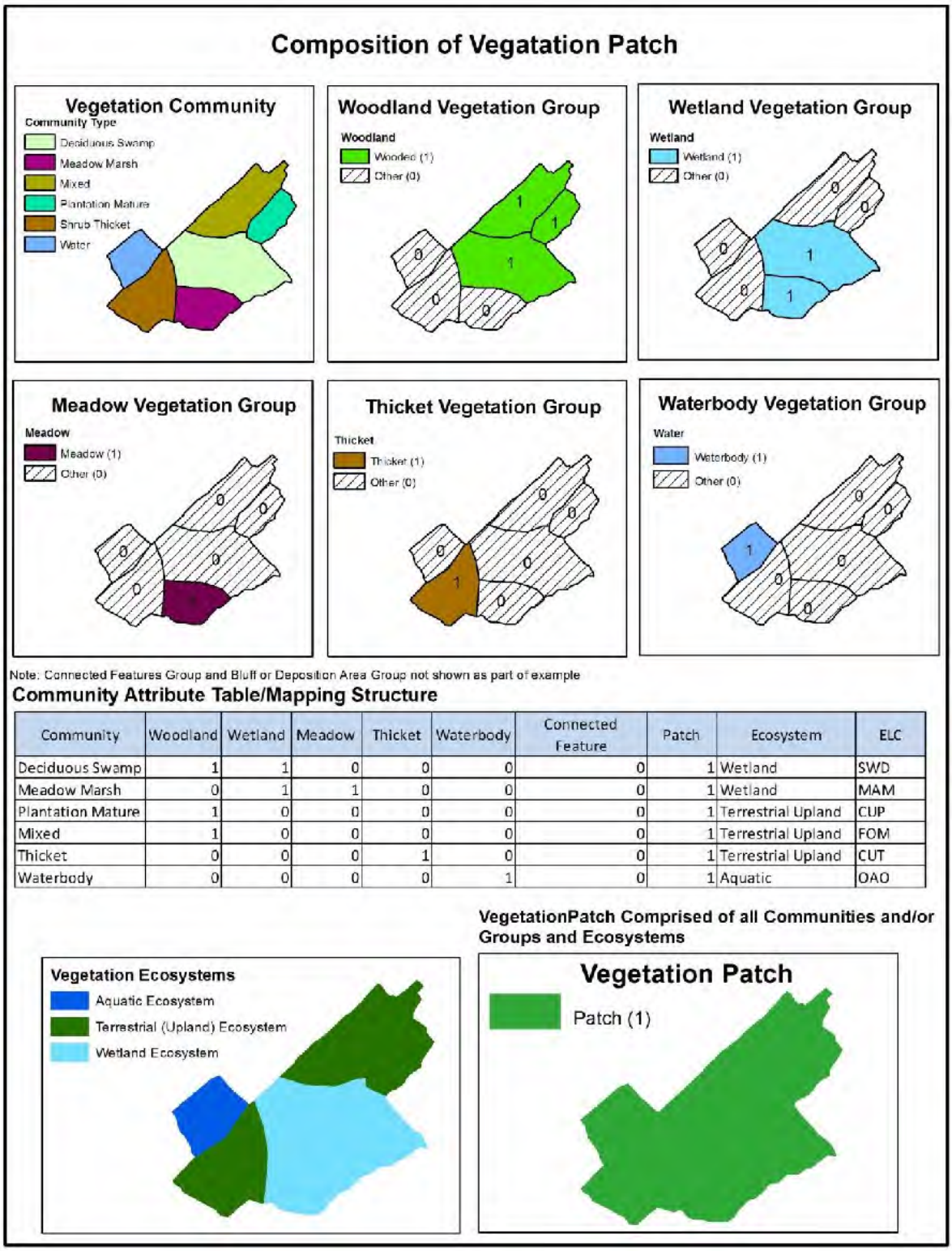
Roads ≥ 20 m wide separate *Vegetation Patches* as they do for *Vegetation Groups*. However, where smaller roads < 20 m wide separate *Vegetation Patches*, the patches are rejoined as a cluster as described for *Vegetation Groups* in Section 2.4.8. Clustering is applied to the *Vegetation Patches* before modeling the patch criteria (see Table 9). Since the NHRM does not calculate the area of a road when determining size and interior (MNR 2010), area criteria will be applied to the entire clustered *Vegetation Patch* less the area of the road. The remaining criteria will be applied to the clustered *Vegetation Patches* and include the road and railroads as part of the *Vegetation Patch* (see Figure 4).

A *Vegetation Patch* digital layer was created with unique number attributes assigned to each *Vegetation Patch*:

- the unique identification number to each *Vegetation Patch*, and
- a unique cluster identification number for clustered *Vegetation Patch*(s).

Floodplains of major watercourses often consist of a mosaic of woodland, thicket, meadow and watercourse vegetation groups. *Photo by UTRCA*

Figure 5. Illustration of the composition of a *Vegetation Patch* comprised of different *Vegetation Communities*, *Groups* and *Ecosystems*



Note: Connected Features Group and Bluff or Deposition Area Group not shown as part of example

Community Attribute Table/Mapping Structure

Community	Woodland	Wetland	Meadow	Thicket	Waterbody	Connected Feature	Patch	Ecosystem	ELC
Deciduous Swamp	1	1	0	0	0	0	1	Wetland	SWD
Meadow Marsh	0	1	1	0	0	0	1	Wetland	MAM
Plantation Mature	1	0	0	0	0	0	1	Terrestrial Upland	CUP
Mixed	1	0	0	0	0	0	1	Terrestrial Upland	FOM
Thicket	0	0	0	1	0	0	1	Terrestrial Upland	CUT
Waterbody	0	0	0	0	1	0	1	Aquatic	OAO

VegetationPatch Comprised of all Communities and/or Groups and Ecosystems

2.6 *Vegetation Ecosystems*

The 18 *Vegetation Communities* belong to one of three *Vegetation Ecosystems*:

1) terrestrial,
2) wetland and
3) aquatic.

Vegetation Groups can belong to one or more *Vegetation Ecosystem* (see Table 5). For example, woodland, thicket and meadow *Vegetation Groups* include both wetland and terrestrial *Vegetation Communities*. The only time *Vegetation Ecosystems* are used is for Criterion 13 on habitat diversity.

Terrestrial Vegetation Ecosystem

Table 5 lists the nine *Vegetation Communities* and five *Vegetation Groups* that are part of the *Terrestrial Vegetation Ecosystem* within this study.

Terrestrial *Vegetation Ecosystems* occur where soil moisture is scarce for at least some point in the growing season. Terrestrial *Vegetation Ecosystems* are distinguished from wetland or aquatic Vegetation Ecosystems by:

- a lower availability of water and the consequent importance of water as a limiting factor,
- greater temperature fluctuations on both a diurnal and seasonal basis,
- greater availability of light and gases (including carbon dioxide for photosynthesis, oxygen for aerobic respiration, and nitrogen for nitrogen fixation), and
- a subterranean portion (soil) from which most water and ions are obtained, and an atmospheric portion from which gases are obtained and where the physical energy of light is transformed into the organic energy of carbon-carbon bonds through the process of photosynthesis.

Wetland Vegetation Ecosystem

Table 5 lists the seven *Vegetation Communities* and four *Vegetation Groups* that are part of the *Wetland Vegetation Ecosystem*. Wetland *Vegetation Ecosystems* are considered semi aquatic. Section 2.4.1 describes how these features were identified and delineated.

Aquatic Vegetation Ecosystem

Table 5 lists the two *Vegetation Communities* (Water Bodies and Major Watercourses) and one *Vegetation Group* (Water Body Feature) that are part of the Aquatic *Vegetation Ecosystem*. Freshwater aquatic *Vegetation Ecosystems* are characterized as lotic (having flowing water) or lentic (still water).

Table 5. Relationship between *Vegetation Communities, Groups* and *Ecosystems*

	Vegetation Ecosystem		
Vegetation Group ↓	**Terrestrial**	**Wetland**	**Aquatic**
Vegetation Community			
Deciduous Woodland	Yes		
Coniferous Woodland	Yes		
Mixed Woodland	Yes		
Mature Plantation	Yes		
Deciduous Swamp		Yes	
Mixed Swamp		Yes	
Coniferous Swamp		Yes	
Plantation Swamp		Yes	
Upland Thicket	Yes		
Wetland Thicket		Yes	
Young Plantation	Yes		
Young Plantation Wetland		Yes	
Upland Meadow	Yes		
Meadow Marsh		Yes	
Water Bodies			Yes
Major Watercourse			Yes
Connected Vegetation Feature	Yes		
Watercourse Bluff + Depositional Area	Yes		
Vegetation Group			
Woodland	Yes	Yes	
Thicket	Yes	Yes	
Meadow	Yes	Yes	
Wetland		Yes	
Water Body Feature			Yes
Connected Vegetation Feature	Yes		
Watercourse Bluff + Depositional Area	Yes		

2.7 Results of Mapping the Vegetation Layers

Table 6 summarizes the number and area of the three vegetation layers: communities, groups and patches. The 7,067 *Vegetation Communities* are merged into 2,942 *Vegetation Groups*, and then are compiled into 2,371 *Vegetation Patches*.

Table 6. Number of Vegetation Communities, Groups and Patches in the Study Area

Vegetation Layers	Approximate Number in the Study Area*
Communities	7,067
Groups	2,942 (809 Wetlands**)
Patches	2,371

*Study area is the area of the geographic Perth County (222,233 ha) plus a 1 km buffer around the perimeter (total 247,324 ha) to capture natural heritage features that are located on both sides of the boundary and need to be modeled based on their full size.
**Wetland Groups are all part of other Vegetation Groups (e.g., Deciduous Swamps are also part of a Woodland Group) so it is double counting to add them in.

Table 7 shows the number and area of each *Vegetation Community* in the study area (buffered Perth). Table 8 shows the same information, sorted from largest to smallest area.

The three *Vegetation Communities* making up the largest area (75% of total vegetation cover) are: deciduous woodland, deciduous swamp and upland meadow. Deciduous woodland is the largest community at 12,760 ha or 42.0% of the total vegetation cover. In second place is deciduous swamp at 6,728 ha or 22.1% of the total vegetation cover. A distant third, upland meadow at 3,292 ha or 10.8% of the vegetation cover.

Table 9 summarizes the information by *Vegetation Group* for the Study Area. As expected, the woodland group is the largest. Overall, woodland covers 10.01% of Perth Study Area, meadow 1.40%, thicket 0.33%, water features 0.31% and connected vegetation features 0.01%. Watercourse bluffs and depositional areas are not mapped but will be very small.

There is 3.75% wetland cover in the county, comprised of swamps, wetland thickets and meadow marshes. It makes up 31.1% of the vegetation cover, or roughly one third. The 3.75% wetland cover is part of the total vegetation cover, not in addition to it.

Table 7. Number and area of the 18 *Vegetation Community* types in the Study Area

Vegetation Community **(sorted by like types)**	**Number of *Vegetation Communities***	**Area of *Vegetation Communities*** (ha)	**% Area of all *Vegetation Communities*** (30,400 ha)	**% of Perth Study Area** (247,323 ha)
Deciduous Woodland	2,346	12,760	41.97	5.16
Mixed Woodland	328	2,037	0.82	6.70
Coniferous Woodland	120	254	0.84	0.10
Mature Plantation	380	1,225	4.03	0.50
Deciduous Swamp	1154	6,728	22.13	2.72
Mixed Swamp	180	1,885	6.20	0.76
Coniferous Swamp	33	113	0.37	0.05
Plantation Swamp	6	143	0.47	0.06
Upland Thicket	239	399	1.31	0.16
Wetland Thicket	66	138	0.45	0.06
Young Plantation	158	306	1.01	0.12
Young Plantation Swamp	4	2	0.01	0.00
Upland Meadow	1529	3,292	10.83	1.33
Marsh Meadow (Meadow Marsh)	220	259	0.85	0.10
Water Body	211	283	0.93	0.11
Major Watercourse	62	551	1.81	0.22
Connected Vegetation Feature	31	24	0.08	0.01
Watercourse Bluff and Depositional Areas *				
TOTAL	**7,067**	**30,400**	**100.00**	**12.29**

*Not yet mapped as these features are usually too small to detect on air photos.
Study Area = Perth County plus a 1 km buffer.

Table 8. *Vegetation Community* types sorted by Area in the Study Area

Order Number	*Vegetation Community*	Area (ha)	% of Total Vegetation Community Area
1	**Deciduous Woodland**	12,760	42.0%
2	**Deciduous Swamp**	6,728	22.1%
3	**Upland Meadow**	3,292	10.8%
4	**Mixed Woodland**	2,037	6.7%
5	**Mixed Swamp**	1,885	6.2%
6	**Mature Plantation**	1225	4.0%
7	**Major Watercourse**	551	1.8%
8	**Upland Thicket**	399	1.3%
9	**Young Plantation**	306	1.0%
10	**Water Body**	283	0.9%
11	**Marsh Meadow**	259	0.9%
12	**Coniferous Woodland**	254	0.8%
13	**Wetland Thicket**	138	0.5%
14	**Plantation Swamp**	143	0.5%
15	**Coniferous Swamp**	113	0.4%
16	**Connected Vegetation Feature**	24	0.1%
17	**Young Plantation Swamp**	2	<0.1%
18	**Watercourse Bluff + Depositional Areas (Bars/Beaches)**	-	-
	Total	**30,400**	**100.0%**

*not yet mapped

Table 9. Area of *Vegetation Groups* as a percentage of Perth Study Area

Vegetation Group	**Area (ha)**	**% Area of Total Vegetation Cover** (30,400 ha)	**% of Perth Study Area** (247,323 ha)
Woodland	24,766	83.0%	10.01%
Thicket	816	2.7%	0.33%
Meadow	3,457	11.59%	1.40%
Water Feature	770	2.6	0.31%
Connected Veg. Feature	23	0.1%	0.01%
Watercourse Bluff and Depositional Area *	-	-	-
Total	**29,832**	**100.00%**	**12.06%**
Wetland Group (part of the total above)	9,284	31.2%	3.75%

*Not yet mapped

3.0 Criteria for Ecological Importance

3.1 Background

In settled landscapes, both habitat loss and fragmentation of the original natural cover increases the significance of, and need to protect, any remaining natural heritage features and functions (Levenson 1981, Lovett *et al*. 2005, Manning *et al*. 2004). However, haphazard 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).

Carter (2000), Bowles (1997) and Bowles *et al*. (2000) argue that no single characteristic can sufficiently measure the value of a natural feature. On the one hand, there is a danger of cumulative loss when habitat patches are assessed solely on site specific characteristics because their importance within the broader landscape is unknown. On the other hand, the external characteristics or location of a feature using landscape metrics such as size, connectedness, regional representation, and hydrological function may not always reflect its internal quality. Instead, it is important to use multiple criteria to assess the characteristics of a natural feature.

Site level analysis (i.e., biological inventory) is not feasible for a county scale study. However, local municipalities, because of their smaller geographic area, are encouraged to conduct more in-depth studies and evaluate their natural heritage features at the site level. For example, the City of London has used landscape, community and species parameters to assess importance/significance (City of London 2006). In general, regional (i.e., county) 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 and site specific content metrics (i.e., what the natural feature contains).

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 1995a, b and c, Forman and Godron 1986, Harris 1984, Turner and Gardner 1991, Schiefele and Mulamoottil 1987, Robbins *et al*. 1989, Hounsell 1989, Weyrauch and Grubb 2004). These metrics act as surrogate measurements of more detailed studies and can be easily measured using remote sensing/GIS.

However, these indicators provide only a partial picture of the complexity of ecosystem functioning. Land managers must realize that conservation of biological diversity might not be achieved by manipulating the size and configuration of remnant *Vegetation Patches*, but instead depend on how the extensive areas surrounding the *Vegetation Patches* are managed. Recognizing that this area of human modified land, the habitat matrix, overwhelmingly dominates all of the world's terrestrial ecosystems (Foley *et al*. 2005, Lindenmayer and Franklin 2002), conservation biologists and resource managers need to also focus attention on improving the quality of the habitat matrix and the environmental impacts associated with a change of land use in the habitat matrix if programs to conserve biological diversity are to succeed.

3.2 Ecologically Important Criteria

According to the Natural Heritage Reference Manual (MNR 2010), the responsibility for the identification and evaluation of significant wetlands and Areas of Natural and Scientific Interest (ANSIs), in accordance with the PPS, lies with the Ontario Ministry of Natural Resources and Forestry (MNRF). The MNRF also approves what is to be considered as significant habitat of endangered species and threatened species. In all other cases, with the exception of fish habitat, the responsibility for the identification, evaluation and designation of significant natural features and areas in accordance with the PPS lies with the planning authority.

The purpose of this 2017 Perth Natural Heritage Systems Study is to identify the Natural Heritage System, which is comprised of "ecologically important" natural features and areas identifiable on 2010 colour air photos of Perth County using a set of ecological criteria that include and go beyond the criteria for Significance according to the PPS.

The term "Significant" as it relates to Natural Heritage Features and Areas in the (PPS) is discussed on page 2 of this report. Natural Heritage Features and Areas include the following:

- Significant Wetlands,
- Significant Woodlands,
- Significant Valleylands,
- Significant Areas of Natural and Scientific Interest (ANSIs),
- Fish Habitat,
- Habitat of Endangered and Threatened Species, and
- Significant Wildlife Habitat.

Of the above features, the following are not identified in this study:

- Earth Science ANSIs,
- Fish Habitat,
- Habitat of Endangered and Threatened Species, and
- Significant Wildlife Habitat.

Earth Science ANSIs are not related to the importance of the vegetation community. The presence of an Earth Science ANSI does not mean that there are unique vegetation community features that result from the characteristics of the Earth Science ANSI (e.g., a moraine or glacial spillway). Fish habitat is identified by DFO (Department of Fisheries and Oceans). The study does not identify or address habitat of endangered and threatened species because Species at Risk have their own legislation and are not uniformly mapped across the landscape. Significant Wildlife Habitat is not mapped currently and can only be identified at the site level. However, it is dealt with in Chapter 5 (recommendations). The identification of all other Natural Heritage Features and Areas is incorporated into the PNHSS criteria.

3.2.1 Fifteen Ecologically Important Criteria

Fifteen criteria were developed in this study to identify ecologically important *Vegetation Patches*, using the discrete *Vegetation Communities*, *Vegetation Groups* and *Vegetation Patches* defined in Chapter 2. Table 10 provides a summary of the criteria. Appendix D provides a more detailed summary table that includes rationale and a list of other studies that have used the criteria.

Of the 15 criteria, nine are used to identify ecologically important *Vegetation Groups*. Three of the nine criteria are applied to all *Vegetation Groups*, while the remaining six criteria are based on specific size cutoffs that depend on the type of *Vegetation Group*. Three criteria are applied to the *Vegetation Patch*. Three criteria are applied to the *Vegetation Group*, but the information is not currently mapped. Therefore, while there are 15 criteria, only 12 were run in the model as three are not currently mapped.

Two additional criteria (patches ≥ 100 ha and woodland with interior) were modeled but did not capture any patches that were not already captured by other criteria, so they were not used. However, the results are provided as additional information. As well, many other criteria were examined but were not used for a variety of reasons as described in Appendix E.

Table 10. Summary of the 15 Ecologically Important Criteria

Criterion #	Key Words	Description
Applied to *Vegetation Groups*		
1	**Significant Valleylands**	Any *Vegetation Group* within or touching a Significant Valleyland
2	**ANSI**	Any *Vegetation Group* located within or touching a provincial or regional Life Science ANSI (Area of Natural and Scientific Interest)
3	**Open Watercourse**	Any *Vegetation Group* located within 30 m of an Open Watercourse
4	**Wetlands**	All evaluated wetlands and all unevaluated Wetland *Vegetation Groups* > 0.5 ha
5	**Woodland Size**	Any Woodland *Vegetation Group* ≥ 1 ha
6	**Woodland Proximity**	Any Woodland *Vegetation Group* within 100 m of a ≥ 1 ha Woodland *Vegetation Group*
7	**Thicket Size**	Any Thicket *Vegetation Group* ≥ 2 ha
8	**Meadow Size**	Any Meadow *Vegetation Group* ≥ 5 ha
9	**Meadow Proximity**	Any Meadow *Vegetation Group* within 100 m of a ≥ 1 ha Woodland or ≥ 2 ha Thicket *Vegetation Group*
Applied to *Vegetation Patches*		
10	**Patches with a *Vegetation Group* that meet a Group Criteria**	Any *Vegetation Patch* that contains a *Vegetation Group* that meets a group criteria (i.e., meets Criteria 1 – 9 above)
11	**Diversity**	Any *Vegetation Patch* that contains a diversity of *Vegetation Communities*, *Groups* or *Ecosystems*
12	**Proximity**	Any *Vegetation Patch* within 100 m of a significant *Vegetation Patch* (i.e., meets Criteria 10 or 11 above)
Applied to *Vegetation Groups* but <u>Not</u> Mapped Currently		
13	**Significant Wildlife Habitat**	Any *Vegetation Group* that contains Significant Wildlife Habitat
14	**Groundwater Dependent Wetland**	Any *Vegetation Group* that contains a Groundwater Dependent Wetland
15	**Bluff or Depositional Area**	All Watercourse Bluff or Depositional Areas

3.2.2 Significant Woodlands

Of the 15 criteria mentioned above and shown in Table 10, six establish Significant Woodlands consistent with the PPS and NHRM (Table 7-2 Recommended Significant Woodland Evaluations Criteria and Standards). Table 11 provides a summary of the five mapped PNHSS criteria and the one unmapped criteria that are applied to woodland vegetation groups that meet the criteria for significance in the PPS.

The GIS layers and associated data for this study have been provided to the County to allow Significant Woodlands (e.g., meeting one or more of the above noted criteria) to be differentiated from other ecologically important woodlands for the purposes of informing Official Plan policy development.

Table 11. PNHSS Criteria for Ecologically Important Woodlands that meet PPS Criteria for Significant Woodlands

PNHSS Ecologically Important Criteria applied to Woodland Vegetation Groups	Description of how it meets/fits PPS Criteria for Woodland Significance	NHRM Table 7-2 Section
Criteria 1 - Any Vegetation Group within or touching a Significant Valleyland	Due to their linkage function	2c
Criteria 2 – Any Vegetation Group located within or touching a provincial or regional Life Science ANSI	Meets standards for proximity and linkage functions	2b, 2c
Criteria 3 – Any Vegetation Group located within 30 m of an Open Watercourse	Meets water protection standard	2d
Criteria 5 – Any Woodland Vegetation Group ≥ 1 ha	Meets size criteria. (Perth County went beyond the recommended 4 ha woodland size cutoff to protect woodland cover, as permitted in the PPS). and May contain woodland interior	1, 2a
Criteria 6 – Any Woodland Vegetation Group within 100 m of a ≥ 1 ha Woodland Vegetation Group	Meets the standard for proximity and linkage function	2b
Unmapped Criteria:		
Criteria 14 – Groundwater Dependent Wetlands and Ecosystems	Meets water protection standard	2d

3.3 Criteria Applied to all *Vegetation Groups* and *Ecosystems*

Note: Small *Vegetation Communities* <0.5 ha become part of Ve*getation Groups* if they are adjacent to another *Vegetation Community* belonging to the same Group (e.g., a small deciduous swamp next to a larger mixed swamp). Small (<0.5 ha) *Vegetation Communities* also become part of the patch if they are adjacent to any other larger *Vegetation Community* or *Group*. Figure 3 in Chapter 2 illustrates this mapping rule.

3.3.1 Criterion 1 – *Vegetation Group* within or touching a SignificantValleyland

Rationale

River valleys perform numerous ecological functions. The Natural Heritage Reference Manual (NHRM) (MNR 2010) recognizes that valleys can be important linkages and corridors for wildlife movement, providing habitat for a variety of wildlife and connecting natural areas over large distances. Some river valleys have unusual features associated with them, such as calcareous seeps, cliffs, bedrock pavements, etc. These features are characterized by micro-environments that may provide conditions for unusual and diverse *Vegetation Communities* and / or species.

Permanent vegetation on valley lands improves water holding capacity and reduces river erosion. Actively eroding valleys have unstable slopes with little or no vegetation cover. As they erode, valleys deepen, widen and land area is lost. Valley land erosion is exacerbated by human activity. Excess weight near the top of the slope from buildings, roads or farm machinery can increase internal stresses. Structural attempts to stabilize valleys (e.g., retaining walls or hardening the toe of the slope) can be expensive and are usually unsuccessful in the long term.

Valleys are linear depressions that stretch across the landscape from their origins in headwater areas to their outlets into aquatic systems such as lakes. They contain water that flows for at least some periods of the year. The Natural Heritage Reference Manual (NHRM) recognizes that an understanding of hydrological and geomorphic structure is important to identifying valley lands. Valley lands are formed by a combination of the down cutting action of swiftly flowing water, the slumping action of river banks, and the removal of slumped material from the river bed (Etmanski and Schroth 1980, Bowles 1993).

Application / Mapping Rules

Table 8-1 (Recommended Significant Valleylands Evaluation Criteria and Standards) of the NHRM was used to identify and map Significant Valleylands in Perth County. It is the responsibility of planning authorities to identify Significant Valleylands using these recommended NHRM criteria and standards. The key components are outlined below.

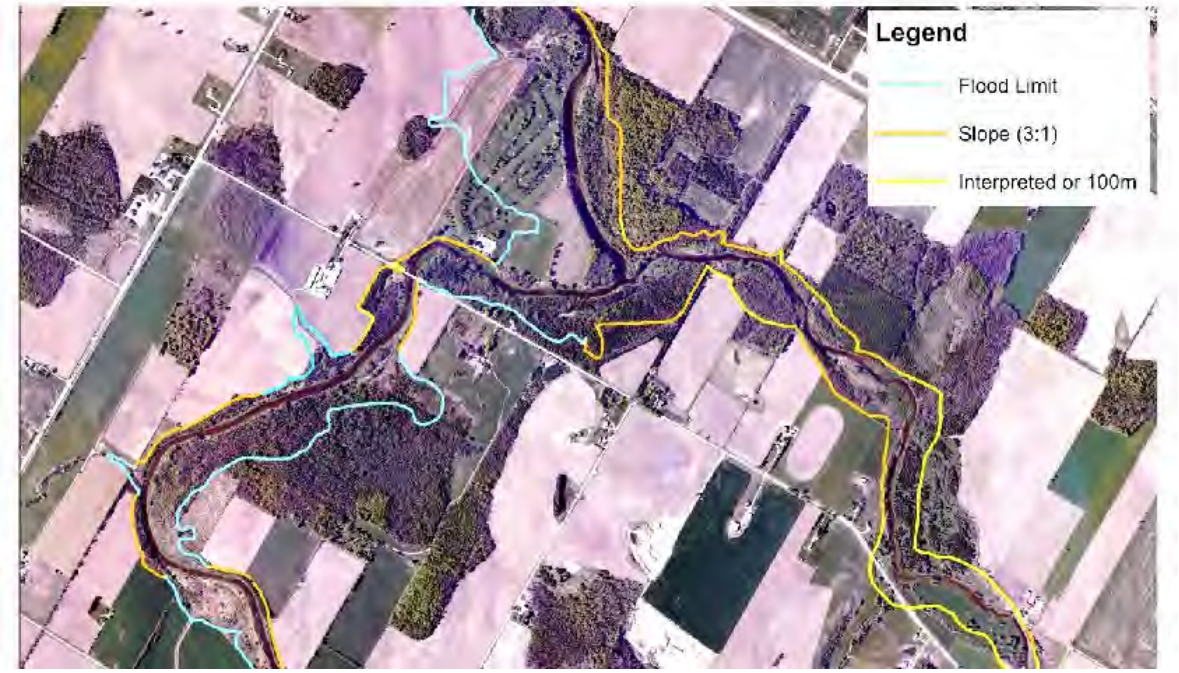
- ***Groundwater function*** – areas contributing to groundwater infiltration and groundwater release. Overlayed Significant Groundwater Recharge Areas (SGRAs) defined by local Source Water Protection Plans (see Appendix J-1). SGRCAs are prominent along the valley borders, suggesting groundwater seepage may be occurring along the banks, creating groundwater dependent wetlands and seepage zones.
- ***Landform prominence*** – Large, well-defined valleylands are often significant landscape features essential to the character of an area. Valley land makes up approximately 6% of the Perth Study Area.
- ***Distinct geomorphic landforms*** – Soils, quarternary geology and physiography mapping provide information that allows distinct landforms to be identified. Fluvial features from the Ministry of Northern Development and Mines Surficial Layer, Bottom Land and Water from the OMAFRA Soils layer, and Beaches and Shorecliff, Spillways, and Water from the

Physiography of Ontario were used to assist in the identification of Significant Valleys (see Appendix J-2).

- ***Degree of naturalness*** – valley land has 43% natural patch cover in Perth County and 17% of total patch cover in the county is within the valley boundaries (see Appendix J-3).
- ***Unique communities*** – though not unique, the valleyland contains a majority of the 18 *Vegetation Communities* in the Study Area, making it one of the most naturally diverse areas within the county
- ***Linkage function*** – some of the largest and most diverse patches within the county are within the valley corridor because of the continuous watercourse layer linking many vegetation communities and groups together. The linkage to the watercourse also provides habitat value as described in the Habitat Value Section of the NHRM.

Figure 6 illustrates the delineation of the Significant Valley System boundary using flood limit, steep slope and 100 m from watercourse edge.

Figure 6. Criterion 1, illustration of Significant Valleyland boundary delineation using flood limit, steep slope and 100 m from watercourse edge



For well-defined valleys, the following components of the Conservation Authority riverine erosion and flooding hazards boundaries were used to identify the stable top of bank (top of slope):

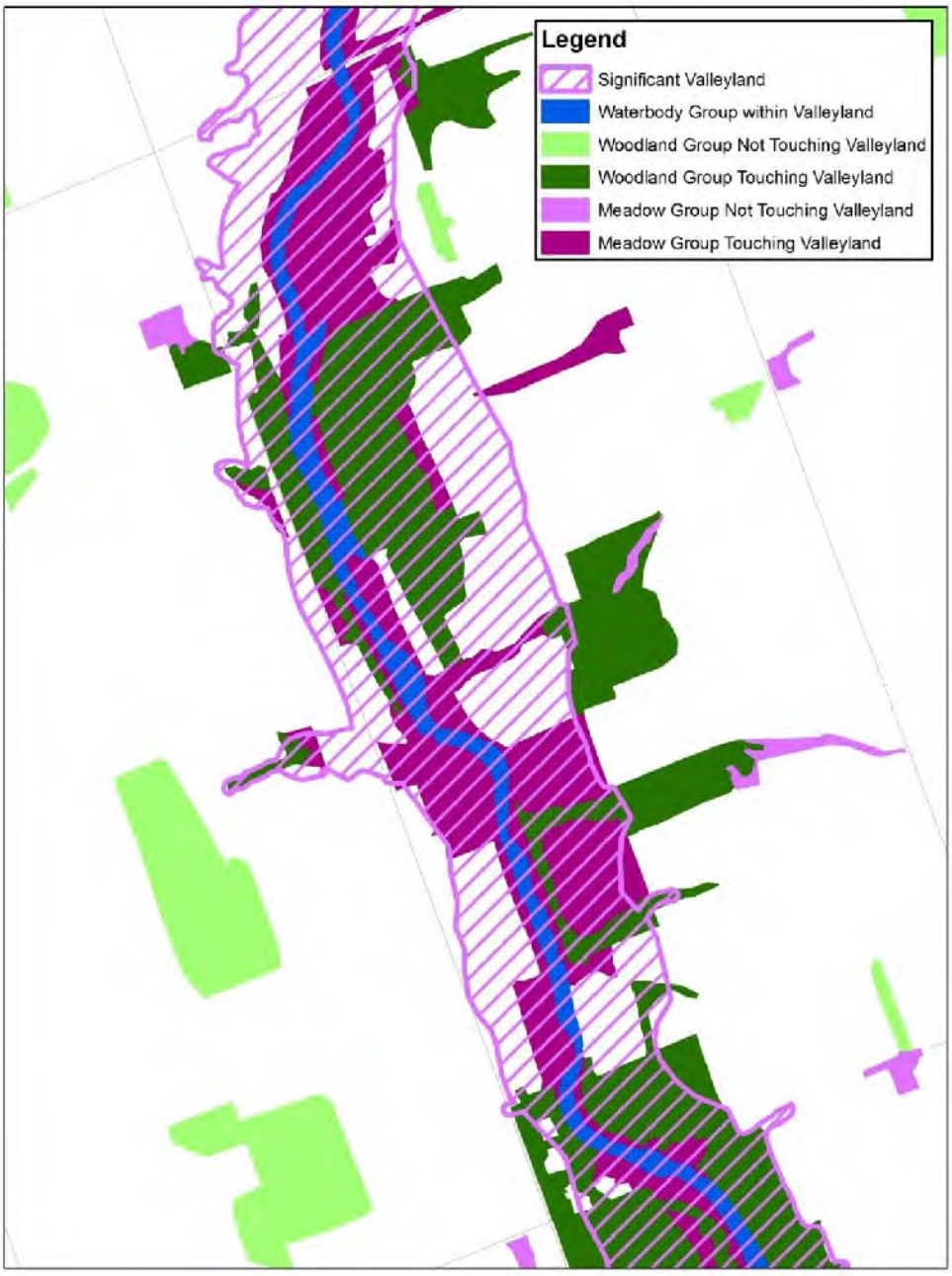
i) The valley must be ≥100 m wide and ≥2 km long.
ii) The valley banks must be ≥3 m in height (extrapolated from 5 m contours at 1:10,000 or better).
iii) To create a continuous valley feature in situations where the valley slope is 3:1 on one side and no slope on the opposite side, the opposite valley limit was delineated using either the limit of the floodplain (based on conservation authority flood lines) or, if unavailable, 100m from the centre line of the water course.
iv) Where 3:1 valley slopes occur on both sides of the river, but they are not continuous, the flood plain limit (or contour information and professional judgment) was used to delineate a continuous valley feature.

For less defined valleys, riparian vegetation, flooding hazard limit (based on regional events), meander belt, or highest seasonal (annual) inundation were used to determine the valley boundary.

All *Vegetation Groups* found within or touching the valley land meet this criterion (see Figure 7).

Other land uses within the valleyland (e.g., cropland, pasture, golf courses) are not identified as part of the Natural Heritage System in this study. However, the valleyland, by its nature, includes natural hazard features (i.e., flood plains, erosion hazards) which are constraints to development. The areas of Significant Valleylands not identified as part of the Natural Heritage System may provide Natural Heritage System linkage functions which should be assessed if a substantial land use change is proposed within or adjacent to such areas. See Chapter 5 for further discussion.

Figure 7. Criterion 1, illustration showing *Vegetation Groups* on or touching a Significant Valleyland



Results

Table 12 below shows the results of the application of Criterion 1 in the Study Area. Almost a quarter (23.5%) of the *Vegetation Groups* meet Criterion 1, accounting for 24.6% of the total vegetation cover (total of all *Vegetation Groups*). Of the *Vegetation Groups* that meet this criterion, only a small number (93 of 1,006) meet only Criterion 1 and no other. See map in Appendix H-1.

Table 12. Criterion 1 Results – *Vegetation Groups* located on or touching Significant Valleylands in the Study Area

	Number				Area			
Vegetation Group	**# that meet Criterion 1**	**Total # Groups**	**% that meet Criterion 1**	**# that meet only Criterion 1**	**Area that meets Criterion 1 (ha)**	**Total area (ha)**	**% Area that meet Criterion 1**	**% of Study Area that meet Criterion 1**
Woodland	441	2,533	17.4%	39	4,722	24,766	19.1%	1.91%
Thicket	101	369	27.4%	22	240	816	29.4%	0.10%
Meadow	424	1,216	34.9%	10	1,698	3457	49.1%	0.69%
Water Feature	30	126	23.8%	21	660	770	85.7%	0.27%
Connected Veg. Feature	10	28	35.7%	1	8	23	34.8%	<0.01%
TOTAL	**1,006**	**4,272**	**23.5%**	**93**	**7,328**	**29,832**	**24.6%**	**2.96%**
Wetland	99	1,120	8.8%	0	854	9,284	9.2%	0.35%

Note: The Study Area (247,324 ha) includes a 1 km buffer around the Geographic/Corporate County border.

3.3.2 Criterion 2 – *Vegetation Group* within or touching any Life Science ANSI

Rationale

The Natural Heritage Reference Manual (MNR 2010) recognizes that significant natural heritage features and areas are typically used as a starting point in natural heritage system studies as they provide a logical foundation upon which to design a planning area's natural heritage system. Life Science Areas of Natural and Scientific Interest (ANSIs) are areas of land and/or water located on both public and private lands that are significant representative segments of Ontario's biodiversity and natural landscapes (MNR 2000a). These areas contain relatively undisturbed vegetation and landforms including specific types of forests, valleys, prairies, and wetlands as well as their associated plant and animal species and communities. ANSIs are a critical complement to provincial parks and conservation reserves as they represent important natural features that are not found in publicly protected areas. Earth Science ANSIs were not included in this criterion for the reasons noted in Appendix E, point 16.

The Ministry of Natural Resources and Forestry (MNRF) evaluates and subdivides candidate ANSIs into three categories of significance: provincial (considered Significant under the PPS), regional or local (not Significant under the PPS). These categories are based on the consideration of five evaluation selection criteria (MNR 2000a):

i. Representation – landform/vegetation features of an ecodistrict,
ii. Condition – degree of human-induced disturbances,
iii. Diversity – the number of high quality, representative features that exist within a site,
iv. Other ecological considerations – ecological and hydrological functions, connectivity, size, shape, proximity to other important areas, etc., and
v. Special features – such as populations of species at risk, special habitats, unusual life science features and educational or scientific value.

Application / Mapping Rules

The Life Science ANSI boundary layer is based on MNRF data. This study considers both provincially and regionally designated Life Science ANSIs as ecologically important as they contain the best examples of landform/vegetation features and contribute to the representation of the natural features and landscapes of the county. All *Vegetation Groups* included within a Life Science ANSI boundary or those touching the ANSI meet Criterion 2 (see Figure 9).

There are four Life Science ANSIs in Perth (see map in Appendix H-2):

Life Science ANSIs in Perth County

- Molesworth Woods ANSI (Provincial)
- Ellice Huckleberry Swamp ANSI (Regional)
- Phillipsburg Swamp ANSI (Regional)
- Little Lakes Bog and Swamp Forest Complex ANSI (Regional)

Results

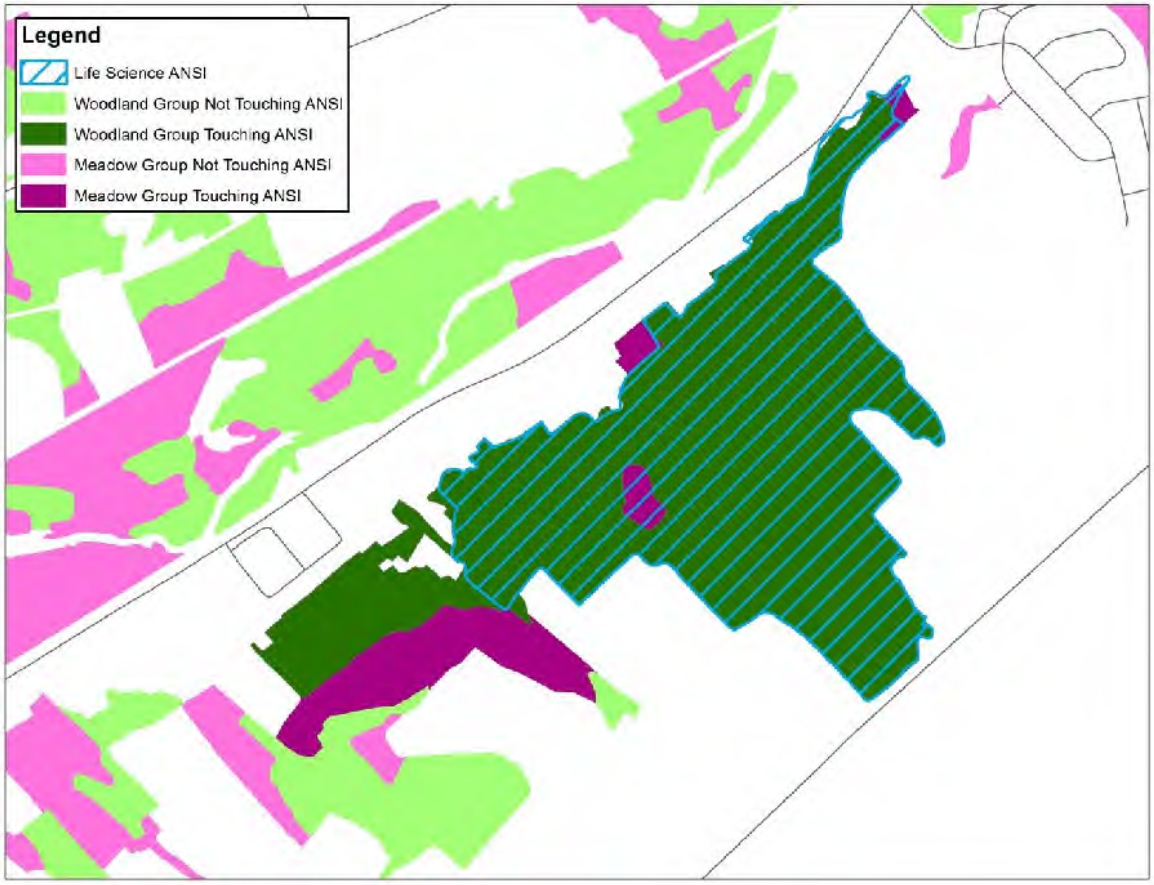
Table 13 below summarizes the mapping results for Criterion 2. Not surprisingly, only a small number of *Vegetation Groups* (30) meet Criterion 2 since there are only four ANSIs in the county. However, the groups that meet this criterion total 1,600 ha or 5.4% of the vegetation cover, indicating that the ANSIs include some of the largest natural areas on the landscape, especially Ellice Huckleberry Swamp. Only 1 *Vegetation Group* meet this criterion and no other, also not surprising since ANSIs are designated on numerous criteria. See map in Appendix H-2.

Table 13. Criterion 2 results – *Vegetation Groups* within or touching a Life Science ANSI in the Study Area

Vegetation Group	Number				Area			
	# that meet Criterion 2	Total # Groups	% that meet Crit. 2	# that meet only Criterion 2 and no other criteria	Area that meet Criterion 2 (ha)	Total area	% Area of All Veg Groups	% of Study Area that meet Criterion 2
Woodland	8	2,533	0.3%	1	1,526	24,766	6.2%	0.62%
Thicket	1	369	0.3%	0	31	816	3.8%	0.01%
Meadow	17	1,216	1.4%	0	34	3,457	1.0%	0.01%
Water Feature	4	126	3.2%	0	9	770	1.2%	0.00%
Connected Vegetation Feature	0	28	0.0%	0	0	23	0.0%	0.00%
Total	**30**	**4,272**	**0.7%**	**1**	**1,600**	**29,832**	**5.4%**	**0.65%**
Wetland	16	1,120	1.4%	0	1,384	9,284	14.9%	0.56%

*Note: Study Area (247,324 ha) includes a 1 km buffer around the Geographic/Corporate County boundary.

Figure 8. Criterion 2, illustration showing *Vegetation Groups* within or touching a Life Science ANSI



3.3.3 Criterion 3 – *Vegetation Group* within 30 m of an Open Watercourse

Rationale

Natural areas adjacent to watercourses (i.e., areas of riparian vegetation) affect and are affected by the water. Open watercourses contain flowing water for at least part of the year and can be natural or channelized but not buried or tiled. A large percent of watercourses in Perth County are classified as agricultural drains owing to the agricultural nature of the county. Whether or not they are open drains or natural watercourses they are all part of the connected river system and can support Species at Risk, sport fish, top predators, cool water species, and have permanent flow. Best available watercourse mapping is shown in Appendix I-3.

The Natural Heritage Reference Manual (MNR 2010) recognizes that the relationship between water features and vegetation is interactive. The physical processes operating in and adjacent to the stream channel create and maintain fish habitat by providing shade for water temperature regulation, food through organic inputs such as leaves, habitat from input of large woody debris, and cover in the form of accumulated vegetation. As a result, fish community composition and productivity in streams is partly related to the condition and health of vegetation beside the stream. Permanent vegetation near waterways protects water quality by reducing peaks in water flow, 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).

Riparian habitats are important terrestrial habitat in their own right and are supported by healthy watercourses. Vegetated riparian areas along streams are regional hot spots for a disproportionately high number of wildlife species, providing a wide array of ecological functions and values (Naiman *et al*. 1993, Fischer and Fischenich 2000). Watercourses and associated riparian areas can provide important linkage functions and act as continuous corridors for the movement of wildlife because the land-water interface usually supports a high level of biodiversity that meets multiple species needs (Wegner and Merriam 1979). Many plants and animals benefit from riparian habitat 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).

Definition

Natural features and areas in proximity to water features maintain linkages across the landscape. The PPS *recognizes linkages between and among natural heritage features and areas, surface water features and ground water features* (MMAH 2014)

Based on a review of literature, Fischer and Fischenich (2000) found that 30 m is the minimum width for ecological functions such as wildlife movement and that a vegetated strip of 30 m will protect most water quality parameters on moderate slopes. Environment Canada (2013) sets a guideline target of at least 30 m wide naturally vegetated riparian areas on both sides of streams, as a minimum to protect aquatic habitat, and wider riparian buffers to provide highly functional wildlife habitat. Environment Canada (2013) also sets a guideline of 75% of stream length be naturally vegetated. In the Upper Thames River Watershed Report Cards (UTRCA 2012), one of three indicators for forest condition grades is “percent riparian zone forested”. Here, a 30 m swath on both sides of a watercourse defines the riparian zone. Conservation Ontario (2011) recommends the same approach for conservation authorities developing watershed report cards.

Since 30 m is a commonly held minimum riparian buffer width, this Criterion 3 captures *Vegetation Groups* that contain a watercourse or lie wholly or in part within this 30 m riparian zone.

Application / Mapping Rules

Open watercourses are linear features that contain flowing water for at least part of the year and can be natural or channelized. They include open intermittent or headwater drainage features, streams, rivers, creeks and open drains. Tiled or buried drains with no surface connection are considered "closed" watercourses and were excluded from the analysis.

Although digital data for watercourses exists for southern Ontario, this data is not current. Recognizing time constraints, a method was developed that eliminates the need to update the entire watercourse layer. Using spring 2010 aerial photography (SWOOP), an on-screen interpretation of the edge of open watercourses (i.e., the bank-full width) was completed in tandem with the interpretation of *Vegetation Community* boundaries. Onscreen measurements were made from the watercourse edge to the *Vegetation Community* edge, and if ≤30 m, the community was identified as being within 30 m of the watercourse.

Terrestrial *Vegetation Communities* within 30 m of the bank-full width of an open watercourse are identified as a riparian area (Figure 9). As these riparian *Vegetation Communities* were attributed to their broader *Vegetation Groups*, the *Vegetation Groups* containing these riparian *Vegetation Communities* meet this criterion.

Results

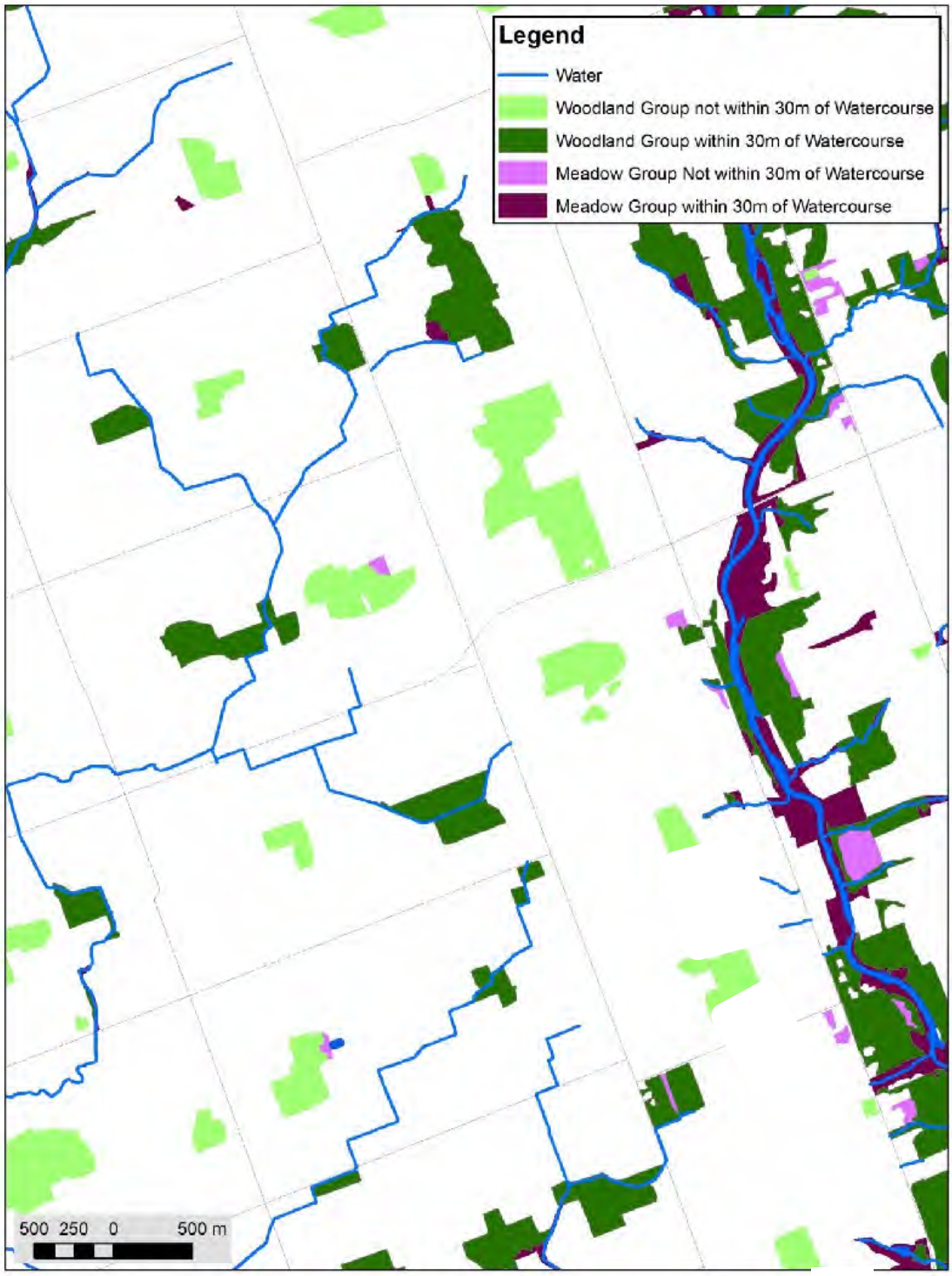
Table 14 below summarizes the results for Criterion 3 and the map in Appendix H-3 shows the results. About half (51.9%) of the *Vegetation Groups* meet this criterion or 71.2% of the vegetation cover. These figures indicate that many of the remaining natural areas on the landscape are near a watercourse because the land is harder to farm or develop and/or because there is a high density of watercourses in the county. Of the 2,219 *Vegetation Groups* that met this criterion, 26% (571) met only this criterion and no other criterion. See map in Appendix H-3.

Table 14. Criterion 3 Results – *Vegetation Groups* containing or within 30 m of an Open Watercourse in the Study Area

Vegetation Group	Number				Area			
	# that meet Criterion 3	Total # Groups	% that meet Criterion 3	# that meet Criterion 3 and no other	Area that meet Criterion 3 (ha)	Total area of Groups (ha)	% Area of All Veg Groups	% of Perth Study Area that meet Criterion 3
Woodland	1,142	2,533	45.1%	250	17,365	24,766	70.1%	7.02%
Thicket	172	369	46.6%	123	420	816	51.4%	0.17%
Meadow	855	1,216	70.3%	166	2,785	3,457	80.6%	1.13%
Water Feature	30	126	23.8%	32	656	770	85.2%	0.27%
Connected Veg Feature	20	28	71.4%	0	18	23	78.3%	0.01%
Total	**2,219**	**4,272**	**51.9%**	**571**	**21,244**	**29,832**	**71.2%**	**8.59%**
Wetland	481	1,120	42.9%	0	6,333	9,284	68.2%	2.56%

Note: Perth Study Area (247,324 ha) includes a 1 km buffer around the geographic/corporate county boundary.

Figure 9. Criteria 3, illustration showing *Vegetation Groups* within 30 m of Open Watercourses (small and large)



3.4 Size Criteria Applied to Specific *Vegetation Groups*

A note about clustering Vegetation Groups around roads, railroads and watercourses

Vegetation Groups separated by a road, railroad or watercourse < 20 m in width were clustered into the adjacent *Vegetation Group* (Section 2.4.8). All criteria for *Vegetation Groups*, except area, were applied to the clustered *Vegetation Group*. When calculating the area of a *Vegetation Group* cluster, the area of the road/railway/watercourse was not included in the calculation. Instead, area was calculated as the area of the entire *Vegetation Group* cluster less the area of the road/railroad/watercourse. Area of the woodland *Vegetation Group* and interior area were calculated on the non-clustered woodland *Vegetation Groups* (i.e., calculated before clustering so it does not include roads or watercourses in the calculation).

3.4.1 Criterion 4 – All Wetland *Vegetation Groups* ≥ 0.5 ha

Rationale

Since European settlement, approximately 85% of wetlands greater than 10 ha have been lost in Southern Ontario (Ducks Unlimited Canada 2010). The Natural Heritage Reference Manual (MNR 2010) recommends protection of wetland areas for their important contribution to stream flow through groundwater release. In catchment basins containing wetland storage areas in the headwaters, the wetlands maintain the hydrological regime of the surrounding area by dampening water peaks and reducing the potential for erosion (Moudrak *et al.* 2017). In Wisconsin, Hey and Wickencamp (1996) found that increasing the amount of wetland in a watershed to 10% resulted in reduced flooding, higher base flows, and reduced occurrence of high flows.

Environment Canada (2013) set the following guideline: "At a minimum, the greater of (a) 10% of each major watershed and 6% of each subwatershed, or (b) 40% of the historic watershed wetland coverage, should be protected and restored". Wetlands are not uniformly distributed across the landscape and there is limited data on historical wetland cover within the watersheds of Perth County (e.g., Thames River, Nith/Grand River, Bayfield River, and Maitland River). Environment Canada (2013) recognizes that a watershed and a municipality are similar-sized units, useful for planning purposes. Perth County is roughly 2220 km^2 and a major watershed such as the Upper Thames River is 3420 km^2 (1700 km^2 for the North Thames River watershed). A tributary subwatershed in the UTRCA is 50-180 km^2, closer to the size of a small lower tier municipality or city.

It has been well documented that wetlands improve water quality and base flow by storing and infiltrating precipitation and runoff on the landscape and filtering out contaminants. Wetlands provide important breeding and overwintering habitat for reptiles and amphibians.

It is important to protect as many wetlands on the landscape as possible. Johnson *et al*. (1990) found that watersheds containing less than 10% wetland cover were more susceptible to incremental losses of wetlands than those with more wetlands. The amount of natural habitat that is located adjacent to wetlands can be important to the maintenance of wetland functions and attributes. The value of a wetland is enhanced where the wetland is located close to other wetlands and natural areas so that wildlife can move between them to take advantage of favourable habitat and food (Findlay and Houlahan 1997, Houlahan and Findlay 2003). For example, wetlands situated within 100 m of other wetlands are more likely to have movement of fish among them (Golet 1976).

Wetlands occur where the water table is close to or at the surface and are characterized as seasonally or permanently covered by shallow water less than 2 m deep. The presence of this abundant water causes the formation of hydric soils. The fluctuation of water levels and the presence of water tolerant plants (herbaceous and woody) distinguish wetlands from aquatic Vegetation Ecosystems (Lee *et al*. 1998).

Application / Mapping Rules

The wetland layer was derived from the MNRF evaluated wetland mapping layer (Significant Wetlands and evaluated wetlands), as well as the unevaluated wetland layers developed by the UTRCA and GRCA (refer to Mapping Criteria Section 2.2 and Appendix B).

All PSWs and evaluated wetlands approved by the MNRF, regardless of size, as well as unevaluated wetlands ≥ 0.5 ha identified by Conservation Authorities, meet Criterion 4.

Note 1: The term "significant wetland" is reserved for wetlands that have been evaluated and deemed significant using the Ontario Wetland Evaluation System (i.e., Provincially Significant Wetland). The identification and delineation of significant wetlands must be approved by MNRF.
Note 2: If a Woodland *Group* contains a Wetland *Vegetation Community*, the entire woodland group does NOT become ecologically important until it becomes a *Vegetation Patch*.

Results

Table 15a shows the results of the wetland *Vegetation Group* (see map in Appendix H-4). There are 1,120 wetland *Vegetation Groups*, totaling 9,284 ha. There is 3.75% wetland cover in the Perth Study Area (3.29% in corporate/geographic Perth) and this figure is below the guideline of Environment Canada (2013) of at least 10% wetland cover at the watershed scale (e.g., county scale equivalent for planning purposes). Table 15b shows the results for each member municipality and corporate/geographic Perth. Perth East has the highest wetland cover (5.20%) owing to the presence of the Ellice and Gads Hill Swamps. The other rural municipalities have less than 3% wetland cover. Environment Canada (2013) recommends a minimum of 6% wetland cover at the subwatershed scale (equivalent to a small sized municipality).

Table 15a. Criterion 4 Results – *Vegetation Groups* that contain Wetland *Vegetation Communities*

Vegetation Group	Number	% that meet Criterion 5	Area (ha)	% of Perth Study Area (247,324 ha)
Wetland *Vegetation* *Group*	1,120	100.0%	9,284	3.75%

Table 15b. Wetland Cover by Member Municipality and Corporate Perth

Name	Municipal Area (ha)	Wetland Area (ha)	% Wetland Coverage
North Perth	49,349	1,200	2.43%
West Perth	57,9633	1,265	2.18%
Perth East	71,289	3,709	5.20%
Perth South	39,516	1,131	2.86%
Stratford	2,845	10	0.35%
St. Marys	1,303	<0	<0.00%
Corporate Perth	**222,233**	**7,314**	**3.29%**

Wetlands include: Provincially Significant Wetlands, Evaluated Wetlands and Unevaluated Wetlands.

3.4.2 Criterion 5 – Woodland *Vegetation Group* ≥ 1 ha

Rationale

Habitat size is one of the most important measures for sustaining stable, diverse and viable populations of wildlife species. Larger woodlands tend to have a greater diversity of habitat niches and are more effectively buffered from external negative influences such as environmental disturbances, nest predation, and parasitism (Askins and Philbrick 1987, Villard *et al*. 1999, Schwartz 1999, Soulé and Terborgh 1999, Burke and Nol 2000, Burke *et al*. 2011, Forman 1995c, Kohm and Franklin 1997, Bennett 2003, Marini *et al.* 1995). In a highly fragmented landscape, the size definition of a "large" woodland can be relatively small. Studies indicate that smaller woodlands (<10 ha) can be considered important and worth protecting as they provide certain ecosystem benefits.

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). Although small woodland *Vegetation Groups* are often regarded as poor habitat for breeding birds, Friesen *et al*. (1999) have demonstrated that small woodlands in agricultural landscapes can experience high pairing success for birds. Small forest fragments of 1 to 4 ha are also important stopover sites for migratory birds (Packett and Dunning 2009, Swanson *et al*. 2005). Insects, especially bees and butterflies, also rely on small woodlands in a fragmented landscape. Small woodlands may be just as important as larger ones for pollinator diversity and abundance (Banaszak 1996, Cane 2001, Donaldson *et al.* 2002).

Application / Mapping Rules

Riley and Mohr (1994) and the Natural Heritage Reference Manual (MNR 2010) recommend that the minimum standard for determining the size of wooded *Vegetation Groups* considered to be significant within the planning area is a function of the percentage of forest cover within that area. The Natural Heritage Reference Manual (MNR 2010) recommends that woodlots of 4 ha or more should be considered significant in landscapes with about 5-15% woodland cover.

Based on this guidance, the 2016 Oxford Natural Heritage Systems Study, 2013 Huron Natural Heritage Systems Study (draft) and 2014 Middlesex Natural Heritage Systems Study all used a woodland size cutoff of ≥ 4 ha. These counties had approximately 13.2%, 16.6% and 15.8% woodland cover respectively. Perth County has approximately 10% woodland cover (see Table 9).

However, the County of Perth had already defined/established significant woodlands as ≥1ha in their Official Plan (see text box below). Thus, to ensure the current level of protection is maintained, this PNHSS also adopts the ≥1 ha as the woodland size cutoff.

Therefore, all woodland *Vegetation Groups* ≥ 1 ha in size meet Criterion 5 (see Appendix H-5).

Text Box: **Significant Woodlands, Section 11.5.5, of the Perth County Official Plan**

11.5.5 Significant Woodlands

ADDED BY In determining what constitutes a significant woodland, the County recognizes

OPA # 47 the scarcity of this important feature and has moved beyond the 4.0 hectare woodlot size criterion as recommended by the Ministry of Natural Resources from the implementation guidelines of the Provincial Policy Statements in an effort to protect as much of the woodland area as possible. Accordingly, woodland areas that are 1.0 hectare or larger in size are designated "Natural Resources" in this Plan. This 1.0 hectare criterion shall be applied based on contiguous woodland area and not on the basis of property ownership.

ADDED BY While woodlands that are 1.0 hectare or larger in size have been identified as

OPA # 47 significant woodlands and are therefore designated "Natural Resources/ Environment", this Plan acknowledges that many of these significant woodlands form and function as part of larger farm properties. Approximately one-third of the woodland areas in the County are less than 1.0 hectare in size and therefore are not designated "Natural Resources/Environment". In order to protect all woodlands, the County has passed a By-law to regulate the destruction of trees by cutting, burning or other means. It is a policy of this Plan that all woodlots be retained and that the clearing of woodlots will not be permitted with the exception of any clearing permitted in accordance with the provisions of the County of Perth's Forest Conservation By-law. For those woodland areas located in the "Agriculture" designation, the policies of Section 5.5.5 of this Plan also apply.

Specific policies for significant woodlands are as follows:

ADDED BY (a) With the exception of the specific activities noted in Clause (b) below,

OPA # 47 development and site alteration shall not be permitted in significant woodland areas;

(b) Notwithstanding the policy of paragraph (a) above, agricultural activities such as maple syrup production and the harvesting of mature trees, and recreational snowmobile trails are considered as appropriate activities in woodlots and therefore are permitted without an environmental impact study or other appropriate study. Such activities are to be carried out in an environmentally sensitive manner so as to preserve the overall woodlot function;

(c) Generally, mineral aggregate extraction should not occur within significant woodlands. Where the extraction of aggregate material from a significant woodland area is justified and where a license for such extraction has been obtained under the provisions of the Aggregate Resources Act, the cutting of woodland to facilitate the extraction shall be permitted provided that only the minimum amount of woodland cutting occurs and that the extraction area is rehabilitated back to woodland use during and following the aggregate removal. Further, the permitted mineral aggregate extraction must be carried out in a manner which is environmentally sensitive to the remaining woodland area; and

ADDED BY (d) The local municipality's Zoning By-law shall zone significant woodlands

OPA # 47 in a manner so as to preclude development and site alteration excepting that permitted (a) and (b) above. The local municipality may zone other woodlands in a manner consistent with the surrounding lands (e.g. agricultural) but shall be encouraged to zone all woodland areas with appropriate regulations to provide long term protection to the woodland areas.

ADDED BY (e) Development may be permitted within the 30 metre adjacent land/buffer

OPA # 47 area provided that such development will not result in negative impacts on the significant woodland. An environmental impact study or other appropriate study may be required in order to assess the impact of development.

Results

Table 16 shows the results for Criterion 5 and a map of the results is provided in Appendix H-5. Slightly fewer than half (45.4%) the woodland *Vegetation Groups* (1,332 of 2,932) met this size criterion but they account for over 91% of the woodland area. Thus, the remaining woodland *Vegetation Groups* that don't meet the criterion are very numerous but small and don't add up to a lot of area. Of the 1,332 *Vegetation Groups* that meet this size criterion, almost a third or 424 meet only Criterion 5 and no other criterion.

Table 16. Criterion 5 Results – Woodland *Vegetation Group* ≥ 1 ha in the Study Area

Vegetation Group	**# that meet criterion 5**	**% of all Woodland Groups** (2,533)	**# that meet only criterion 5**	**Area that meet Criterion 5** (ha)	**% of Total Woodland Group Area** (24,766 ha) **that meet Criterion 5**	**% of Study Area** (247,324 ha) **that meet Criterion 5**
Woodland *Vegetation Group* ≥ 4 ha	2,087	82.4%	754 (4,427 ha)	24,448	98.7%	9.89%

Note: For comparison purposes, when the PNHSS model was run using ≥4ha woodland cutoff, 72.6% of woodland groups and 95.2% of woodland group area met one or more criteria. When the model was run using ≥1 ha, 93% of woodland groups and 99.5% of woodland group area met one or more criteria.

3.4.3 Criterion 6 – Woodland *Vegetation Groups* within 100 m of a Woodland *Vegetation Group* ≥ 1 ha

Rationale

The Natural Heritage Reference Manual (MNR 2010) recognizes that the distance between individual woodlands is an important factor in maintaining woodland integrity. Woodlands that happen to be situated near each other or to other natural features have more opportunities for restoring connectivity since linkages are important for both animal and plant dispersal. Small woodlands located close to large woodlands are more important in feature and function than those that are isolated. One reason is that smaller woodlands that are closely spaced can serve as stepping stones for species movement. For example, Bowles (1997) found that species richness was higher for small *Vegetation Patches* closely linked to larger *Vegetation Patches* than similarly sized *Vegetation Patches* not linked to larger *Vegetation Patches*.

The identification of landscape connectivity is an evolving science. Sutherland *et al*. (2000) compared dispersal data for 77 bird and 68 mammal species. In the case of birds, maximum dispersal distances ranged from 130 m for the European Magpie to 1,305 km for the Great Horned Owl. For mammals, maximum dispersal distances ranged from 140 m for the Prairie Vole to 930 km for the Lynx. As for plants, the limited distances that most seeds travel are well documented for all growth forms (Cain *et al*. 2000, Harper 1977, Howe and Smallwood 1982, Willson 1993, Cain *et al*. 1998). Recognizing that plants (seeds, pollen) have limited mobility compared to animals, the average wind dispersal distance of 100 m (Nathan *et al*. 2002) was used as the distance that would functionally connect two woodlands.

Application and Mapping Rules

In Perth County, woodland *Vegetation Groups* that are within 100 m of a woodland *Vegetation Group* ≥ 1 ha, regardless of what is surrounding them, meet Criterion 6 (see Figure 10).

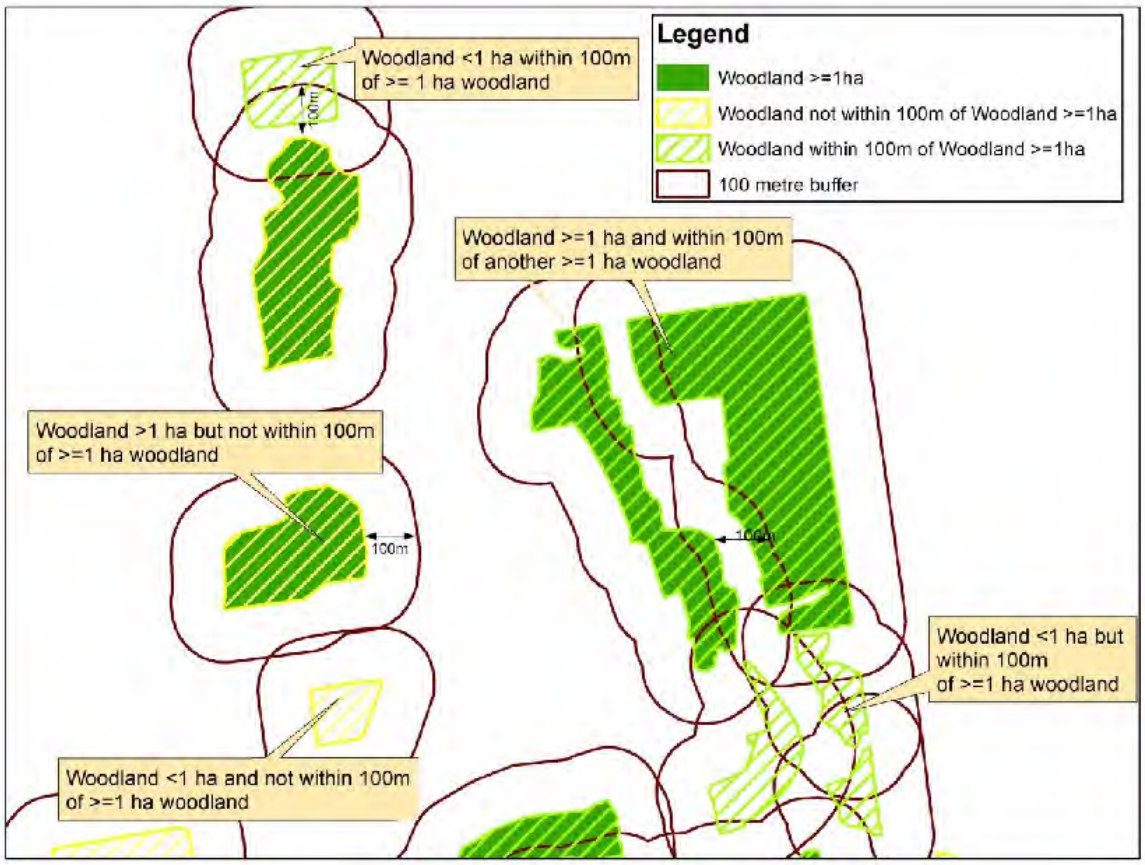
Results

The findings are shown in Table 17 and in Appendix H-6. Approximately a third (35.1%) of all the woodland *Vegetation Groups* are within 100 m of a woodland *Vegetation Group* ≥ 1 ha, amounting to 51% of all woodland area. These figures indicate that about half of woodland area is in close enough proximity to larger woodland to help maintain ecological integrity.

Table 17. Criterion 6 Results – Woodland *Vegetation Groups* within 100 m of a Woodland *Vegetation Group* ≥ 1 ha in the Study Area

	# meet Criterion 6	**% of all Woodland Groups** (2,533)	**# that meet only Criterion 6**	**Area meeting Criterion 6** (ha)	**% of Total Woodland Group Area** (24,766 ha)	**% of Study Area** (226,920 ha)
Woodland *Vegetation Group* within 100 m of a Woodland *Vegetation Group* ≥ 1 ha	889	35.1%	74 (51 ha)	12,625	51.0%	5.1%

Figure 10. Criterion 6, illustration of 100 m proximity between woodland Vegetation Groups ≥ 1 ha



3.4.4 Criterion 7 – Thicket *Vegetation Group* ≥ 2 ha

Rationale

Thickets are a vegetation community dominated by shrubs or young trees. Like woodlands, they are most likely to support and sustain a diversity of species if they are large (Rodewald and Vitz 2005, MNR 2012). Often thicket habitats are temporary and eventually succeed or transition into woodlands/forests. For example, when a farm field is left fallow for just a few years, grasses and sun-loving herbaceous plants will colonize the field first as part of the natural succession process. A few years later the area is colonized by shrubs (e.g., hawthorn, sumac, Grey Dogwood) and young trees such as poplars and willows; this is the thicket stage. As the trees mature, they shade out most shrubs, grasses and sun-loving wildflowers and within 25 to 30 years, the area becomes a young woodland. Some thickets do not succeed to woodlands as they are maintained by wet, poor or shallow soils or disturbances such river flooding and ice scour. Wetland thickets and upland thickets can be identified by remote sensing.

The literature on bird species that use thickets suggests that thicket habitat is on the decline and large thickets are becoming increasingly uncommon. Thicket habitats may be declining due to changes in rural land uses (e.g., more cropland and less rough land pasture and hedgerow). As a result, many of the bird species that typically use thickets and early succession stages of woodland development are also declining rapidly (Sauer *et al*. 2001). Some thicket birds are area sensitive and select large areas of contiguous habitat for breeding. Birds such as the Chestnut-sided Warbler will use smaller areas less than 0.5 ha, but the more uncommon species such as Golden-winged Warblers, Yellow-breasted Chats or Woodcock require areas of 10 ha or more (Chandler *et al.* 2009, Rodewald and Vitz 2005, Oehler *et al*. 2006, Schlossberg and King 2008, King *et al*. 2001, King and Byers 2002, King *et al*. 2009). In general, large blocks of any habitat (grassland/meadow, thicket, mature forest, wetland, etc.) are more valuable to wildlife because they tend to support both the common species and the uncommon species.

Note: It is recognized that the policies of the PPS do not provide protection for upland thickets and meadows as natural heritage features and areas, unless they have been determined to be significant wildlife habitat. Wetland thickets are protected under wetland policies.

Application / Mapping Rules

If managing thickets to enhance the long-term survival of a variety of wildlife, larger is better. Thickets of at least 10 ha in size are required for area sensitive thicket birds, yet this class size is very rare in Perth County. To determine the cut-off size for thicket *Vegetation Groups* in the study area, the top 25th percentile of data was calculated (a method of descriptive statistical analysis to determine rarity). The 25th percentile was 2.4 ha and it was then rounded to the nearest whole number, 2 ha. Thus, all thicket *Vegetation Groups* ≥2 ha meet Criterion 7.

Results

The results of the mapping are shown in Table 18 and in Appendix H-7. Almost one third (29.3%) of all thicket *Vegetation Groups* (103 of 369) meet the criterion, accounting for almost two-thirds (61%) of all thicket area. Appendix I-6 shows the results in map form. Only 70 of 369 thicket *Vegetation Groups* (19%) met only this criterion and no other criterion.

Table 18. Criterion 7 Results – Thicket *Vegetation Group* ≥2 ha in the Study Area

	Number	**% of all thicket groups** (369)	**# that meet only Criterion 7**	**Area (ha)**	**% area of all thicket groups** (816 ha)	**% of Study Area** (247,324 ha)
Thicket *Vegetation Group* ≥2 ha	108	29.3%	70 (77 ha)	498	61.0%	0.20%

3.4.5 Criterion 8 – Meadow *Vegetation Group* ≥ 5 ha

Rationale

Meadows and grasslands of all sizes are used by many different native wildlife species from butterflies and bees to birds and mammals. The amount of native grassland and meadow habitat has declined drastically throughout North America. Minimum habitat size is not usually a limiting factor for most generalist species and no reasonable estimate of minimum habitat size exists for butterflies as a group (USDA and the Wildlife Habitat Council 2000).

Grassland birds, however, are of special concern since they are habitat size dependant and have suffered more serious population declines than any other group of birds (Igl and Johnson 1997, Peterjohn and Sauer 1999, Sauer *et al.* 2001). Johnson (2001) demonstrated a number of grassland bird species, including the Savannah, Grasshopper, and Henslow's Sparrow prefer large grasslands far in excess of their territory size (typically <1 ha). Corace *et al*. (2009), Davis (2004), Winter *et al*. (2006) and Ribic and Sample (2001) found that the density of open land bird species is regulated by the interaction of field size, shape and edge type, and that larger open areas tend to support a more diverse bird community.

The Significant Wildlife Habitat Technical Guide (MNR 2000b) identifies 10 ha blocks of undisturbed grassland as excellent raptor hunting areas, and meadows >30 ha as significant open country bird breeding habitat. Grassland species such as Bobolink, Savannah Sparrow, Eastern Meadowlark and Grasshopper Sparrow are more abundant as breeding birds in continuous grassland habitats of 4-6 ha (McCracken *et al*. 2013, Ochterski 2006a, 2006b, Mitchell *et al*. 2000). Bobolinks and Eastern Meadowlarks can nest in relatively small patches of grassland, but abundance and productivity are higher in large patches (>10 ha) and in patches surrounded by other open habitats (e.g., Ribic and Sample 2001, Herkert *et al*. 2003, Bollinger and Gavin 2004, Keyel *et al.* 2011). The General Habitat Description for the Eastern Meadowlark (MNR undated) notes that "*minimum patch area requirements to support breeding habitat for the species have been reported at 5 ha (Herkert 1994), however abundance and productivity are higher in larger patches and in patches surrounded by other open habitats"*. Regardless of the patch size, breeding habitat for Eastern Meadowlark is protected under the Endangered Species Act.

Application

Based on the Bobolink and Eastern Meadowlark Recovery Strategy (McCracken *et al*. 2013) and the General Habitat Description for the Eastern Meadowlark, patch areas of 5 ha support these grassland bird species protected under the Endangered Species Act. In Perth County the natural cover is fragmented by other land uses and grassland/meadow patches closer to 5 ha may be more widely utilized by listed grassland birds because there is a lack of larger patches to support breeding pairs. In fact, the top 25th percentile of meadow sizes in Perth is 2.5 ha, indicating most meadows are less than 2.5 ha in size. Thus, all meadow habitats ≥ 5 ha meet Criterion 8.

Note: It is recognized that the policies of the PPS do not provide protection for upland thickets and meadows as natural heritage features and areas, unless they have been determined to be significant wildlife habitat.

Results

The results for Criterion 8 are shown in Table 19 below. Only 13.9% of the meadow *Vegetation Groups* meet this criterion, but account for over half (51.6%) of the meadow area. Of the 169 meadow *Vegetation Groups* that meet the criterion, only six meet this criterion alone and no other criteria. Thus the vast majority of meadows meet other criteria as well. The map in Appendix H-8 shows the meadows that meet criterion 8.

Table 19. Criterion 8 Results – Meadow *Vegetation Groups* ≥ 5 ha in the Study Area

	# that meet Criterion 8	**% of Total Number** (1,216)	**# that meet only Criterion 8**	**Meadow Area** (ha)	**% of total Meadow Area** (3,457 ha)	**% of Study Area** (247,324 ha)
Meadow *Vegetation Groups* ≥ 5 ha	169	13.9%	6 (49 ha)	1,785	51.6%	0.72%

3.4.6 Criterion 9 – Meadow *Vegetation Group* within 100 m of a ≥ 1ha Woodland or ≥2 ha Thicket *Vegetation Group*

Rationale

While larger meadows are required for grassland and open country birds, smaller meadows and meadows closely associated with woodlands and thickets are used by other animals. Mammals such as White-tailed Deer, Red Fox, and Coyote are generalists and live in many diverse habitats from forests to grasslands. Meadows provide both food and cover for animals at times when the woodlands do not.

Butterflies, in particular, rely on this habitat mosaic of meadow-thicket-woodland. According to the U.S. Department of Agriculture (USDA) and the Wildlife Habitat Council (2000), land use and development practices have resulted in significant losses of native butterfly habitat. Among the invertebrates, butterflies are an iconic species for recognition and conservation for many reasons; butterflies are important pollinators, are not usually considered pest species, are of interest to the public, have a relatively short lifespan as an adult, are relatively low in biodiversity, and are a food source for other species.

Minimum habitat size is not usually a limiting factor for most generalist species and no reasonable estimate of minimum habitat size exists for butterflies as a group (USDA and the Wildlife Habitat Council 2000). Instead, it is important to consider meadow butterfly habitat in context with the surrounding range of habitats. To be effective, butterfly habitat must support as many of the life stages of the butterfly species as possible. These life stages have very different food and cover needs. Adult butterflies have a strong preference for open, sun-lit habitats with nectar sources, while the larvae require host trees, shrubs and herbaceous plants found in shaded thicket and woodland habitats (USDA and the Wildlife Habitat Council 2000). Larger woodlands and thickets are more likely to contain a wider variety of species to meet the needs of a range of butterfly species.

Application / Mapping Rules

Given the benefits associated with proximity of meadows to larger woodland and thicket habitats and using 100 m as the cutoff distance (a conservative estimate based on the scientific literature discussed in Section 3.4.3), all meadow *Vegetation Groups* found within 100 m of a ≥ 1 ha woodland *Vegetation Group* (see Criterion 6) or large (≥ 2 ha) thicket *Vegetation Group* (see Criterion 7) meet Criterion 9.

Note: It is recognized that the policies of the PPS do not provide protection for upland thickets and meadows as natural heritage features and areas, unless they have been determined to be significant wildlife habitat.

Results

The results for Criterion 9 are shown in Table 20 and in Appendix H-9. Over 80% of all meadow *Vegetation Groups* meet this criterion. Of the 1,216 groups that meet this criteria, a moderate number, 208 (21%), meet only this criterion and no others. These results suggest the three habitat types (meadow, thicket and woodland) are closely tied and intermixed in the landscape.

Table 20. Criterion 9 results – Meadow *Vegetation Groups* within 100 m of a ≥2 ha woodland or ≥2 ha thicket *Vegetation Group* in the Study Area

	# that meet Criterion 9	**% of all Meadow Groups** (1,216)	**# that meet only Criterion 9**	**Area that meet Criterion 9** (ha)	**% of all Meadow Area** (3,457 ha)	**% of Study Area** (247,324 ha)
Meadow *Vegetation Group* within 100 m of a ≥ 1 ha woodland or ≥2 ha thicket *Vegetation Group*	981	80.7%	208 (285 ha)	3,001	86.8%	1.21%

3.5 Criteria Applied to All *Vegetation Patches*

3.5.1 Criterion 10 – *Vegetation Patches* containing a *Vegetation Group* that meets a Group Criterion

Note: Criterion 10 is used to identify the natural heritage system since it recognizes that *Vegetation Groups* identified using Criteria 1-9 and 13-15 do not exist in isolation. Criterion 10 is a mapping rule that translates *Vegetation Group* criteria 1-9 and 13-15 into a single *Vegetation Patch* criterion.

Rationale

Vegetation Patches are comprised of one- to- many *Vegetation Groups*. The spatial arrangement between the *Vegetation Communities* within the *Vegetation Patch* determines the resistance to flow or movement of species, energy, materials, and water (Forman 1995b). Recognizing this interdependency between landscape structure and function, it is important to consider the entire *Vegetation Patch* as a single entity when determining importance. To maintain biological diversity, natural functions, and viable populations of native species and ecosystems, significant natural features and functions cannot exist in isolation.

Application

Mapping rules of adjacency and proximity were used to define a *Vegetation Patch*. If a *Vegetation Patch* contained a *Vegetation Group* that met a group criterion (i.e., Criterion 1, 2, 3, 4, 5, 6, 7, 8 or 9), the entire *Vegetation Patch* meets this criterion.

Results

The results for Criterion 10 are shown in Table 21 and in Appendix H-10. Almost 90% (89.5%) of the patches met this criterion, accounting for 99.1% of the patch area. Since Criterion 10 is really a summary of Criteria 1 through 9, it should account for a great number of patches on the landscape.

Table 21. Criterion 10 Results – *Vegetation Patches* that contain a *Vegetation Group* that meets a group criteria in the Study Area

	# that meet Criterion 10	**% of all *Vegetation Patches*** (2,371)	**# that met only Criterion 10**	**Patch Area** (ha)	**% Area of all *Vegetation Patches*** (30,404 ha)	**% of Study Area** (247,324 ha)
***Vegetation Patches* that contain a *Vegetation Group* that meets a Group Criterion**	2,121	89.5	1,408 (6,779 ha)	30,144	99.1%	12.19%

3.5.2 Criterion 11 – *Vegetation Patch* Containing a Diversity of Vegetation Ecosystems, Groups or Communities

Rationale

Representation approaches have become key concepts in developing methods to select the most significant remaining natural areas (Canadian Council on Ecological Areas 1991, Peterson and Peterson 1991, Horn and Koford 2004). The Natural Heritage Reference Manual (MNR 2010) recognizes that a fundamental step in natural heritage system planning is to consider the protection of the full range of natural features that occur in an area (representation), including both rare and common features, in order to preserve biodiversity at the species and community levels.

Natural areas (or clusters of areas) that span a range of topographic, soil and moisture conditions tend to contain a wider variety of plant and animal species, and may support a greater diversity of ecological processes. The diversity of species is dependent upon the diversity of habitats on the landscape since dissimilar habitats provide food, shelter, and reproductive requirements for different species. Since many species use more than one habitat type to meet their life cycle requirements, it is important for *Vegetation Patches* to be comprised of different habitat types or communities. This criterion encompasses structural diversity (i.e., the full range of canopy heights and types), as well as diversity in the context of slope, aspect, wetness, physiography, etc.

Definition

The number of different *Vegetation Ecosystems*, *Vegetation Groups* and *Vegetation Communities* in a *Vegetation Patch* can be used as proxy measures of diversity.

The three types of *Vegetation Ecosystems*, terrestrial, wetland and aquatic (see Table 3), are linked by a multitude of processes. For example, aquatic *Vegetation Ecosystems* in forests are coupled to adjacent terrestrial *Vegetation Ecosystems* by transitional riparian zones and wetland areas. Processes within wetlands and riparian zones can regulate the retention and release of nutrients and carbon into the aquatic *Vegetation Ecosystem* (Tufford *et al*. 1998, Junk *et al*. 1989). At a broader scale, the inflow of water, nutrients, and sediments from surrounding watersheds are heavily influenced by conditions within the floodplain. Conversely, floodplain plant and animal habitat value and sediment supply and fertility are often determined by river hydrology. The surrounding landscape can also influence the capacity of wetlands to perform functions such as sequestering pollutants, modifying nutrient loads, and providing habitat (Wetzel 2001). The interdependencies between the three natural *Vegetation Ecosystems* provide strong support for criteria based on linkages and spatial patterns.

Application

Three different measures were used to determine if a *Vegetation Patch* was diverse. If any one of the following three measures was met, the *Vegetation Patch* met this criterion (see Figure 11). To determine the number thresholds, many scenarios were run on the data set to find the right combination that reduced redundancy within the three layers. The results are below:

i) *Vegetation Patch* contains > 1 *Vegetation Ecosystem* and/or
ii) *Vegetation Patch* contains > 2 *Vegetation Groups* and/or
ii) *Vegetation Patch* contains > 3 *Vegetation Communities*.

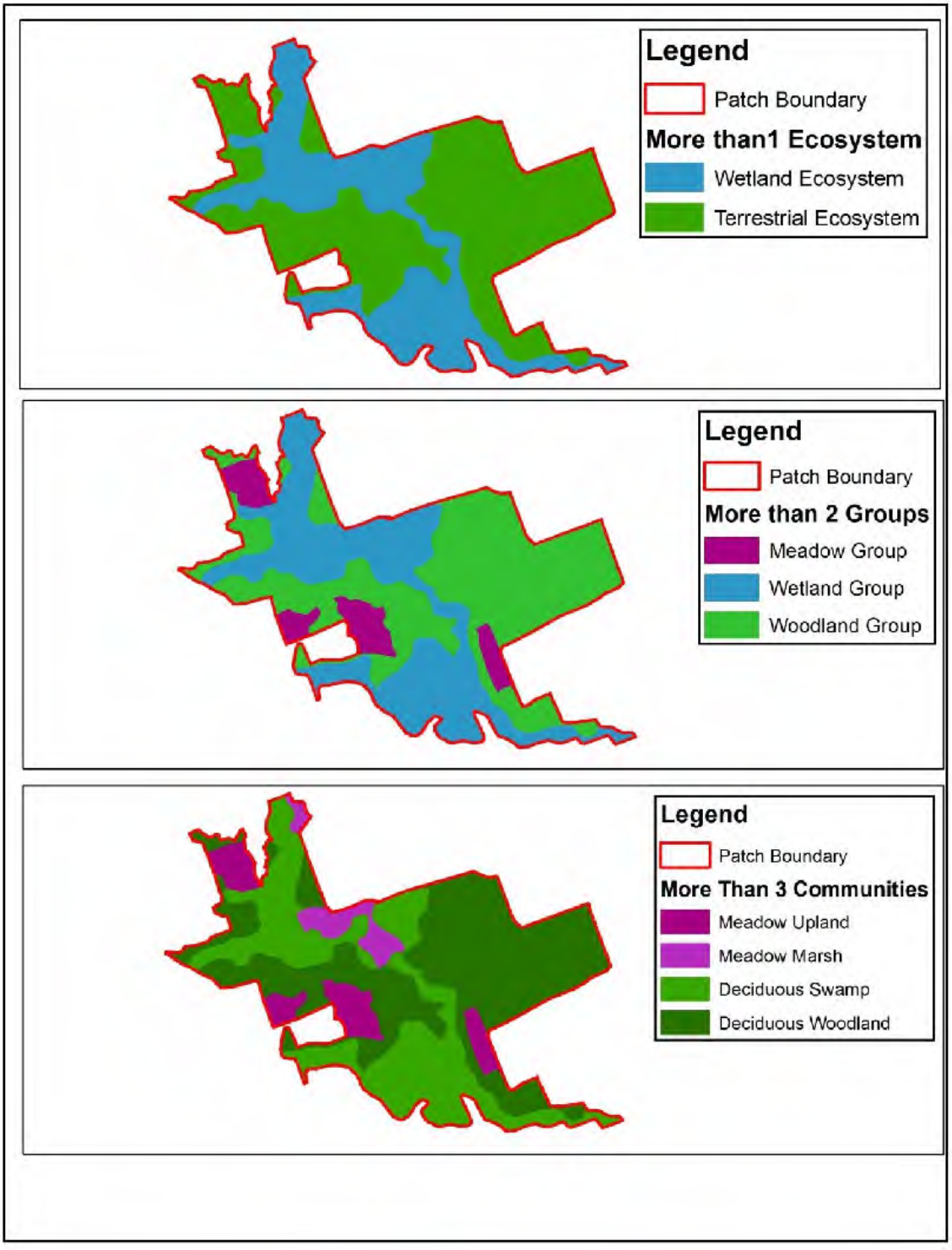
Results

Table 22 shows the results for Criterion 11 and the results map is included in Appendix H-11. Approximately a third (31%) of all patches met this criterion, representing 77% of patch area. Because of the large area it captures, this diversity criterion picks up mostly larger patches. It is not surprising that large patches contain more habitat types than small patches. Only a small number of patches (39) met this criterion alone.

Table 22. Criterion 11 Results –*Vegetation Patches* that contain a diversity of *Vegetation Ecosystems, Groups* and/or *Communities* in the Study Area

	# that meet Criterion 11	**% of *Vegetation Patches*** (2,371)	**# that meet only Criterion 11**	**Area** (ha)	**% Total Patch Area** (39,409 ha)	**% of Study Area** (247,324 ha)
***Vegetation Patches* that contain:** **> 1 Vegetation Ecosystem and/or** **> 2 Vegetation Groups and/or** **> 3 Vegetation Communities**	736	31.0%	39 (86 ha)	23,412	77.0%	9.47%

Figure 11. Criterion 11, illustration of patches containing many different *Vegetation Ecosystems, Groups* and *Communities*



3.5.3 Criterion 12 − *Vegetation Patches* that don't meet any criteria that are within 100 m of a *Vegetation Patch* that meets other Patch Criteria

Rationale

The presence of large natural habitat patches is not sufficient to counteract the effects of fragmentation, especially if there are relatively few such patches, they are widely dispersed, or there are few natural corridors linking them (Riley and Mohr 1994, Prugh *et al*. 2008). Natural areas close to protected areas are increasingly seen as important to the ecological integrity of the protected sites. Research shows local landscapes that include large natural areas, linked to the regional landscape mosaic by a network of smaller interacting natural areas and corridors, offer the highest probability of maintaining overall ecological integrity (Larson *et al*. 1999, Villard *et al*. 1999).

Smaller *Vegetation Patches* of natural cover that are closely spaced can serve as stepping stones for species movement. For example, Baguette and Van Dyck (2007) showed that the ability and willingness of wildlife species to move between and successfully settle in different *Vegetation Patches* was affected by the distance between the *Vegetation Patches*. Environment Canada (2013) found that two or more *Vegetation Patches* are more likely to support more species collectively than they would if they were isolated from each other. In areas where large core areas do not exist, clusters of smaller natural areas that span a range of habitats and are arranged close together support a greater diversity of ecological processes and are able to reduce the effects of fragmentation.

Application / Mapping Rules

Recognizing that plants have limited mobility compared to animals, the average wind dispersal distance of 100 m (for seeds and pollen) was used as the distance that would functionally connect two *Vegetation Patches* (Cain *et al*. 2000, Harper 1977, Howe and Smallwood 1982, Nathan *et al*. 2002, Willson 1993, Cain *et al*. 1998). In Perth County, all *Vegetation Patches* that do not meet a criterion but are within 100 m of a *Vegetation Patch* that does meet a criterion, meet Criterion 12. Figure 12 illustrates this criterion.

Results

Table 23 below shows the mapping results for Criterion 12. The map showing the results is included in Appendix H-12 (note, the patches are very tiny and difficult to see). This criterion is met by only 1.5% of the patches and accounts for only 0.3% of patch area. Because this is the last criterion and it is targeted at those patches that have not met any other criterion, it stands to reason that all of these patches only meet this one criterion. Thus, this criterion picks up a small number of patches that would not have been picked up with any other criteria.

Table 23. Criterion 12 Results –*Vegetation Patches* that do not meet any criteria but are within 100 m of a *Vegetation Patch* that meets other patch criteria in the Study Area

	# that meet Criterion 12	**% of all *Vegetation Patches*** (2,371)	**# that only meet criterion 12**	**Patch Area** (ha)	**% Total Patch Area** (30,404 ha)	**% of Study Area** (247,324 ha)
***Vegetation Patches* within 100 m of a *Vegetation Patch* that meets other patch criteria**	35	1.5%	35	36	0.1%	0.01%

Figure 12. Criterion 12, illustration of a small patch that does not meet any criteria but is within 100 m of a patch that does meet criteria

3.6 Criteria Applied to *Vegetation Groups* Not Currently Mapped

There are three criteria that are not currently included in the PNHSS modelling because the data is not available:

- Significant Wildlife Habitat,
- Groundwater Dependent Wetlands, and
- Watercourse Bluffs and Depositional Areas.

For these criteria an EIS may be needed to confirm their presence/absence if development is proposed. Recommendations for EIS requirements and patch validation are included in Chapter 5.

3.6.1 Criterion 13 − Significant Wildlife Habitat (SWH)

Rationale

The Significant Wildlife Habitat Technical Guide (MNR 2010) describes four categories of significant wildlife habitat:

- Seasonal concentrations of animals
- Rare *Vegetation Communities* or specialized habitat for wildlife (includes IUCN S1-S3)
- Habitat of species of conservation concern
- Animal movement corridors

Criteria for Significant Wildlife Habitat (SWH) are provided by MNRF in the Significant Wildlife Habitat Technical Guide (MNR 2000b) and the Natural Heritage Reference Manual (MNR 2010). More detailed guidelines for evaluating habitat within Ecoregions 6E and 7E, including thresholds of number of species that designate an area as a Significant Wildlife Habitat, have been provided in the January 2015 Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E and 7E (MNRF 2015). The MNRF also recommends that the IUCN (International Union for Conservation of Nature) class S1-S3 species be considered under Significant Wildlife Habitat.

Application / Mapping Rules

Currently, Significant Wildlife Habitat (SWH) as defined by MNRF is not comprehensively mapped at a county scale in Ontario. Identification of this habitat can occur through field studies conducted through EISs or other field studies/inventories, and then reported to the MNRF.

Green Frog. *Photo by Cathy Quinlan*

3.6.2 Criterion 14 − Groundwater Dependent Wetlands (GDW)

Rationale

Groundwater is not only an important water source to meet human consumptive needs, it also plays a critical role in supporting many ecosystems. However, the policies and regulations that protect groundwater for human consumption may not necessarily protect Groundwater-Dependent Wetlands (GDWs), a vital yet poorly understood sub-set of the natural environment (Howard and Merrifield 2010).

GDWs are ecosystems that require access to groundwater to maintain their communities of plants and animals, ecological processes and ecosystem services. Typical examples of these systems are springs, seeps, fens and perched groundwater wetlands.

In all of these systems, terrestrial vegetation interacts with the groundwater. Recognizing that the chemical composition of groundwater is closely related to the type of bedrock and surficial deposits through which it has moved, the groundwater contributes water and nutrients to maintain a rich and unique biodiversity adjusted to these special conditions (Howard and Merrifield 2010).

There has not been a great deal of study or conservation planning around groundwater-dependent ecosystems. Consequently, there is much that needs to be learned about these ecosystems. The increasing demand for groundwater resources due to the combined pressures of development, a variable climate, and a growing population threatens these ecosystems (Brussard *et al.* 1999, MacKay 2006). The availability of surface water to meet consumptive needs has declined and the pressure on groundwater resources is growing. GDWs are threatened by the alteration of the quality or quantity of groundwater discharge resulting from development in groundwater recharge areas and by heavy machinery either in the GDW itself or in its immediate vicinity. Heavy machinery can create deep ruts that destroy the vegetation, alter the hydrology, and disturb resident amphibian species that spend their adult lives in or near water.

Definition

According to the NHRM (MNR 2010), woodlands should be considered significant if they are located within, or a specific distance from, a sensitive groundwater discharge area (e.g., springs, seepage slopes). Groundwater discharge is evident at the seep margin and provides a constant supply of water to the seep community, with flows at many seeps persisting even through the driest summer months. As a result of the continuous soil saturation, thin surface organic layers are generally present over saturated mineral soils.

Currently, areas of groundwater release tend to be small occurrences (i.e., not picked up by satellite imagery). Groundwater ecosystems can be classified by their geomorphic setting (aquatic or terrestrial) and associated groundwater flow mechanism (deep or shallow). On this basis, Howard and Merrifield (2010) identified three groundwater dependent ecosystem types: springs and seeps, wetland ecosystems and groundwater dependent streams.

- **Springs and seeps** − small wetlands formed by groundwater discharge from relatively deep flow systems that rise to form distinctive springs with associated and often unique aquatic ecosystems. Downward movement of groundwater is often impeded, resulting in horizontal flow and discharge of water at the surface. Seeps are typically long and narrow with a total area less than 0.5 acre and tend to occur on or near the base of slopes or watercourses or on benches in upland forests. Seeps can vary seasonally and depend on the depth and size of the groundwater resource supporting them.

- **Wetland ecosystems** − discharge of shallow and sometimes perched groundwater flow. Fens are an example of a groundwater dependent wetland.

The third type identified by Howard and Merrifield (2010) is groundwater dependent streams, but these are not considered in the PNHSS.

Application

Groundwater Dependent Wetlands of any size can be found and mapped through site inventories, studies and EISs. A possible procedure for a landscape scale study is found in Appendix C.

Skunk Cabbage (*Symplocarpus foetidus)* along a groundwater discharge stream. *Photo by Cathy Quinlan*

3.6.3 Criterion 15 – Watercourse Bluff and Deposition Areas

Rationale

Steep slopes, cliffs, valley bluffs, gravel bars and beaches are similar to upturned sections of earth and can create unique natural features for specialized assemblages of plants and animals.

Bluffs found along rivers can be devoid of life due to the arid conditions or full of rare and fragile plant life that grow sporadically along different soil layers. Bluffs of steep river banks are formed by river erosion on the outside of a meander. Erosion can also be the result of ground water movement and surface runoff. Bluffs can provide prime nesting quarters for all sorts of birds, including an assortment of swallows, Belted Kingfishers and Turkey Vultures.

The Bank Swallow that nests along naturally eroding slopes of streams, rivers, and lakes, has undergone significant population declines throughout Canada. In Ontario, Bank Swallows have declined at a rate of 4.7% annually over the last 40 years based on Breeding Bird Survey (BBS) data. Although the precise mechanisms driving the declines are unknown, the size and longevity of Bank Swallow colonies is dependent on bank erosion, which determines suitable nesting habitat. Declines are generally thought to be a consequence of habitat loss, changes in food source (i.e., aerial insects), and threats during migration or on the wintering grounds.

Depositional areas include gravel bars and beaches that form in watercourses where water flow is slower (e.g., inside river meander), allowing soil, sand and gravel to settle out of the water column. These features, while often small in scale, are prime nesting sites for turtles, especially Snapping Turtles and Spiny Softshells. Bars and beaches can be unvegetated or support early successional plants, depending on how recent there has been flooding and re-shaping of the feature.

Application

To identify potential bluffs on the landscape, one could use digital contour data and GIS analysis of very steep slopes. However, it is very difficult to accurately identify a vertical face. Therefore, as this habitat is detected and / or verified through site studies as part of the Environmental Impact Study and should be mapped. Proposed development along watercourses would require approval from the Conservation Authority. As part of the permit process an EIS may be required. All Watercourse Bluff and Depositional Area *Vegetation Groups* meet criterion 15.

3.7 Additional Information – Criteria that did not pick up any patches not already picked up by other criteria

Two criteria, *Vegetation Patches* ≥ 100 ha and Woodland Interior, were part of the 2006 Oxford Natural Heritage Study and other early natural heritage studies. However, the current study has more and slightly different criteria. For example, the woodland size cutoff is 1 ha versus 10 ha in the earlier study (see section 3.4.3). When the model was run for the current study, these two criteria did not pick up any patches that were not already picked up by other criteria. These two criteria and their results are provided here as added information items.

3.7.1 *Vegetation Patches* ≥ 100 ha

Rationale

Size is a key landscape-level factor affecting the presence, abundance, and diversity of species (Environment Canada 2013, Mazerolle and Villard 1999, Lovett-Doust and Kuntz 2001, Lovett-Doust *et al*. 2003, Bender *et al*. 1998). The Natural Heritage Reference Manual (MNR 2010) recognizes that large patches of natural area are more valuable than smaller patches, provided that size is not the only consideration.

The size of a *Vegetation Patch* considered to be 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, the size of areas considered to be large would be smaller than in a region where natural feature cover is extensive. As well, natural areas should be large enough to be resilient to typical natural disturbances. Current science suggests that 100 hectare woodland *Vegetation Groups* will support approximately 60% of area sensitive species while 200 hectare woodland *Vegetation Groups* will support approximately 80% (Environment Canada 2013). Burke and Nol (2000) determined that reproductive success of forest birds in southern Ontario was consistently higher for woodland *Vegetation Groups* greater than 94 ha.

However, the size of a patch does not take into account its shape and long liner patches would not function the same as square shaped patches of the same size.

Application / Mapping Rules

Since natural cover is relatively low in Perth County, all *Vegetation Patches* ≥ 100 ha in size or greater were identified as meeting the large *Vegetation Patch* parameter.

Results

Table 24 shows that there are only 36 patches (1.5% of all patches) that are 100 ha or larger. However, these patches account for almost a third (31.9%) of all the vegetation area. Appendix I-1 shows the results in map form. Some of the large patches include the Ellice and Gads Hill Swamps as well as long, narrow patches that follow watercourses.

Table 24. *Vegetation Patches* ≥ 100 ha

	# meeting this criterion	**% of all *Vegetation Patches*** (2,371)	**# meeting this criterion and no other**	**Patch Area** (ha)	**% Total Patch Area** (30,404 ha)	**% of Study Area** (247,324 ha)
***Vegetation Patches* ≥ 100 ha**	36	1.5%	0	9,633	31.9%	3.89%

3.7.2 Woodland Interior Habitat

Interior habitat is useful as a measure of ecosystem health (Weathers *et al*. 2001, LRC and MNR 2000, Sandilands and Hounsell 1994, Sisk *et al*. 1997), but not as useful in selecting significant woodlands. Environment Canada (2013) recommends that a minimum of 10% of watersheds should be in woodland interior habitat. Many area-sensitive forest birds require the protective core of a woodland to nest successfully, away from the edge habitat that is more prone to high predation, wind damage and alien species invasion. The NHRM (MNR 2010) defines edge habitat as habitat that exists within 100 m from the outermost trees. Meffe and Carroll (1997), Matlack (1993), Chen *et al*. (1995), and Hamill (2001) consider edge habitat as a zone of influence that varies in depending on where and what is being measured.

Application / Mapping Rules

To define interior habitat, a swath of 100 m around the inside perimeter of the woodland *Vegetation Group* before clustering around roads was delineated as "edge" habitat. Any habitat within the woodland *Vegetation Community*, but not within the 100 m wide edge, was identified as woodland interior. Figure 13 provides an illustration of the mapping of interior.

The 2006 ONHS used an interior habitat criterion because the woodland size cutoff was 10 ha and the study wanted to capture those woodlands 4-10 ha with interior. Woodlands 4 to 10 ha in size may contain interior habitat depending on their shape, but woodlands < 4 ha do not (i.e., a perfectly square 4 ha woodlot is 200 m x 200 m, leaving no room for interior). Since the current study uses a 4 ha woodland size minimum, there should be no woodlands smaller than 4 ha that contain interior.

Results

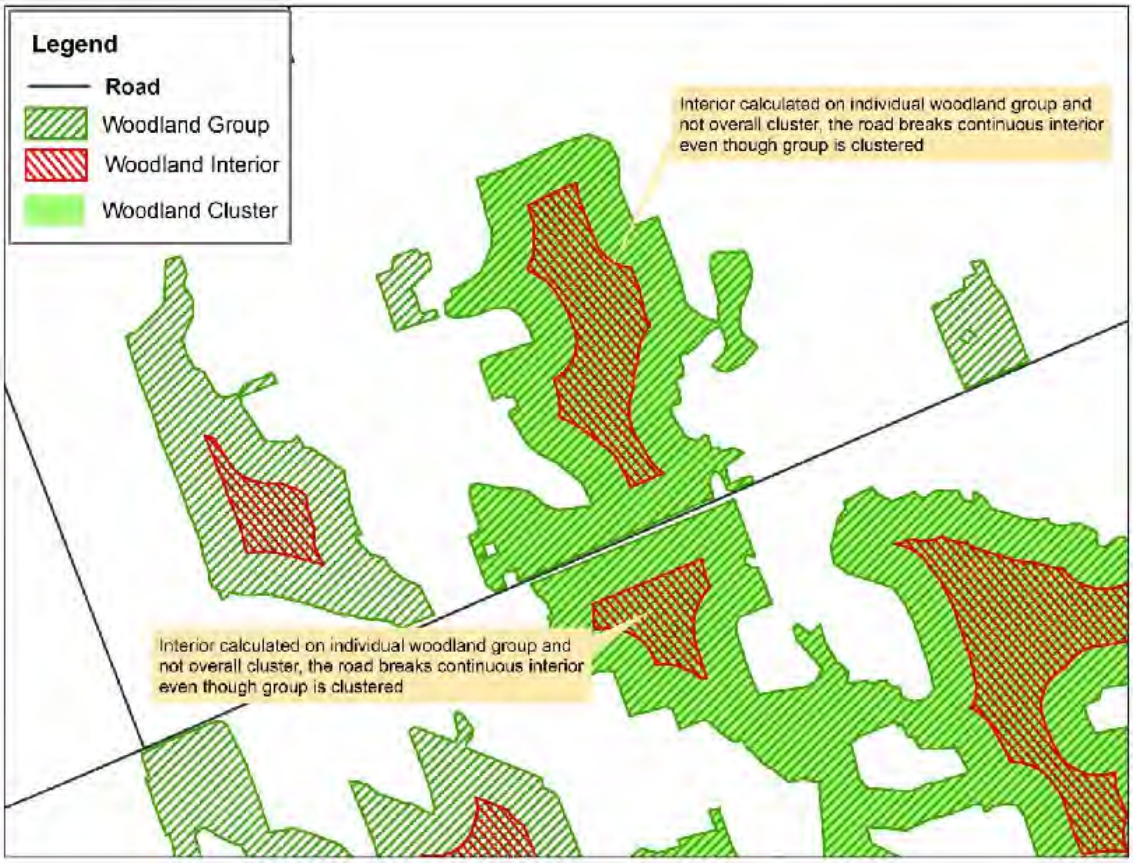
Table 25 and Appendix I-2 provide a summary of interior woodland habitat in the Study Area. Only 17.8% of all woodland groups contain interior habitat, indicating the majority of woodlands are too small and/or narrow to contain interior. The woodlands with interior habitat capture about two-thirds (63.2%) of all woodland *Vegetation Group* area. However, the area of woodland interior >0.5 ha only (that protected area of woodland 100 m or more from an edge) adds up to only 3,753 ha and makes up only 15.5% of the woodland area and 1.52% of the Perth study area. Environment Canada (2013) recommends at least 10% woodland interior cover by watershed.

Table 25. Woodland Groups with Woodland Interior Habitat

	# that have interior	**% of all Woodland Groups** (2,533)	**# that only meet this criterion**	**Area of woodland groups with interior** (ha)	**Total Area of woodland interior >0.5 ha** (ha)
Woodland *Vegetation Groups* that contain ≥0.5 ha of interior woodland habitat	451	17.8%	0	15,648 (63.2% of Woodland area) (6.32% of Study Area)	3,753 (15.5% of Woodland area) (1.52% of Study Area)

Study Area = 247,324 ha; Woodland Area = 24,766 ha

Figure 13. Illustration of how interior woodland area is calculated



3.8 Criteria Reviewed but Not Included

Several additional potential criteria were suggested and reviewed as part of the 2014 Middlesex Natural Heritage Systems Study and 2016 Oxford NHSS and were not used for a variety of reasons. Many did not add value (e.g., were redundant), did not fit the study or had other limitations. A full description of these criteria and the rationale for not including them is shown in Appendix E. Below is a list of the 19 criteria that were not used:

- Best representative *Vegetation Patch* on landform physiography and soil type
- Located on a distinctive, unusual or high quality landform. All areas (both vegetated and non-vegetated) on: gullies, valley lands, within 30 m of limestone outcroppings
- *Vegetation Patch* on an Earth Science ANSI that contributes to the presence of an uncommon *Vegetation Community*
- All *Vegetation Patches* found alongside a coldwater watercourse or watercourse containing Brook Trout
- Shape of *Vegetation Patch* (i.e., closest to a round shape)
- Adjacent to an MNR evaluated wetland or life science ANSI
- Contains an area identified in the local official plans such as the Locally Significant Natural Areas identified by Hilts and Cook 1982
- Unique intrinsic characteristics (i.e., site level characteristics)
- Distance from development (e.g., permanent infrastructure and buildings) or matrix
- Persistence or threatened
- Porous or erodible soils
- *Vegetation Patch* contains a large sized wetland defined as:
    - wooded wetlands > 4 ha based on Environment Canada (2013),
    - wetland meadows and marshes >10 ha based on Environment Canada (2013),
    - small wetland meadows and marshes adjacent to other *Vegetation Communities* may be vital to butterflies,
    - wetland thicket size determined by top 75th percentile distribution cutoff of all county wetland thicket sizes.
- *Vegetation Patch* contains a wetland that is within 1,000 m of another wetland
- *Vegetation Patch* contains a recently observed (post 1980) regionally rare plant
- *Vegetation Patch* contains thicket with interior
- Carolinian Canada Big Picture Corridors
- Interior woodland habitat that is ≥0.5 ha in size of continuous habitat
- Species at Risk

4.0 Results of Running the Ecologically Important Criteria

Each criterion in this study measures a unique aspect of the ecological services that a natural feature provides. Thus, any patch that meets at least one criterion is considered "ecologically important" in Perth. This one-criterion approach has been utilized in many other studies including the 2016 Oxford Natural Heritage Systems Study, 2014 Middlesex Natural Heritage Systems Study and the 2014 Huron Natural Heritage Study. In Middlesex and Huron studies, the criteria were called "significance criteria", but in this study the word "significant" has been replaced with "ecologically important". This change was made to distinguish it from the use of the word significant in the Provincial Policy Statement for certain Natural Heritage Features and Areas such as Provincially Significant Wetlands and Provincially Significant ANSIs (see section 1.1).

As explained in the previous chapter, the running of the criteria was done on the Study Area that includes a 1 km buffer around the perimeter of Corporate Perth County. This was done so that natural features that spanned the border would be modelled in their entirety and not cut off by the political boundary. After the *Vegetation Group* and Patch Criteria were modelled, the boundary could then be clipped down to Corporate Perth for reporting purposes. The results for both the Study Area and Corporate Perth are shown in this chapter.

Section 4.1 summarizes the results of running the group level criteria (Criteria 1 to 9).
Section 4.2 summarizes the results of running the group and patch level criteria (Criteria 1 to 12).
Section 4.3 describes the three categories of woodlands that inform Official Plan policies.

Small and medium-sized woodlots dot the Perth County landscape. UTRCA Photo

4.1 *Vegetation Groups* that meet Criteria

Table 26 summarizes the results of running the model for *Vegetation Groups* for the Perth Study Area.

As expected, the woodland group, which is the largest group, has the largest percentage that is ecologically important (99.49%). The meadow group has the second largest area and 96.90% of the area is ecologically important. The thicket and water feature groups both have approximately the same area but the thicket group has 80.39% and the water feature group has 88.83% ecologically important.

The wetland group, made up of woodland, thicket, and meadow vegetation communities, is also quite large at 9,284 ha or 3.75% of the county. All wetland groups are ecologically important.

The map in Appendix K-1 shows the woodland groups that meet a criterion (and are ecologically important) and those that do not. Since the woodland group criteria (Criteria 1, 2, 3, 5 and 6) establish significance for woodlands consistent with the PPS (see Table 7-2 of the NHRM), the ecologically important woodland groups also represent Significant Woodlands as per the PPS.

The map in Appendix K-2 shows the meadow groups that meet a criterion (and are ecologically important) and those that do not. A map was not completed for the thicket group because the thicket groups are too small to show up well at the county scale.

Note: It is recognized that the policies of the PPS do not provide protection for upland thickets and meadows as natural heritage features and areas, unless they have been determined to be significant wildlife habitat.

Table 26. *Vegetation Group* Results for Perth Study Area

Vegetation Group ↓	**Total Group Area** (ha)	**% Total Group Area of Perth Study Area** (247,324 ha)	**Ecologically Important Area** (ha)	**% Ecologically Important Group Area of Study Area** (247,324 ha)	**% Group Area that is Ecologically Important**
Woodland	24,766	10.01%	24,640	9.97%	99.49%
Thicket	816	0.33%	656	0.27%	80.39%
Meadow	3,457	1.40%	3,350	1.35%	96.90%
Water Feature	770	0.31%	684	0.28%	88.83%
Connected Veg. Feature	23	0.01%	18	0.01%	78.26%
Total	**29,832**	**12.06%**	**29,348**	**11.87%**	**98.38%**
Wetland	9,284	3.75%	9,284	3.75%	100.00%

Wetlands include woodland, thicket and meadow groups and are already part of the total.
Ecologically Important *Woodland Groups* also meet criteria for Significant Woodlands as per the PPS

4.2 *Vegetation Patches* that meet Criteria

Table 27 summarizes the number of vegetation patches that met a certain number of criteria in the Study Area. The number of criteria met refers to the total number of criteria, not any specific criterion. The maximum number of criteria any patch can meet is ten since Criterion 10 is simply a mapping rule to bring Criteria 1-9 from a *Vegetation Group* to a *Vegetation Patch*, and Criterion 12 can only apply to patches that have not yet met any criteria.

Over 90% of patches meet at least one criterion, and are thus ecologically important. Only 192 or 8.1% of vegetation patches do not meet any criterion, however, the total area of these very small patches is fairly small (see Table 29).

Table 27. The number of *Vegetation Patches* versus the Number of Criteria Met in the Perth Study Area

# of Criteria Met	# *Vegetation Patches*	% of Patches (2,371)
0	192	8.1%
1	640	27.0%
2	537	22.6%
3	229	9.7%
4	222	9.4%
5	235	9.9%
6	153	6.5%
7	83	3.5%
8	52	2.2%
9	18	0.8%
10	10	0.4%
TOTAL	**2,371 (2,179 meet one or more criteria)**	**100.0%**

Notes:
The number of criteria met refers to the total number of criteria, not any specific criterion.

Tables 28a and 28b summarize the results of modeling all 12 criteria combined for all vegetation patches by municipality and for the county as a whole. The three unmapped criteria cannot be modeled at this time (see Section 3.6). The corresponding maps showing the patches that do and do not meet a criterion for each municipality are included in Appendix K3 to K9.

The key findings are:

- 12.06% of the Perth Study Area (PSA) is in natural vegetation/patch cover (29,832 ha of 247,324 ha) and 11.87% is in ecologically important vegetation/patch cover (29,348 ha)
- 98.3% of the natural vegetation/patch cover by area (29,348 ha of 29,832 ha) meets one or more criterion and is ecologically important and only 1.6% of the vegetation patch cover (484 ha) meet no criteria 8.1% of the number of patches)
- 3.75% of the PSA is in wetland cover (evaluated and unevaluated wetlands totaling 9,284 ha)
- 10.01% of the PSA is in woodland/forest cover and 9.97% is in significant ecologically important woodland cover
- 1.40% of the PSA is in meadow cover and 1.35% ecologically important meadow cover

Table 28a. Number of Vegetation Patches that are Ecologically Important by Municipality

Municipality	# Patches	# patches that are ecologically important	% of patches that are ecologically important
Stratford	47	37	78.7%
North Perth	499	454	91.0%
West Perth	471	431	91.5%
St. Marys	20	19	95.0%
Perth East	712	658	92.4%
Perth South	358	322	90.0%
Perth County	**2,084**	**1,911**	**91.7%**

Table 28b. Area of Vegetation Patches that are Ecologically Important by Municipality

Municipality	Municipal Area (ha)	Area of all patches (ha)	% of municipality in patch cover	Area of patches that are ecologically important (ha)	% of patch area that is ecologically important	% of Municipality that is ecologically important
Stratford	2,845	206	7.23%	194	94.3%	6.82%
North Perth	49,349	5,455	11.05%	5,414	99.2%	10.97%
West Perth	57,963	5,295	9.14%	5,262	99.4%	9.08%
St. Marys	1,303	215	16.50%	214	99.5%	16.42%
Perth East	71,289	8,409	11.80%	8,358	99.4%	11.72%
Perth South	39,516	5,155	13.05%	5,135	66.9%	12.99%
Perth County (Corporate)	**222,233**	**24,731**	**11.13%**	**24,572**	**99.4%**	**11.06%**

- Areas of each municipality were calculated based on municipal corporate boundaries. The patches were clipped at the municipal boundaries and no buffer was added. The area of each municipality was obtained from Land Information Ontario, 2017 and may not coincide exactly with the area known to the municipality.
- Note, the Perth County (Corporate) area is smaller than the Perth Study Area as the 1 km buffer is not included.

4.3 Woodlands: Significant, Ecologically Important, and Other

To inform Official Plan policies, woodlands have been sorted into three categories:

1) Significant Ecologically Important Woodlands
   - *Definition*: woodland groups that meet group level criteria within the PNHSS
   - As explained in section 3.2.2, PNHSS criteria 1, 2, 3, 5 and 6 establish significance for woodlands consistent with the PPS (see Table 7-2 of the NHRM).
   - These woodlands are considered to be both significant as per the PPS and ecologically important as per the PNHSS.

2) Non-Significant Ecologically Important Woodlands
   - *Definition:* woodland communities or groups within a patch that meet patch level criteria but not group level criteria within the PNHSS
   - Some woodlands that do not meet *Vegetation Group* level criteria, may be part of a larger patch made up of other vegetation groups such as thicket, meadow, or water feature, that does meet a patch level criteria (i.e., Criteria 10, 11 or 12).
   - Thus, the woodland is ecologically important and part of the Perth Natural Heritage System, though not Significant as per the PPS.

3) Other Woodlands / Non-ecologically Important Woodlands
   - *Definition:* woodland groups and patches containing woodlands that do not meet any group or patch level criteria within the PNHSS
   - Although non-ecologically important based on mapped PNHSS criteria, these woodlands could still be considered "candidate sites" until an EIS determines that no unmapped criteria are present (see Chapter 5 recommendations).

Appendix L-1 provides a map that shows these three categories of woodlands in Perth County. Other PPS features (e.g., Provincially Significant Wetlands) are not shown on this map as they are part of the provincial data layer available from MNRF. The Significant Valleylands are shown separately in Appendix H-1. Table 29 shows that 99.5% of the woodland group area falls under the significant ecologically important category and occupies 9.967% of the Perth County study area.

The GIS data for the PNHSS allows the planning agencies to determine which criteria any individual vegetation group or patch met, as well as other details.

Table 29. Woodland Category Results for Perth Study Area

Woodland Category	Number of Woodland Groups	% of Total Number of Woodland Groups	Area (ha)	% of Total Woodland Group Area	% of Perth Study Area (247,324 ha)
Significant Ecologically Important	2,355	93.0%	24,640	99.5%	9.96%
Non-significant Ecologically Important	57	2.3%	43	0.2%	0.02%
Other (non-ecologically important)	121	4.7%	83	0.3%	0.03%
Total	**2,533**	**100.0%**	**24,766**	**100.0%**	**10.01%**

5.0 Recommendations

The Perth Natural Heritage Systems Study (PNHSS) is a science based study that identifies natural heritage system components following a landscape ecology methodology. The information it provides can be implemented through both regulatory and non-regulatory approaches. However, regulation must play a role in implementation due to the need for local planning policies and decisions to be consistent with the PPS natural heritage policies. This section provides various recommendations for implementation of the study.

It is important to note that the PNHSS focused primarily on the natural heritage system of the Perth landscape and that implementation will also require consideration of cultural, economic and public health and safety factors. This broader consideration of factors is inherent in implementation processes under the Planning Act and the Environmental Assessment Act which have the realization of the public interest as their ultimate goal. These processes involve considerable review and consultation to assist in determining the various interests that make up the public interest.

The PNHSS project did not include a process to engage stakeholders on implementation options. However, extensive consultations on implementation options were undertaken as part of the 2006 ONHS. The majority of the implementation options developed as part of that study could be applied to the Perth County area and so are included in Appendix K for reference. The PNHSS focused primarily on identifying and characterizing natural heritage features and areas and the broader natural heritage system, so that this information could inform the various implementation options. It is recognized that further stakeholder consultation will be undertaken as part of the various processes required to implement the study recommendations (e.g., updates to Official Plan policies and Woodland Conservation By-Law).

At 1100 ha, Ellice Swamp is the largest natural area in Perth County. Photo by UTRCA.

5.1 Land Use Planning

The results of the study should be incorporated into the County Official Plan policies, as necessary to ensure consistency with the natural heritage policies of the Provincial Policy Statement (PPS). The PPS notes that the policies represent minimum standards while planning authorities and decision-makers may go beyond these standards to address matters of local importance (see text box below). This was the case for Perth County, going from the recommended 4 ha minimum woodland size threshold for significance to 1 ha.

> ***Excerpt from 2014 PPS (page 3)***
>
> **Policies Represent Minimum Standards**
>
> The policies of the Provincial Policy Statement represent minimum standards.
>
> Within the framework of the provincial policy-led planning system, planning authorities and decision-makers may go beyond these minimum standards to address matters of importance to a specific community, unless doing so would conflict with any policy of the Provincial Policy Statement.

The most appropriate means to implement the results of the study will be determined at the time that Planning Act applications are considered and will be guided by the Provincial Policy Statement, Official Plan policies and input obtained through the process. That being said, to ensure an appropriate review framework is put in place to evaluate such applications, this study provides a number of specific land use planning recommendations for consideration by the County, as follows:

1) It is recommended that the County utilize the PNHSS 2018 as the scientific basis for identifying Natural Heritage Features and Areas and the broader Natural Heritage System within the County of Perth in the Official Plan, as required by the 2014 Provincial Policy Statement (PPS). The official plan should also include policies governing the protection of natural heritage features and areas and the protection of natural heritage systems through land use change and the policies should require assessment that is appropriate to the scale of the proposed land use change. For example, small scale applications should consider the potential impact on the natural heritage system through the preparation of an Environmental Impact Study (EIS) or edge management planning process (i.e., verifying natural feature boundaries on a site specific basis for scoped level assessments). Larger scale developments and urban expansions should be assessed at a subwatershed scale of study and include the integration of natural heritage, natural hazard and servicing planning.

2) An updated Environmental Impact Study (EIS) guideline document should be developed to provide more specific guidance on the implementation of the PNHSS through the land use planning and development process, including initial consultation, EIS submission requirements, review process and scoping and/or waiver criteria.

   a) A patch validation guideline should be developed to support the EIS guideline document. The patch validation guideline can assist with confirming patch attributes (i.e., criteria met, including the three un-mapped criterion/features) and boundaries.

   b) Patches that do not meet any criteria can be viewed as non-ecologically important or candidate ecologically important. If development is proposed, preparation of an EIS could be requested to confirm that the patch does not meet any of the 12 mapped criteria or the three unmapped criteria (Significant Wildlife Habitat, Groundwater Dependent Wetlands, bluffs and depositional areas).

      Note: It should be recognized that development and site alteration may not be permitted in fish habitat and habitat of endangered species and threatened species except in accordance with provincial and federal requirements (MMAH, 2014). These features need to be confirmed to be consistent with the PPS.

   c) The guideline document should also identify instances where the completion of an EIS can be scoped and/or waived (i.e., maintenance activities associated with stormwater management ponds and sewage lagoons, minor additions to buildings, etc.)

3) If agricultural or other similar lands are proposed to be developed for settlement or other non-agricultural land uses, the system linkages that would have been provided in the working agricultural or other pre-development landscape may be disrupted or eliminated by the post development landscape. In such cases, it is necessary that natural heritage system linkages be studied at an appropriate level of detail and that appropriate system linkages be identified (e.g., through an EIS) and provided as part of the development review process.

4) Significant valleylands have been identified in this study. The vegetation groups within or abutting these valleylands meet the criteria for significance consistent with the PPS, as well as this study. However, the portions of the significant valleylands that do not correspond with an ecologically important vegetation group as defined in this study are not specifically identified as part of the Perth Natural Heritage System. As such, assessment of negative impacts through an EIS should not, generally, be required for development adjacent to those portions of significant valleylands. Development within valleylands is typically already limited by the Natural Hazard features with which the valleyland is associated. However, in the limited instances where development may be proposed within a significant valleyland, natural heritage system linkages should be studied at an appropriate level of detail and appropriate system linkages identified (e.g., through an EIS) and provided as part of the development review process.

5) Policies should be included in the Official Plan to maintain, restore and improve the existing natural heritage system. *Note*: The PNHSS does not determine if there are enough natural heritage features, whether they are in the right places or of the right type. Also, this study does not determine whether the existing natural heritage system is sustainable over the long term.

5.2 Other Implementation Measures

1. The County Woodland Conservation By-Law should be reviewed with respect to its role in protecting the woodlands and other treed features (e.g., connected features) identified in this study. Further, the area municipalities should consider enacting, or delegating the authority to enact, Woodland Conservation By-Laws to protect smaller woodland features (i.e., 0.5 to 1 ha) that are not covered by the County By-Law, to reduce further loss of natural cover in the County. The PNHSS should be used to inform the review of applications for exemption made under the Woodland Conservation By-Law(s).

2. The PNHSS should be considered in the development and ongoing implementation of stewardship and incentive programs, education programs and the management of publicly owned forests and natural areas in the County.

3. Management plans should be developed for all publicly owned natural *Vegetation Patches*, including County Forests. [Allan, does Perth have county forests?]

4. Municipalities should work with conservation authorities and the Ministry of Natural Resources and Forestry to develop a framework for meadow/thicket management planning for publicly and privately owned lands that are zoned for development, but not yet developed. For example, the owner of such lands could let their land naturalize for an interim period without concern that natural heritage restrictions relating to such features might potentially affect the future development potential of the lands. There may only be some recommendations to consider the timing of removal in order to protect the wildlife nesting cycle. It is recognized that these are transitional areas until such time as development occurs. *Note:* It is recognized that the policies of the PPS do not provide protection for upland thickets and meadows as natural heritage features and areas, unless they have been determined to be significant wildlife habitat.

5. The county/municipalities should produce a factsheet on ways to minimize negative impacts on wildlife during maintenance of man-made pond structures. Man-made ponds, including sewage lagoons, stormwater management ponds, irrigation ponds, and ponds in licensed aggregate pits can be included in the Water Feature *Vegetation Group* if they are connected to meadows, woodlands or other *Vegetation Groups*. Some of these *Vegetation Groups* may be ecologically important by meeting one or more criteria. The results of this study do not presume to change the intended purpose of these man-made structures. These structures can continue to function as designed. However, since they attract plants and wildlife by their very design (i.e., holding water, using biological processes to break down pollutants, etc.), undertaking cleanouts and other maintenance activities should be done prior to wildlife hibernation or after fledging. A factsheet to assist managers of these pond structures would be helpful. Regular maintenance activities would not require the submission of an EIS, however, the updated EIS guidelines recommended above should address this.

6. The county/municipalities should continue to support the Southwestern Ontario Ortho-Imagery Project (SWOOP), or other similar partnerships, to obtain updated digital aerial photography on a regular basis. The County should update the vegetation layers as new ortho-imagery becomes available (roughly every 5 years) to assess vegetation cover changes. The county can do the work in-house or contract out the UTRCA to complete the updates. The natural heritage system model should be re-run with the updated vegetation layers. The PNHSS criteria should be re-visited after 10 years (2028).

7. The watercourse layer should be updated to ensure that smaller watercourses are accurately delineated and categorized to distinguish them from other features such as swales and enclosed drains. *Note:* Notwithstanding the current state of the water course mapping layer shown in this study, all open watercourses are considered to be potential fish habitat and should be screened for at the site level as part of any development application. All open watercourses are considered part of the aquatic system, however, this study focuses on the terrestrial system.

8. The County should review the implementation recommendations contained in the 2006 ONHS (see Appendix M) for consideration in Perth County.

Ironwood, Blue Beech, Black Cherry, and Sugar Maple are common tree species in Perth County woodlands. UTRCA photo.

References

Agriculture Canada and Ministry of Agriculture and Food. 1992. *Best Management Practices: Farm Forestry and Habitat Management.*

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.

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 Middlesex 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

Brussard, P.F., D.A. Charlet and D. Dobkin. 1999. "The Great basin – Mojave desert region." In: Mac, M.J., P.A. Opler, C.E. Puckett-Haecker and P.D. Doran (eds.). *The status and trends of the nation's biological resources.* Reston, VA: U.S. Department of the Interior, U.S. Geological Survey: pp. 505-542.

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.

Burke, D.M., K. Elliot, K. Falk and T. Piraino. 2011. *A Land Managers Guide to Conserving Habitat for Forest Birds in Southern Ontario*. MNR Science and Information Resources Division. Queen's Printer for Ontario. MNR # 52508. ISBN: 978-1-4435-0097-5.

Canadian Council on Ecological Areas (CCEA). 1991. *Framework for Developing a Nation-wide System of Ecological Areas.* CCEA Systems Plan Task Force report. 12pp.

Cain, M.L., B.G. Milligan and A.E. Strand. 2000. "Long-distance seed dispersal in plant populations." *American Journal of Botany* 87(9): 1217- 1227.

Cain, M. L., H. Damman, and A. Muir. 1998. "Seed dispersal and the Holocene migration of woodland herbs." *Ecological Monographs* 68: 325–347.

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.

Chandler, R.B., D.I. King, and C.C. Chandler. 2009. "Effects of management regime on the abundance and nest survival of shrub land birds in wildlife openings in northern New England, USA." *Forest Ecology and Management* 258:1669-1676.

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.

City of London. 2006. *Guideline Document for the Evaluation of Ecologically Significant Woodlands*. Approved by Council June 26, 2006.

Conservation Ontario. 2011. *Guide to Developing Conservation Authority Watershed Report Cards.*

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 Huron. 2013 (Draft). *Huron County Natural Heritage Study*. Project management by Upper Thames River Conservation Authority.

County of Lambton, City of Sarnia, St. Clair Region Conservation Authority, Carolinian Canada Coalition, and North-South Environmental Inc. 2012 (Draft). *Lambton County Natural Heritage Study*.

County of Middlesex and Upper Thames River Conservation Authority. 2003. *Middlesex Natural Heritage Study (MNHS): A natural heritages study to identify significant woodland patches in Middlesex County. 41 pps. + Appendixes.* (also referenced under UTRCA)

County of Middlesex. 2014. *Middlesex Natural Heritage Systems Study*: A study to identify natural heritage systems in Middlesex County. Project management by Upper Thames River Conservation Authority in cooperation with Middlesex County Conservation Authorities.

County of Oxford. 2006. *Oxford Natural Heritage Study*. www.county.oxford.on.ca

County of Oxford. 2016. Oxford Natural Heritage Systems Study: A study to identify natural heritage systems in Oxford County. Project management by Upper Thames River Conservation Authority in cooperation with Oxford County Conservation Authorities.

County of Perth. 2008. *Perth County Official Plan*. http://www.perthcounty.ca/County_of_Perth_Official_Plan

Cunningham, R.B., D.B. Lindenmayer, M. Crane, D. Michael, C. MacGregor, R. Montague-Drake and J. Fischer. 2008. "The combined effects of remnant vegetation and tree planting on farmland birds." *Conservation Biology*. 22:742–752.

Curtis, J.T. 1959. *The Vegetation of Wisconsin*. University of Wisconsin Press, Madison, Wisconsin.

Davis, N.B. 1978. "Territorial defense in the speckled wood butterfly (*Pararge aegenia*): the resident always wins." *Anim. Behav*. 26: 138-147

Davis, S.K. 2004. "Area sensitivity in grassland passerines: effects of patch size, patch shape, and vegetation structure on bird abundance and occurrence in southern Saskatchewan." *Auk* 121: 1130 – 1145.

Dillon Consulting Ltd. and D.R. Poulton and Associates. 2011. *The City of London Thames Valley Corridor Plan.*

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?* Third Edition. Environment Canada, Toronto, Ontario.

Etmanski, A., and R. Schroth. 1980. *An inventory of gully erosion problems along the Lake Middlesex shoreline.* Maitland Valley Conservation Authority. 77pp.

Experimental Farm Service. 1952. *Soil map of Middlesex 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.

Findlay, S. and J. Houlahan, 1997. "Anthropogenic correlates of species richness in south eastern Ontario wetlands." *Conservation Biology* 11(4):1000-1009.

First Base Solutions. 2007. *Selected Vector Compilation*. Ausable Bayfield Conservation Authority (ABCA). Markham, Ontario.

Fischer, R. A. and J. C. Fischenich. 2000. *Design recommendations for riparian corridors and vegetated buffer strips*. EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-24). U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://el.erdc.usace.army.mil/elpubs/pdf/sr24.pdf

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.

Foley, J.A., R. DeFries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, J.H. Helkowski, T. Halloway, E.A. Howard, C.J. Kucharik, C. Manfreda, J.A. Patz, I.C. Prentice, N. Ramankutty, and P.K. Snyder. 2005. "Global consequences of land use." *Science* 309:570–574.

Forman, R.T.T. 1995a. *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge University Press, New York.

Forman, R. T. T. 1995b. "Some general principles of landscape and regional ecology." *Landscape Ecology* 10(3):133-142.

Forman, R.T.T. 1995c. "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.

Golet, F.C. 1976. "Wildlife Wetland Evaluation Model." *Models for the Evaluation of Freshwater Wetlands*. J.S. Larson (ed.). Water Resources Research Centre, University of Massachusetts. Pp. 13 – 34.

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.

Harper, J. L. 1977. *Population Biology of Plants*. Academic Press, London, UK.

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.

Herkert, J.R. 1994. The effects of habitat fragmentation on Midwestern grassland bird communities. Ecological Applications 4:461-71.

Hey, D.L., and J.A. Wickencamp. 1996. "Effects of wetlands on modulating hydrologic regimes in nine Wisconsin watersheds." *The Wetlands Initiative*. Chicago, Illinois.

Hilts, S.G., and F.S. Cook. 1982. *Significant Natural Areas of Middlesex County*.

Hobbs, J. and D. McGrath. 1998. A Guide to Multifunctional Hedgerows in Western Oregon.

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.

Houlahan, J.E. and S.C. Findlay. 2003. "The effects of adjacent land use on wetland amphibian species richness and community composition." *Canadian Journal of Fisheries and Aquatic Sciences* 60(9):1078-1094.

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.

Howard, J. and M. Merrifield. 2010. "Mapping Groundwater Dependent Ecosystems in California. " *PLOS One*: 5(6): e11249.

Howe, H. F., and J. Smallwood. 1982. "Ecology of seed dispersal." *Annual Review of Ecology and Systematics* 13: 201–228.

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.

Igl, L.D., and D.H. Johnson. 1997. "Changes in breeding bird populations in North Dakota: 1967 to 1992-93." *Auk* 114: 74-92.

Jalava, J.V., P.J. Sorrill, J. Henson and K. Brodribb. 2000. "The Big Picture Project: Developing a natural heritage vision for Canada's southernmost ecological region." *Science and Management of Protected Areas Association (SAMPAA), Conference Proceedings*. 12 pp.

Johnson, D.H. 2001. "Habitat fragmentation effects on birds in grasslands and wetlands: A critique of our knowledge." *Great Plains Research* 11: 211- 231. Published by the Center for Great Plains Studies.

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.

Junk, W.J., P.B. Bayley and R.E. Sparks. 1989. "The flood pulse concept in river floodplain systems." Pp. 110-127. In: D.P. Dodge (ed.). Proceedings of the International Large River Symposium. *Can. Spec. Publ. Fish. Aquat*. Sci.106.

King, D.I., Degraaf, R.M., and C.R. Griffin. 2001. "Productivity of early-successional shrub land birds in clear cuts and group cuts in an eastern deciduous forest." *Journal of Wildlife Management* 65: 345 – 350.

King, D.I. and B.E. Byers. 2002. "An evaluation of power line rights-of-way as habitat for early-successional shrub land birds." *Wildlife Society Bulletin* 30: 868-874.

King, D.I., R.B. Chandler, J.M. Collins, W.R. Petersen, and T.E. Lautzenheiser. 2009. "Habitat use and nest success of scrubland birds in wildlife and silvicultural openings in western Massachusetts, U.S.A." *Forest Ecology and Management* 257:421 – 426.

Kohm, K.A., and J.F. Franklin (eds.). 1997. *Creating a Forestry for the 21st Century: The Science of Ecosystem Management*. Island Press, Washington, DC.

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.

Lederhouse, Robert C. 1982. "Territorial defense and lek behavior of the black swallowtail butterfly, *Papilio polyxenes*. " *Behavioral Ecology and Sociobiology* 10 (2): 109-118

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.

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.

Lindenmayer, D.B, J.F. Franklin. 2002. Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach (Island Press, Washington, DC).

Lomolino, M.V. and R. Channell. 1995. "Splendid Isolation: Patterns of Geographic Range Collapse in Endangered Mammals." *Journal of Mammalogy* 76:335-347.

Lovett, G.M., C.G. Jones, M.G. Turner, K.C. Weathers, J.F. Franklin. 2005. (In): *Ecosystem Function in Heterogeneous Landscapes*, (eds) Lovett, G.M., C.G. Jones, M.G. Turner, K.C. Weathers, (Springer, New York), pp 427–441.

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.

MacKay, H. 2006. "Protection and management of groundwater-dependent ecosystems: emerging challenges and potential approaches for policy and management." *Australian Journal of Botany*. 54: 231-237.

Manning, A.D., D.B. Lindenmayer, H.A. Nix. 2004. "Continua and Umwelt: Novel perspectives on viewing landscapes." *Oikos* 104:621–628.

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.

Middlesex County – see County of Middlesex

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.

Ministry of Municipal Affairs and Housing (MMAH). 2014. *Provincial Policy Statement.* 50p.

Ministry of Natural Resources (MNR). 2000a. *Identification and Confirmation Procedure for Areas of Natural and Scientific Interest*. Parks and Protected Areas Policy. Procedure PAM 2.08

Ministry of Natural Resources (MNR). 2000b. *Significant Wildlife Habitat Technical Guide.* 151p.

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

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

Ministry of Natural Resources (MNR). 2012. *Significant Wildlife Habitat Ecoregional Criteria Schedules.* EBR # 011-5740

Ministry of Natural Resources (MNR). 2013. *Ontario Wetland Evaluation System Southern Manual Covering Hills Site Regions 6 and 7*. 4th ed.

MNR http://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_ghd_est_mdwlrk_en.pdf

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.

Moudrak, N., Hutter, A.M., Feltmate, B. 2017. "When the Big Storms Hit: The Role of Wetlands to Limit Urban and Rural Flood Damage." Prepared for the Ontario Ministry of Natural Resources and Forestry. Intact Centre on Climate Adaptation, University of Waterloo.

Naiman, R.J., H. Dé camps, and M.Pollock. 1993. "The role of riparian corridors in maintaining regional biodiversity." *Ecological Applications* 3:209-212.

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.

Oehler, J.D., D.F. Covell, S. Capel, and B. Long (eds.). 2006. *Managing Grasslands, Shrublands and Young Forest Habitats for Wildlife: A Guide for the Northeast*. The Northeast Upland Habitat Technical Committee and the Massachusetts Division of Fisheries and Wildlife.

Ochterski, J. 2006a. *Transforming Fields into Grassland Bird Habitat*. Cornell Cooperative Extension of Schuyler County, NY. SCNY Agriculture Team Natural Resources.

Ochterski, J. 2006b. *Hayfield Management and Grassland Bird Conservation*. Cornell Cooperative Extension of Shuyler County, NY. 8 p.

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

Oxford County – see County of Oxford

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.

Peterson, E.B. and N.M. Peterson. 1991. *A First Approximation of Principles and Criteria to make Canada's Protected Areas System representative of the Nation's Ecological Diversity*. Western Ecological Services Ltd., Victoria, BC. Report for the Canadian Council on Ecological Areas. 47pp. + app.

Prugh, L.R., K.E. Hodges, R.E. Sinclair, J.S. Brashares. 2008. "Effect of habitat area and isolation on fragmented animal populations." *Proc Natl Acad Sci USA* 105:20770–20775.

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*. MNR, 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.

Rodewald, A.D. 2003. "The importance of land uses within the landscape matrix." *Wildlife Society Bulletin* 31 (2): 586 – 592.

Rodewald, A.D. & A.C. Vitz. 2005. "Edge- and area-sensitivity of shrub land birds." *The Journal of Wildlife Management* 69(2): 681-688.

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.

Schlossberg, S.R., and D.I. King. 2008. "Are shrub land birds edge specialists?" *Ecological Applications* 18:1325-1330.

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

Sisk, T.,N.M. Haddad, P.R. Ehrlich. 1997. "Bird assemblages in patchy woodlands: Modeling the effects of edge and matrix habitats." *Ecol Appl* 7:1170–1180.

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.

Sutherland, G. D., A. S. Harestad, K. Price, and K. P. Lertzman. 2000. "Scaling of natal dispersal distances in terrestrial birds and mammals." *Conservation Ecology* 4(1): 16. [online] URL: http://www.consecol.org/vol4/iss1/art16/

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.

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.

Upper Thames River Conservation Authority (UTRCA). 2003. *The Middlesex Natural Heritage Study (MNHS): A Natural Heritage Study to Identify Significant Woodland Patches in Middlesex County*. 41pps. + Appendices.

UTRCA. 2012. Upper Thames River Watershed Report Cards.

USDA and Wildlife Habitat Council. 2000. *Butterflies (Order: Lepidoptera).* Fish & Wildlife Habitat management leaflet. No. 15. 12 pp.

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.

Wetzel, R.G. 2001. "Fundamental processes within natural and constructed wetland ecosystems: Short-term verses long-term objectives." *Water Science and Technology* Vol 44 (11-12): 1-8.

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.

Willson, M. F. 1993. "Dispersal mode, seed shadows, and colonization patterns." *Vegetation* 107/108: 261–280.

Winter, M., D.H. Johnson, J.A. Shaffer, T.M. Donovan, and W.D. Svedarsky. 2006. "Patch size and landscape effects on density and nesting success of grassland birds." *The Journal of Wildlife Management* 70(1): 158 – 172.

List of Acronyms

ANSI	Area of Natural and Scientific Interest
CA	Conservation Authority
CCCA	Catfish Creek Conservation Authority
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species At Risk in Ontario
DEM	Digital Elevation Model
DFO	Department of Fisheries and Oceans
EIS	Environmental Impact Study
ELC	Ecological Land Classification
EO	Element Occurrence
ESA	Environmentally Significant Areas
FEFLOW	Finite Element Subsurface FLOW System (software package for modeling fluid flow)
GDE	Groundwater Dependent Ecosystems
GIS	Geographic Information System
GRCA	Grand River Conservation Authority
HVA	Highly Vulnerable Aquifer
IRS	Indian Remote Sensing
ISI	Intrinsic Susceptibility Index
IUCN	International Union for Conservation of Nature
LPRCA	Longpoint Region Conservation Authority
MMU	Minimal Mapping Unit
MNHS	Middlesex Natural Heritage Study (2001 and 2012)
NHIC	Natural Heritage Information Centre
NHRM	Natural Heritage Reference Manual
NHS	Natural Heritage System
NRVIS	Natural Resource Value Information System
OBM	Ontario Base Mapping
OMAF	Ontario Ministry of Agriculture and Food
ONHS	Oxford Natural Heritage Study (2006)
MMAH	Ministry of Municipal Affairs and Housing
MNR	Ministry of Natural Resources
MNRF	Ministry of Natural Resources and Forestry
OWES	Ontario Wetland Evaluation System
PPS	Provincial Policy Statement
SAR	Species At Risk
SOLRIS	Southern Ontario Land Resource Information System
SWH	Significant Wildlife Habitat
SWHTG	Significant Wildlife Habitat Technical Guide
SWOOP	South West Ontario Ortho Photography
SWP	Source water Protection
USDA	United States Department of Agriculture
UTRCA	Upper Thames River Conservation Authority

Appendices

Appendix A-1. Ecological Land Classification (ELC) Code Descriptions

FOC – Coniferous Forest
FOD – Deciduous Forest
FOM – Mixed Forest
CUP – Cultural Plantation
TPW – Tallgrass Woodland
CUT – Cultural Thicket
CUW – Cultural Woodland
TPO – Open Tallgrass Prairie
CUM – Cultural Meadow
BBO – Open Beach / Bar
BBS – Shrub Beach / Bar
BBT – Treed Beach / Bar
BLO – Open Bluff
BLS – Shrub Bluff
BLT – Treed Bluff
CLO – Open Cliff
CLS – Shrub Cliff
CLT – Treed Cliff
TAO – Open Talus
TAS – Shrub Talus
TAT – Treed Talus
SWC – Coniferous Swamp
SWD – Deciduous Swamp
SWM – Mixed Swamp
SWT – Thicket Swamp
FET – Treed Fen
FES – Shrub Fen
BOT – Treed Bog
BOS – Shrub Bog
FEO – Open Fen
BOO – Open Bog
MAM – Meadow Marsh
MAS – Shallow Marsh
SAS – Submerged Shallow Aquatic
SAM – Mixed Shallow Aquatic
SAF – Floating-leaved Shallow Aquatic
OAO – Open Aquatic

Source: Lee *et al*, 1998. *Ecological Land Classification for Southern Ontario: First Approximation and Its Application.* SCSS Field Guide FG-02.

Appendix A-2. The similarities and differences between the ELC *Vegetation Community* Series and the PNHSS *Vegetation Groups*

ELC *Vegetation Community* Series		PNHSS 2018 *Vegetation Group*	
Code	**Definition**	***Veg. Group* (Ecosystem)**	**Definition**
SWC, SWD SWM	>25% tree or shrub cover; >20% standing water;	Woodland (Wetland)	>20% standing water; >25% tree or shrub
CUP	>60% tree cover; >20% standing water; ≥1 linear edge;		
FOC, FOD FOM	>60% Tree cover	Woodland (Terrestrial)	>60% Tree cover <20% standing water
CUP	>60% tree cover < 20% standing water; ≥1 linear edge		
TPW	35-60% tree cover	Thicket (Terrestrial)	25-60% tree/shrub cover; <20% standing water
CUT	<25% Tree cover; >25% shrub cover		
CUW, TPW	35-60% tree cover		
SWT	<25% tree cover; >25% hydrophytic shrub cover	Thicket (Wetland)	10-25% tree cover or <10% tree cover and >25% shrub cover; >20% standing water
FET	20-25% tree cover		
FES	<10% tree cover; >25% shrub cover		
BOT	10-25% tree cover		
BOS	<10% tree cover; >25% shrub cover		
TPO CUM	<25% tree cover; <25% shrub cover	Meadow (Terrestrial)	<10% tree cover and <25% shrub cover
FEO BOO	<10% tree cover; <25% shrub cover	Meadow (Wetland)	<10% tree cover and <25% shrub cover; located in wetland as defined in Section 2.2.2.1 below
MAM MAS	<25% tree cover; <25% shrub cover		
SAS, SAM SAF	No tree cover; >25% macrophytes		
OAO	No vegetation; open water	Water Feature (Aquatic)	No vegetation; open water
BBO, BBS BBT	<60% tree cover; along shorelines	Watercourse Bluff and Depositional Area (Terrestrial)	<60% tree cover; on naturally active sites such as shorelines, steep slopes and base of cliffs
BLO BLS BLT	<10% tree cover; on active or steep near vertical surfaces		
CLO, CLS CLT	<60% tree cover; on steep near vertical surfaces		
TAO, TAS TAT	<60% tree cover; on slopes of rock rubble at base of cliffs		

*Note: Connected *Vegetation Group* can be made up trees and shrubs

Appendix B. Wetland Layer Methodology and Sources

The wetland layer for Perth was derived from the following sources:

(1) Ministry of Natural Resources and Forestry (MNRF) Evaluated Wetlands

The Ontario Ministry of Natural Resources and Forestry evaluates wetlands based on the Ontario Wetland Evaluation System (OWES) Southern Manual (MNR 2013). Sites are evaluated in the field, mapped, and then scored based on field data, hydrology and use. Since evaluated wetlands have been mapped during site visits, they can be smaller than 0.5 ha and are retained as part of the natural heritage system.

In some cases, CA staff found the perimeter of the evaluated wetland did not match the natural heritage feature boundary on the latest orthoimagery and so boundary amendments were made. It should be noted that this may have resulted in extending or decreasing the wetland beyond the boundary approved under OWES at the time of the evaluation.

For policy decisions, the approved wetland boundary should be referenced. Recognizing that wetlands are dynamic, an Environmental Impact Study be completed to determine the accurate wetland boundary using the OWES (MNR 2013). The OWES uses an open file system where files can be amended as new information becomes available. MNRF is the approval authority on Significant Wetlands so any changes to the boundaries must be approved by the MNRF.

(2) Upper Thames River Unevaluated Wetlands

The Upper Thames River Conservation Authority (UTRCA) began identifying unevaluated wetlands in 2006 in an attempt to consolidate information and map the numerous wetlands that were not part of the evaluated wetland layer of MNR to better represent natural features in the watersheds. These wetland areas were identified for the generic regulations using the following desk-top procedure:

i. Wetland indicators:
   a. *Historic Forest Cover* -- historic forest cover information collected in the 1950s and 1960s by teams of foresters who examined every woodlot in the watershed and characterized dominant cover types. Identify areas associated with wetland species (e.g., Silver Maple, Black Ash, cedar, White Elm, and Tamarack).
   b. *Soils* -- organic and clay soils (wetland soils) using OMAF soils maps.
   c. *Elevation* -- areas in depressions or lower elevations using a Digital Elevation Model (DEM).
   d. *Groundwater* -- discharge areas as defined in the Six CA Groundwater Model Study, July 2008, and recharge areas as defined as Significant Groundwater Recharge Areas from the Thames-Sydenham and Region Source Protection Region, Upper Thames River Source Protection Area, Assessment Report, Approved, September 16, 2015.
   e. *Proximity* -- areas within 120 m of an MNRF evaluated wetland since 120 m is the distance at which adjacent lands may have an impact on a wetland.

ii. Overlay the indicators to determine possible wetland areas. The more indicators that overlap, the more likely there is a wetland in that area.

iii. Compare the areas delineated by overlaying the wetland indicators to an aerial photo interpretation of wetland areas where wetness is indicated by color (dark), texture (granular), and canopy cover (sparse or spotty). Areas that matched were identified as unevaluated wetlands.

Appendix B continued

(3) Maitland Valley Conservation Authority (CA) Unevaluated Wetlands

The Maitland Valley CA began identifying unevaluated 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 MNR 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, soil analysis, current drainage patterns and field site visits.

(4) Ausable Bayfield Conservation Authority (CA) Unevaluated Wetlands

The Ausable Bayfield CA developed a methodology for progressively updating their regulated wetland layer in 2006. Regulated unevaluated 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, cultivated field or other identified wetland
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 field 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 1986 OMNR Ontario Base Map series

Appendix B continued

(5) GRCA Unevaluated Wetlands (Metadata: Wetlands)

Abstract
This layer defines wetland boundaries within the Grand River watershed. Wetland boundaries were confirmed through detailed desktop review using orthoimagery and various other data, augmented by field verification in select areas. Wetlands documented in this layer are as defined in Section 25 of the Conservation Authorities Act:

a. seasonally or permanently covered by shallow water or has a water table close to or at its surface; directly contributes to the hydrologic function of a watershed through connection with a surface watercourse; has hydric soils, the formation of which has been caused by the presence of abundant water; and, has vegetation dominated by hydrophytic plants or water tolerant plants, the dominance of which has been favoured by the presence of abundant water, but does not include periodically soaked or wet land that is used for agricultural purposes and no longer exhibits a wetland characteristic referred to in clause (c) or (d)."
b. Wetland boundaries have been delineated based on research using a collection of resources including: previous GRCA digital wetland boundary locations; soils and drainage layers; Forest Resource Inventory digital data and map information; contour elevations; Ecological Land Classification (ELC) mapping; 2004 SPOT satellite imagery (where available); and interpretation of orthoimagery flown April 2000 and the year 2006.

In preparation for Ontario Regulation 150/06, this layer received a watershed wide update in 2005. All wetland boundaries were checked against the April 2000 orthoimagery. These updates were subject to inhouse, peer, and public review.

Colour orthoimagery flown in 2006 is currently used as the orthoimagery base against which updates are made, augmented by site visits as required. This layer will be used for regulation and planning purposes, conservation and restoration management, and for Natural Heritage planning.

Feature Type	Polygon
Location	SDE_GRCA
Feature Dataset N	ATURAL_HAZARDS
Geographic Extent	GRCA Watershed

WE_VERIFIED	Verification Type	Short Integer	Verification Type '1': Ortho 2000 '2': From Road '3': Field Work '4': Field Investigation '5': Surveyed '6': Not Verified '7': Ortho SPOT5 2004 '8': Ortho 2006 '9': Ortho 2010
WE_QUALIFIER	Qualifier Type	Short Integer	Qualifier Type '1': Connected '2': Isolated
WE_LASTEDIT	Last Edit	Date	Date of last modification
WE_MNR_RECONCILE	MNR Reconcile	Short Integer	MNR Reconcile Status '0': Not reconciled with NRVIS '1': Reconciled with NRVIS '2': Cannot be reconciled '3': Approved by MNR District
WE_COMMENT	Comments	Text	Notes on wetland feature
SHAPE		Short Integer	

Appendix B continued

GRCA
Update History (last 5)

Feb 04, 2016	System Update Data	January 2016 site specific updates
Jan 04, 2016	System Update Data	November and December 2015 site specific updates
Nov 12, 2015	System Update Data	October 2015 site specific updates
Sep 18, 2015	System Update Data	July, Aug, Sept 2015 site specific updates
Jul 13, 2015	System Update Data	June 2015 site specific updates

Contact Information

Contact	Supervisor of Natural Heritage, Grand River Conservation Authority

(http://gis.grandiver.ca/metadata/?ID=2476

Appendix C. Groundwater Dependent Wetlands and a possible procedure for landscape scale study

An index of ecosystem groundwater dependency can be developed for the watershed by mapping and overlaying the following three ecosystem types to determine areas of ecosystem groundwater dependency:

Springs and seeps. Survey the landscape in late fall (e.g., by plane) when there is fog to identify seeps. Map as point features. All springs are groundwater dependent regardless of location.

Groundwater dependent wetlands. Use the spatial layer of wetland *Vegetation Groups* developed in Section 2.2.2.1 as base layer. Since groundwater dependent wetlands are defined by hydric or partially hydric soils, the wetland *Vegetation Group* layer was intersected with a soils layer to remove all surface water dependent wetlands. Surficial geology can also be used to identify groundwater dependent wetlands as most are located on sand and gravel deposits.

Groundwater dependent streams. Survey the landscape in winter and summer to identify groundwater dependent streams.

Alternatively, as groundwater discharge areas are detected through site studies as part of the Ecological Site Assessment Process and recorded in the Environmental Impact Study (EIS), it is recommended that the appropriate Conservation Authority is notified and the location of discharge is mapped as significant.

Source: UTRCA Staff

Appendix D-1. Summary of Ecologically Important Criteria and Rationale, Criteria 1 to 5

#	***Vegetation Group* Criteria**	**Scientific Rationale**	**Application**
1	Any *Vegetation Group* within or touching a significant **valleyland**	Vegetation on valley lands prevents erosion, improve water holding capacity that ensures regeneration of vegetation, and encourages wildlife movement.	*Vegetation Group* on valley land defined using 3:1 slope or 100m from centerline of watercourse.
2	Any *Vegetation Group* located within or touching a **Life Science ANSI** (Area of Natural and Scientific Interest) (provincial and regional)	Recognized ANSIs are a logical foundation on which to design a natural heritage system.	Pre-determined by MNR using five evaluation selection criteria: representation, condition, diversity, other ecological considerations, and special features.
3	Any *Vegetation Group* located within 30 m of an **open watercourse**	Relationship between water course and vegetation is interactive whereby vegetation along watercourses improves water quality for aquatic Vegetation Ecosystems through reduction in soil erosion and input of nutrients; while the watercourse attracts animals and acts as a corridor.	All *Vegetation Groups* within 30 m from the edge of an open watercourse (defined as the bank-full width if greater than 20m wide, or a defined channel visible on the aerial photography if less than 20m wide).
4	All evaluated wetlands and any unevaluated **wetland** *Vegetation Group* ≥0.5 ha	Wetlands have disproportionately been removed from the landscape of southern Ontario. Some of their important functions are to maintain the hydrological regime of the surrounding area by dampening water peaks in the gullies, reduce the potential for erosion and provide critical breeding and overwintering habitat for reptiles and amphibians.	The wetland layer was derived from the MNRF evaluated wetland mapping layer, as well as the unevaluated wetland layers developed from each of the Conservation Authorities in Perth County (refer to Mapping Criteria Section 1.3).
5	Any **woodland *Vegetation Group* ≥ 1 ha**	Habitat size is one of the most important measures for sustaining stable, diverse and viable populations of wildlife species. In a highly fragmented landscape, the definition of a “large sized” woodland can be relatively small.	All woodland vegetation groups ≥ 1 ha meet this criterion.

Appendix D-2. Summary of Criteria and Rationale, Criteria 6 to 10

#	***Vegetation Group* Criteria**	**Scientific Rationale**	**Application**
6	Any Woodland *Vegetation Group* **within 100 m of a ≥ 1 ha Woodland** *Vegetation Group*	The < 100 m distance is based on average seed dispersal distances in the literature.	All woodland less than 1 ha within 100 m of a ≥ 1 ha woodland, regardless of what land use surrounds them, meet this criterion.
7	Any **Thicket *Vegetation Group* ≥ 2 ha in size**	Larger thickets are better if managing to enhance the long-term survival of a variety of wildlife. Large thickets >2 ha are relatively rare in Perth County, yet thickets of at least 10 ha in size are required for uncommon species (Oehler *et al.* 2006).	Thickets ≥ 2 ha meet this criterion. They are relatively rare in Perth County
8	Any **Meadow *Vegetation Group* ≥ 5 ha in size**	The amount of native 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. Johnson (2001) demonstrated a preference for large grassland *Vegetation Groups* by a number of grassland bird species, irrespective of territory size.	All meadows ≥ 5 ha meet this criterion.
9	Any **Meadow *Vegetation Group* within 100 m of a ≥1 ha Woodland or ≥2 ha Thicket** *Vegetation Group*	Meadow butterfly habitat must be considered in context with the surrounding range of habitats. Using the average distance of wind dispersed seeds as a conservative estimate, all meadows found within 100 m of a large shrub land or woodland were identified meeting this criterion.	All meadows within 100 m of a ≥1 ha woodland or ≥2 ha thicket meet this criterion.
10	**Any *Vegetation Patch* that contains a *Vegetation Group* identified as significant**	Criterion 10 is really a summary of Criteria 1 through 9.	All *Vegetation Patches* containing a *Vegetation Group* that has been identified as significant.

Appendix D-3. Summary of Criteria and Rationale, Criteria 11 to 15

#	***Vegetation Group*** **Criteria**	**Scientific Rationale**	**Application**
11	Any *Vegetation Patch* that contains a diversity of *Vegetation Communities*, Ecosystems or Groups	The number of *Vegetation Communities* in a *Vegetation Patch* is a measure of habitat and species diversity.	The *Vegetation Patch* was identified as significant if it either contained more than one Vegetation Ecosystem, or more than two *Vegetation Groups*, or more than three *Vegetation Communities*.
12	Any *Vegetation Patch* within 100 m of a significant *Vegetation Patch*	Local landscapes that include 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. The < 100 m distance is based on average seed dispersal distances in the literature.	All *Vegetation Patches* within 100m of a significant *Vegetation Patch*, regardless of what land use surrounds them, are identified.
13	Any *Vegetation Group* that contains **Significant Wildlife Habitat**	According to the PPS, wildlife habitat is considered significant where it is ecologically important in terms of features, functions, representation or amount. Suggested criteria for determining Significant Wildlife Habitat are provided by MNR in the Significant Wildlife Habitat Technical Guide (MNR 2000b), the Significant Wildlife Habitat Ecoregional Criteria Schedules (MNR 2012), and the Natural Heritage Reference Manual (MNR 2010).	Currently, SWH is not mapped at a county scale in Ontario. Identification of this habitat can occur through field studies conducted through EISs or other field studies/inventories, and then reported to the MNRF and local planning authority.
14	Any *Vegetation Group* that contains a **Groundwater Dependent Wetland (GDW)**	GDWs are ecosystems that require access to groundwater to maintain their communities of plants and animals, ecological processes and ecosystem services. Examples: seeps, fens	GDW of any size can be found and mapped through site inventories, studies and EISs. A possible procedure for a landscape scale study is found in Appendix C.
15	Any *Vegetation Group* that contains a **Watercourse Bluff or Deposition Area**	Steep slopes, areas of erosion and beaches (depositional areas) can create unique natural features for specialized assemblages of plants and animals.	Deposition Areas, Steep Slopes, Cliffs and Valley Bluffs identified through the EISs should be mapped and provided to the planning authority.

Appendix E. Summary of rationale for 19 criteria NOT used

Criteria	Rationale for Not Including	Use in Other Natural Heritage Studies*
1. Best representative *Vegetation Patch* on **landform physiography and soil type**	This is redundant as the Life Science ANSI uses this criterion, even though it is done at a different scale (i.e., by site district rather than by county).	ONHS 2006: largest patch on each landform and each soil type LCNHS 2013: largest patch on slope of 10% or greater and largest patch on each landform and each soil type COL 2006: patch contains either: - > 1 ecosite in 1 Community series OR - > 2 vegetation types OR - > 1 topographic feature OR - 1 vegetation type with inclusions/ complexes
2.Located on a **distinctive, unusual or high quality landform**	Definition of a distinctive, unusual or high quality landform is subjective.	COL 2006: patch located on either - Beach Ridge - Sand Plain - Till Plain - Till Moraine
3.All areas (both vegetated and **non-vegetated**) on: - **Valley lands** - **Gullies** - within 30 m of **limestone outcroppings**	The PNHSS will identify *Vegetation Patches* on Significant valleylands as ecologically important and recommend that other land uses on valley lands (e.g., agriculture, golf courses, etc.) be considered as special policy areas with limitations on further development to maintain valley land connectivity. Gullies not used because they require field level surveys to map; it is an important feature in Huron County by the Lake shoreline Limestone outcroppings are not mapped at this time.	ONHS 2006: patches on valley lands HCNHS 2013: patches on or < 100m from landform features - dunes, - shore bluffs, - gullies, - valley lands, - within 30m of limestone outcroppings
4.All *Vegetation Patches* found alongside a **coldwater watercourse or watercourse containing Brook Trout**	Definition of a watercourse, both cold and warm, includes an additional area immediately adjacent to the water (in proportion to the size of the watercourse feature) and therefore it is not necessary to include additional lands for protection (e.g., *Vegetation Patches* 30 m from edge) Non vegetated setbacks from watercourses can be restricted using other official plan and zoning plan policies. Questions remain: Is this sensitive information? How easy is it to determine coldwater streams? Are they already identified?	
5.Shape of *Vegetation Patch*	When shape metrics are used, often very small and round *Vegetation Patches* are selected over larger *Vegetation Patches*.	COL 2006: has perimeter to area ratio <3.0 m/m^2

Appendix E continued

Criteria	Rationale for Not Including	Use in Other Natural Heritage Studies*
6.Adjacent to a MNRF evaluated wetland or life science ANSI	This is redundant as other adjacency rules have these features incorporated into them.	MNHS 2003: woodland < 750m from recognized feature. ONHS 2006: < 150m of non-wetland feature
7.Contains an area identified in the local official plans e.g. **Local ESAs (**Hilts and Cook 1978).	The PNHSS uses modern landscape parameters. Verification that the old ESAs are being identified as locally important will occur.	ONHS 2006: Local OP designated habitats
8.Unique Intrinsic Characteristics (i.e., site level)	No field work or site visits are being conducted for this landscape study, so it is not possible to evaluate the intrinsic or site specific characteristics of *Vegetation Patches* at this fine scale.	LCNHS 2013: > 0.5 ha woodland with either - - unique species composition, - cover type, - age, and - structure. COL 2006: woodland with either – - mid to old age community, or - tree size > 50 cm DBH, or - > 16 m2/ha for trees >25 cm DBH, or - > 12 m2 / ha for trees > 10 cm DBH, or - All diameter class sizes represented or - community with MCC > 4.1, or - patch MCC > 3.9, or - > 1 community in good condition or - Community with SRANK > S4 or - > 1 northern / specialized habitat / tree / shrub species or - > 2 Carolinian tree / shrub species
9.Distance from development (e.g., permanent infrastructure and buildings) or matrix	Difficult to evaluate. Too complex for this study.	COL 2006: > 7% vegetation cover within 2 km radius from woodland centroid
10.Persistence or Threatened	A natural feature that persists through time is not necessarily more important or significant. However, it is interesting to compare 2006 to 2010 aerial photography to see what the trends are and why.	LCNHS 2013: > 0.5 ha woodland with high economic or social value
11.Porous or erodible soils	The aim of the PNHSS is to identify important biological natural heritage features, not to protect the ground water system.	MNHS 2003: woodland on porous soils COL 2006: patch on either- - 25% slope any soil - Remnant slope - >10% to <25% on clay, silty clay

Appendix E continued

Criteria	Rationale for Not Including	Use in Other Natural Heritage Studies*
12.*Vegetation Patch* contains **a large sized wetland** defined as: • Wooded wetlands > 4 ha based on Env. Canada • Wetland meadows and marshes > 10ha based on Env. Canada • Small wetland meadows and marshes adjacent to other *Vegetation Communities* may be vital to butterflies • Wetland thicket size determined by top 75th percentile distribution cutoff of all county wetland thicket sizes	The PNHSS has identified all wetlands ≥0.5 ha (MMU) as ecologically important, regardless of size or type.	HCNHS 2013: either - - 4 ha wooded wetland - 10ha wetland meadow or marsh - 2.5ha wetland shrubland COL 2006: woodland contains or contiguous to a wetland
13.*Vegetation Patch* contains a wetland that is **within 1,000m of another wetland;** distance based on S. Ont. Wetland Evaluation Manual where wetlands are scored based on their proximity to another wetland (Section 1.2.4) and receive points if they are within 1 km of another wetland. The 750m is for delineating wetland boundaries, not scoring wetlands.	PNHSS 2016 has identified all wetlands ≥0.5 ha (MMU) as ecologically important.	ONHS 2006: < 750 m from wetland HCNHS 2013: < 1000 m from wetland
14.*Vegetation Patch* contains a recently observed (post 1980) **Regionally Rare Plant**	Regional rarity was once tracked by MNR Aylmer but no longer. Data is difficult to find and confirm. Neither MNRF Aylmer nor NHIC have retained or digitized the historic data. Presently, no agency is responsible for ensuring the data is being updated and monitored for change in status	ONHS 2006: contains rare species COL 2006: Contains either: • Rare tree / shrub • Rare herbaceous • Regionally rare plant

Appendix E continued

Criteria	Rationale for Not Including	Use in Other Natural Heritage Studies*
15.*Vegetation Patch* contains **thicket with interior**	Although studies have shown that most shrub land birds avoid edges (Schlossberg and King 2008) and experience lower nesting success near edges (King et al. 2001, King and Byers 2003, King et al. 2009b), there is not a consistent definition of edge habitat. Rather, the size of a shrub land is used as a proxy measure of edge habitat.	
16.*Vegetation Patch* on an **Earth Science ANSI** that contributes to the presence of an uncommon *Vegetation Community*	Biodiversity planning requires an understanding of uncommon *Vegetation Communities* in terms of their distribution on significant/important areas. However, the presence of an ES ANSI does not mean there are unique *Vegetation Community* features that are resulting from the characteristics of the Earth Science ANSI. Soils have more of an influence on vegetation than deeper features. Uncommon Vegetation Communities are not usually identifiable from ortho-imagery. Field level analysis would be needed.	
17.Carolinian Canada **Big Picture Corridors**	Carolinian Canada's Big Picture has been accepted as a planning tool when no other landscape level studies were complete. Many of the rules used to identify Carolinian Corridors on the larger landscape (SW Ont) have been incorporated in the PNHSS criteria, but refined for the smaller County scale (e.g., valley land definition layer and proximity criteria). The Big Picture corridors incorporate areas that are <u>not</u> vegetated at present, as part of a restoration plan. The PNHSS captures only vegetated natural heritage patches, not farmland or other lands that could be restored or naturalized. Picking corridors at a larger scale is somewhat arbitrary. It is proposed that more current science and mapping be used to delineate corridors. Recommend as a followup step to the PNHSS or deal with it when there is a landuse change.	<u>MNHS 2003</u>: woodland within recognized corridor <u>COL 2006</u>: woodlands connected by either – - Watercourses - Gaps < 40m - Recognized corridors - Abandoned rail and utility lines - Open space greenways and golf courses - Active agriculture or pasture
18.Interior woodland habitat that is ≥ **0.5 ha in size** of continuous habitat	No patches were picked up with this criteria that were not already picked up by other criteria, therefore redundant. This criteria was used in the past when the woodland size cutoff of ≥ 10 ha (i.e., woodlands 4-10 ha that had interior were picked up).	<u>MNHS 2003</u>: has interior >100 m from edge <u>ONHS 2006</u>: has interior >100 m from edge <u>HCNHS 2013</u>: has interior > 0.5 ha that is > 100 m from edge <u>LCNHS 2013</u>: has interior >100 m from edge <u>COL 2006:</u> : has interior >100 m from edge

Appendix E continued

Criteria	Rationale for Not Including	Use in Other Natural Heritage Studies*
19.Species at Risk	• Includes plants, *Vegetation Communities*, birds, mammals, herptofaunal (frogs, toads, salamanders, turtles and snakes). Rare or uncommon species can be indicators of unusual and rare habitat and are often used to guide conservation strategies (Lesica and Allendorf 1995, Lomolino and Channell 1995). • Table 3-4 in the Natural Heritage Reference Manual (MNR, 2010) recognizes species rarity as an ecological function, and habitats that contain rare species are more valuable. MNR recommends that this be restricted to END and THR. • SAR have their own legislation for protection and an EIS needs to consider their presence This is not a criterion for the following reasons: - This is a landscape study rather than an intrinsic characteristics study and there is not a complete inventory - The absence of a species does not mean that suitable habitat or conditions are not present - Areas with END or THR species are already protected in the SAR Act while IUCN S1 – S3 are considered under SWH - Mapping limitations of the past limit accuracy in identifying locations. New species are added to the SAR over time. • These areas are not mapped currently but it is recommended that they be mapped as they are identified through site studies on the landscape and reported to the MNR and the appropriate Conservation Authority.	

Natural Heritage Studies Referenced above

COL – City of London (City of London, 2006)
- evaluation of woodlands, cutoffs based on medium to high rankings

HCNHS – Huron County Natural Heritage Study (County of Huron, 2013 Draft)
- based on more complete natural heritage system mapping and no field work

LCHNS – Lambton County Natural Heritage Study (County of Lambton *et al*., 2012 Draft)
- based only on woodlands and field work

MNHS – Middlesex Natural Heritage Study (UTRCA, 2003)
- based only on woodlands and field work

ONHS – Oxford Natural Heritage Study (County of Oxford, 2006)
- based on woodlands, floodplain meadows, watercourses and dated fieldwork

Perth – Perth County Official Plan Amendment #47 (County of Perth Official Plan. 2008. Section 11.5.5)
- regarding minimal woodland size

Appendix F. Metadata: Patch and Group Criteria Mapping and Field Description

The following Information describes the feature classes (layers) and fields that are associated with the criteria section of the report. The feature classes are being delivered in a file geodatabase format (name).

Naming Convention

A naming convention is being followed that should make data easy to understand and follow.

Table 1 describes short forms used for Groups:

Group Type	Short Form
Woodland	WDL
Meadow	MDW
Thicket	THK
Wetland	WTL
Connecting Features	CNF
Waterbody	WBY

Table 2 describes short forms used for Patches:

Patch	Short Form
Patch	PTC

Table 3 describes how the levels of information are defined:

Level of Detail	Detail
Field provides criteria of the individual group	CR
Field provides supporting information that may be important to the group	INF

Populated Data and Field Structure

Field names are generally named in the following manner "Short Form"_"Detail"_Description (e.g. Woodland_Criteria_Greater Than 4ha is WDL_CR_GT4ha)

Group, Patch and Information fields are *short integers* fields and are populated with 1 or 0, where 0=Not applicable, 1=Applicable (see table below)

"Short Form"_"CR"_Total are short integers fields that indicate the total number of criteria met within the individual group

Appendix F continued.

Table 4 provides field descriptions and field names within each group and patch feature class. It also provides information of what values are populated.

Feature Name and Field Description	Field Name	Value
Group_Woodland_Cluster		
Within valley land	WDL_CR_Valleyland	0= Not applicable, 1=Applicable
With Life Science ANSI	WDL_CR_ANSI	0= Not applicable, 1=Applicable
Group within 30m of Watercourse	WDL_CR_Watercourse	0= Not applicable, 1=Applicable
Any Woodland or Woodland Cluster >1ha	WDL_CR_GT1ha	0= Not applicable, 1=Applicable
Any Woodland within 100m of a Woodland Cluster> 1ha	WDL_CR_100m_GT1ha	0= Not applicable, 1=Applicable
Number of Significant Woodland Criteria Met	WDL_CR_Total	0 = Not applicable >0=Applicable
Wetland within Woodland	WDL_INF_Wetland	0= Not applicable, 1=Applicable
Individual Woodland or Woodland within Cluster has Interior	WDL_INF_Interior	0= Not applicable, 1=Applicable
Group_Meadow_Cluster		
Within valley land	MDW_CR_Valleyland	0= Not applicable, 1=Applicable
With Life Science ANSI	MDW_CR_ANSI	0= Not applicable, 1=Applicable
Group within 30m of Watercourse	MDW_CR_Watercourse	0= Not applicable, 1=Applicable
Any Meadow or Meadow Cluster >5ha	MDW_CR_5ha	0= Not applicable, 1=Applicable
Any Meadow within 100m of a 1ha Woodland or 2ha Thicket	MDW_CR_Proximity	0= Not applicable, 1=Applicable
Number of Meadow Significant Criteria Met	MDW_CR_Total	0 = Not applicable >0=Applicable
Wetland within Meadow	WDW_INF_Wetland	0= Not applicable, 1=Applicable
Any Meadow or Meadow Cluster >10ha	MDW_INF_10ha	0-Not applicable, 1=Applicable
Group_Thicket_Cluster		
Within valley land	THK_CR_Valleyland	0= Not applicable, 1=Applicable
With Life Science ANSI	THK_CR_ANSI	0= Not applicable, 1=Applicable
Group within 30m of Watercourse	THK_CR_Watercourse	0= Not applicable, 1=Applicable
Any Thicket or Thicket Group >2ha	THK_CR_GT2 ha	0= Not applicable, 1=Applicable
Number of Significant Thicket Criteria Met	THK_CR_Total	0 = Not applicable >0=Applicable
Wetland within Thicket	THK_INF_Wetland	0= Not applicable, 1=Applicable

Group_Wetland		
Within valley land	WTL_CR_Valleyland	0= Not applicable, 1=Applicable
With Life Science ANSI	WTL_CR_ANSI	0= Not applicable, 1=Applicable
Group within 30m of Watercourse	WTL_CR_Watercourse	0= Not applicable, 1=Applicable
Any wetland >0.5 ha or Provincial Evaluated Wetland	WTL_CR_Wetland	0 = Not applicable >0=Applicable
Number of Significant Wetland Criteria Met	WTL_CR_Total	>0=Applicable
Group_Connected_Feature		
Within valley land	CNF_CR_Valleyland	0= Not applicable, 1=Applicable
With Life Science ANSI	CNF_CR_ANSI	0= Not applicable, 1=Applicable
Group within 30m of Watercourse	CNF_CR_Watercourse	0= Not applicable, 1=Applicable
Number of Connecting Features Significant Criteria Met	CNF_CR_Total	0 = Not applicable >0=Applicable
Wetland within Connecting Feature	CNF_INF_Wetland	0= Not applicable, 1=Applicable
Group_Waterbody		
Within valley land	WBY_CR_Valleyland	0= Not applicable, 1=Applicable
With Life Science ANSI	WBY_CR_ANSI	0= Not applicable, 1=Applicable
Group within 30m of Watercourse	WBY_CR_Watercourse	0= Not applicable, 1=Applicable
Number of Waterbody Significant Criteria Met	WBY_CR_Total	0 = Not applicable >0=Applicable
Perth_NHSS_Patch_Cluster_2010		
Patch contains at least one group significant from field list below (see field descriptions below in Patch Information) MDW_CR_Significant- patch meets a criteria THK_CR_Significant - patch meets a criteria WDL_CR_Significant- patch meets a criteria WTL_CR_Significant- patch meets a criteria CNF_CR_Significant- patch meets a criteria WBY_ CR_Significant- patch meets a criteria	PTC_CR_Group	0= Not applicable, 1=Applicable
Vegetation Communities I) Patch contains more than one vegetation ecosystem, or ii) Patch contains more than two vegetation groups, or iii) Patch contains more than three vegetation communities	PTC_CR_Diversity	0= Not applicable, 1=Applicable
Patch within 100m of a large vegetation Group i) Any Woodland or Woodland Cluster> 1ha ii) Any Thicket >2ha iii) Any Meadow >5ha	PTC_CR_Proximity	0= Not applicable, 1=Applicable
Number of Patch Criteria Met	PTC_CR_Total	0= Not applicable, >0=Applicable

Patch Information		
Patch contains a Woodland Group criteria	WDL_CR_Signficant	0= Not applicable, 1=applicable
Patch contains a Meadow Group criteria	MDW_CR_Signficant	0= Not applicable, 1=applicable
Patch contains a Thicket Group criteria	THK_CR_Signficant	0= Not applicable, 1=applicable
Patch contains a Wetland Group criteria	WTL_CR_Signficant	0= Not applicable, 1=applicable
Patch contains a Connecting Feature Group criteria	CNF_CR_Signficant	0= Not applicable, 1=applicable
Patch contains a Waterbody Group criteria	WBY_CR_Signficant	0= Not applicable, 1=applicable
Number of Group Criteria in total each Patch meets	PTC_Group_CR_Totals	0 -10

Appendix G. Metadata for Vegetation Communities and Vegetation Groups

The following information describes the feature classes (layers) and field names within the Study data.

Naming Convention

Table 1 describes short forms used for Groups:

Group Type	Short Form
Woodland	WDL
Meadow	MDW
Thicket	THK
Wetland	WTL
Connecting Features	CNF
Waterbody	WBY

Table 2 describes short forms used for Patch:

Patch	Short Form
Patch	PTC

Table 3 describes how the level of information is defined:

Level of Detail	Detail
Field provides criteria of the individual group	CR
Field provides supporting information that may be important to the group	INF

Perth_NHSS_Community_2010

The community feature class consists of all community features that allow them to be dissolved into individual Groups or create the overall Patch Feature Class. Zero in the field indicates that it is not applicable to the community or group/patch type and 1 indicates that it is applicable (i.e., 0=Not Applicable, 1=Applicable). Visible Bluff or Deposition areas have been mapped but not all features can be defined so they have not been mapped as a group.

Field Name	Type	Parameters
NH_Community_ Type	Text	Bluff or Deposition, Coniferous, Deciduous, Connected Vegetation Feature, Meadow Marsh, Meadow Upland, Mixed, Plantation Mature, Plantation Young, Thicket, Water Body, Watercourse
NH_Woodland	Short	0, 1
NH_Wetland	Short	0, 1
NH_Meadow	Short	0, 1
NH_Shrub	Short	0, 1
Patch	Short	0, 1
NH_Riparian	Short	0, 1
NH_Water	Short	0, 1
NH_Connecting_ Features	Short	0, 1
Vegetation_Group	Text	Bluff or Deposition Area, Connected Vegetation Feature, Meadow, Meadow and Wetland*, Thicket, Thicket and Wetland*, Water, Water and Wetland*, Woodland, Woodland and Wetland* [* included in both groups]

<table>
<tr><td>Vegetation_ Ecosystem</td><td>Text</td><td>Aquatic, Wetland, Terrestrial Upland</td></tr>
<tr><td>WTL_Defined_By</td><td>Text</td><td>GRCA- wetlands supplied by Grand River Conservation Authority
ABCA- wetland supplied by Ausable Bayfield Conservation Authority
UTRCA – wetlands supplied by Upper Thames River Conservation Authority
MVCA – wetlands supplied by Maitland Valley Conservation Authority
UTRCA for MVCA – Created by UTRCA for MVCA
HC – Huron County
MNR-2015 – created Ministry of Natural Resources and Forestry Evaluated Wetlands and possibly edited by UTRCA
MNR-2015 Unevaluated - Ministry of Natural Resources and Forestry unevaluated Wetlands and possibly edited by UTRCA</td></tr>
<tr><td>ELC_CODE</td><td>Text</td><td>Bluff or Deposition Area (BBO),
Connecting Vegetation Feature (NA),
Meadow (CUM),
Meadow and Wetland (MAM),
Thicket and Plantation Young(CUT),
Thicket and Wetland, Plantation Young and Wetland (SWT),
Water (OAO),
<table>
<tr><td>Woodland</td><td>Conifer (FOC),
Deciduous (FOD),
Mixed (FOM),
Mature Plantation (CUP)</td></tr>
<tr><td>Woodland and Wetland</td><td>Conifer Swamp (SWC),
Deciduous Swamp (SWD),
Mixed Swamp (SWM).
Plantation Swamp (CUT)</td></tr>
</table>
</td></tr>
</table>

Group Woodland

This feature class was created by exporting woodlands from the Perth_NHSS_Community_2010 feature class. Using values equal to one in the NH_Woodland field, data was exported to a new feature class and all communities were dissolved using the NH_Woodlands field equal to one to create a seamless polygon woodlands feature class. The woodlands less than 0.5 ha were then deleted using the Shape Area Field to create the Group_Woodland feature class. This feature class was then used to establish the Woodland Cluster Feature Class (see below) and perform the interior forest calculation.

Group_Woodland_Cluster

This feature class was created from the Group_Woodland_02_21_2014 Feature Class. The values in the WDL_Cluster_ID field were merged to create multipart features which act as a single woodland polygon.

This feature class supports the criteria information for the woodland group.

Zero in the field indicates that it is not applicable to criteria or information and 1 indicates that it is applicable (i.e., 0=Not Applicable, 1=Applicable).

Field Name	Type	Parameters
WDL_Cluster_ID	Short	Unique Value, values over 7000 have been clustered
WDL_CR_Valleyland	Short	0, 1
WDL_CR_ANSI	Short	0, 1
WDL_CR_Watercourse	Short	0, 1
WDL_CR_GT_1ha	Short	0, 1
WDL_CR_GT_1ha_100m	Short	0, 1
WDL_INF_Wetland	Short	0, 1
WDL_INF_Interior	Short	0, 1
WDL_CR_Total	Short	0 to 5

Group Meadow

This feature class was created by exporting meadows from the Perth_NHSS_Community_2010 feature class. Using values equal to one in the NH_Meadow field, data was exported to a new feature class and all communities were dissolved using the NH_Meadow field equal to one to create a seamless polygon meadow feature class. The Meadows less than 0.5 ha were then deleted using the Shape Area Field to create the Group_Meadow Feature Class. This feature class was then used to establish the Meadow Cluster Feature Class (see below).

Group_Meadow_Cluster

This feature class was created from the Group_Meadow feature class. The values in the MDW_Cluster_ID field were merged to create multipart features which act as a single meadow polygon.

This feature class supports the criteria information for the meadow group.

Zero in the field indicates that it is not applicable to criteria or information and 1 indicates that it is applicable (i.e., 0=Not Applicable, 1=Applicable).

Field Name	Type	Parameters
MDW_Cluster	Short	Unique Value, values over 7000 have been clustered
MDW_CR_Valleyland	Short	0, 1
MDW_CR_ANSI	Short	0, 1
MDW_CR_Watercourse	Short	0, 1
MDW_CR_GT_5ha	Short	0, 1
MDW_CR_Proximity	Short	0, 1
MDW_INF_Wetland	Short	0, 1
MDW_CR_Total	Short	0 - 5

Group Thicket

This feature class was created by exporting Thickets from the Perth_NHSS_Community_2010 feature class. Using values equal to one in the NH_Thicket field, data was exported to a new feature class and all communities were dissolved using the NH_Thicket field equal to one to create a seamless polygon Thicket Feature Class. The Thickets less than 0.5 ha were then deleted using the Shape Area Field to create the Group_Thicket Feature Class. This feature class was then used to establish the Group Thicket Cluster Feature Class (see below).

Group_Thicket_Cluster

This feature class was created from the Group_Thicket feature class. The values in the THK_Cluster_ID field were merged to create multipart features which act as a single Thicket polygon.

This feature class supports the criteria information for the Thicket group.

Zero in the field indicates that it is not applicable to criteria or information and 1 indicates that it is applicable (i.e., 0=Not Applicable, 1=Applicable).

Field Name	Type	Parameters
Unique_Cluster	Short	Unique Value, values over 7000 have been clustered
THK_CR_Valleyland	Short	0, 1
THK_CR_ANSI	Short	0, 1
THK_CR_Watercourse	Short	0, 1
THK_CR_GT_2ha	Short	0, 1
THK_INF_Wetland	Short	0, 1
THK_CR_Total	Short	0 - 5

Group Wetland_all

This feature class was created by exporting Wetlands from the Perth_NHSS_Community_2010 Feature Class. Using values equal to one in the NH_Wetland field, data was exported to a new feature class and all communities were dissolved using the Wetland field equal to one to create a seamless polygon Wetland feature class. All wetlands that were identified are included in this layer. The Wetland_Group field identifies wetlands that are used to be identified as significant (greater than 0.5 ha or evaluated), where zero in the field indicates that it is not applicable and 1 indicates that it is applicable.

Field Name	Type	Parameters
Group_Wetland	Short	0, 1

Appendix G continued

Group Wetland

This feature class was created from the Group Wetland_02_21_2014_all feature class. The values equal to 1 in the Group_Wetland field were selected and features were exported to a new layer Group Wetland.

This feature class supports the criteria information for the wetland group.

Zero in the field indicates that it is not applicable to criteria or information and 1 indicates that it is applicable.

Feature Class	Field Name	Type	Parameters
Group_Wetland	WTL_CR_Valleyland	Short	0, 1
	WTL_CR_ANSI	Short	0, 1
	WTL_CR_Watercourse	Short	0, 1
	WTL_CR_Wetland	Short	0, 1
	WTL_CR_Total	Short	1 to 4

Group Connected Vegetation Features all

This Feature Class was created by exporting Connected Vegetation Features from the Perth_NHSS_Community_2010 Feature Class. Using values equal to one in the NH_ Connected_Features field, data was exported to a new Feature Class and all communities were dissolved using the NH_Connecting_Features field equal to one to create a seamless polygon Group_Connected_Features, Feature Class.

Field Name	Type	Parameters
Connecting_Feature	Short	0, 1

Group Connected Vegetation Features

This feature class was created from the Group_Connected_Feature_all feature class. The values >0.5ha in shape field were exported to a new feature class.

This feature class supports the criteria information for the Connected Vegetation Feature group.

Zero in the field indicates that it is not applicable to criteria or information and 1 indicates that it is applicable.

Field Name	Type	Parameters
CNF_CR_Valleyland	Short	0, 1
CNF_CR_ANSI	Short	0, 1
CNF_CR_Watercourse	Short	0, 1
CNF_INF_Wetland	Short	0, 1
CNF_CR_Total	Short	0 - 3

Group_Waterbody_All

This feature class was created by exporting Group_Waterbody_All from the Perth_NHSS_Community_2010 Feature Class. Using values equal to one in the NH_Water field, data was exported to a new Feature Class and all communities were dissolved using the NH_Water field equal to one to create a seamless polygon Waterbody feature class.

Zero in the field indicates that it is not applicable to the Information being provided and 1 indicates that it is applicable.

Feature Class	Field Name	Type	Parameters
Group_Waterbody_All	NH_Water	Short	0, 1

Group _Waterbody

This feature class was created from the Group_Waterbody_all feature class. The values in the >0.5ha in shape field were exported to a new feature class.

This feature class supports the criteria information for the Waterbody group. Zero in the field indicates that it is not applicable to criteria or information and 1 indicates that it is applicable.

Field Name	Type	Parameters
WBY_CR_Valleyland	Short	0, 1
WBY_CR_ANSI	Short	0, 1
WBY_CR_Watercourse	Short	0, 1
WBY_CR_Total	Short	0 to 3

PNHSS_Valley_2010

Valley Land data was created according to the description in this report. This layer represents the major valley areas within the County.

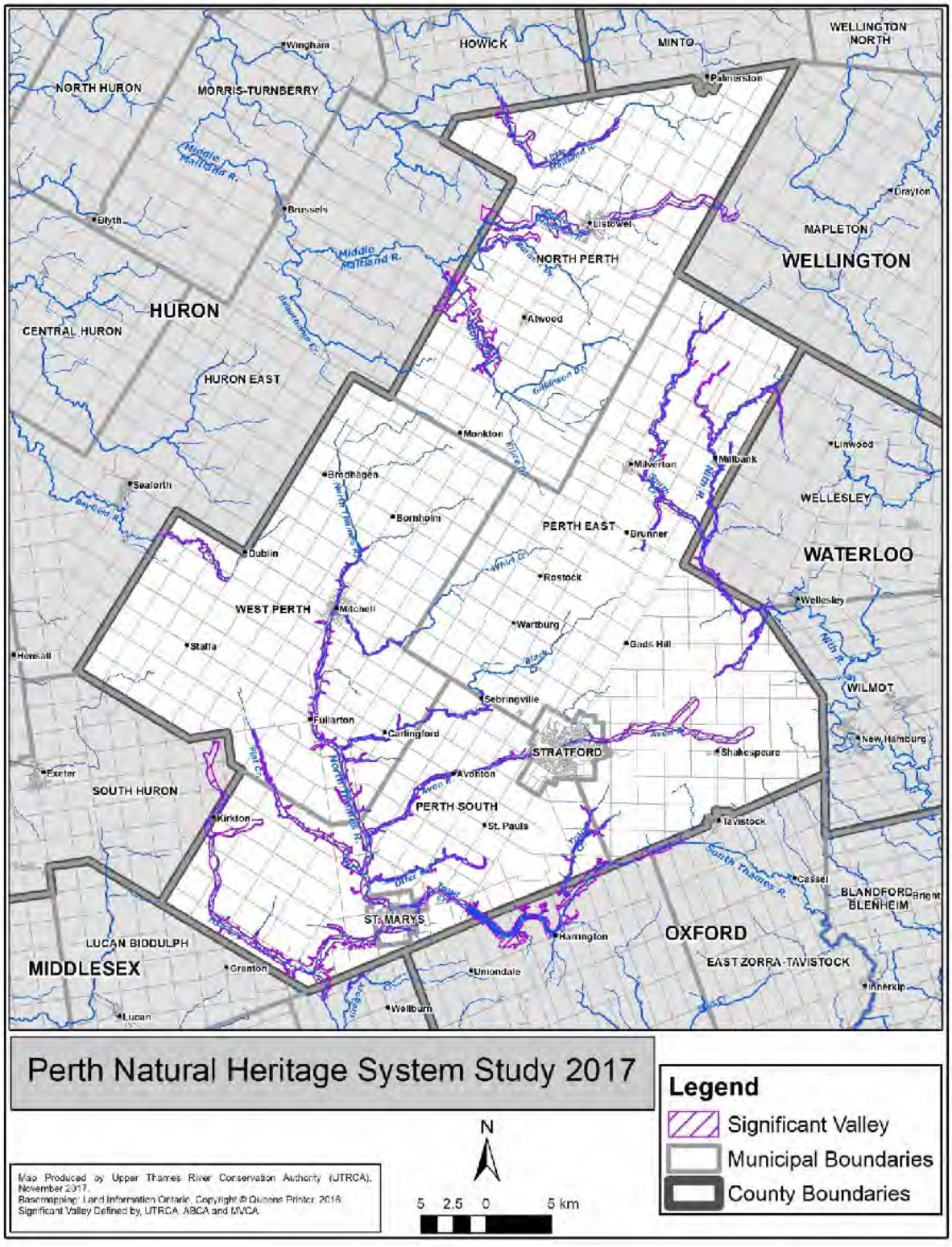
Field Name	Type	Parameters
CA	Text	GRCA, ABCA, MVCA, UTRCA

PC_Patch_2010 (Perth County Patch 2010)

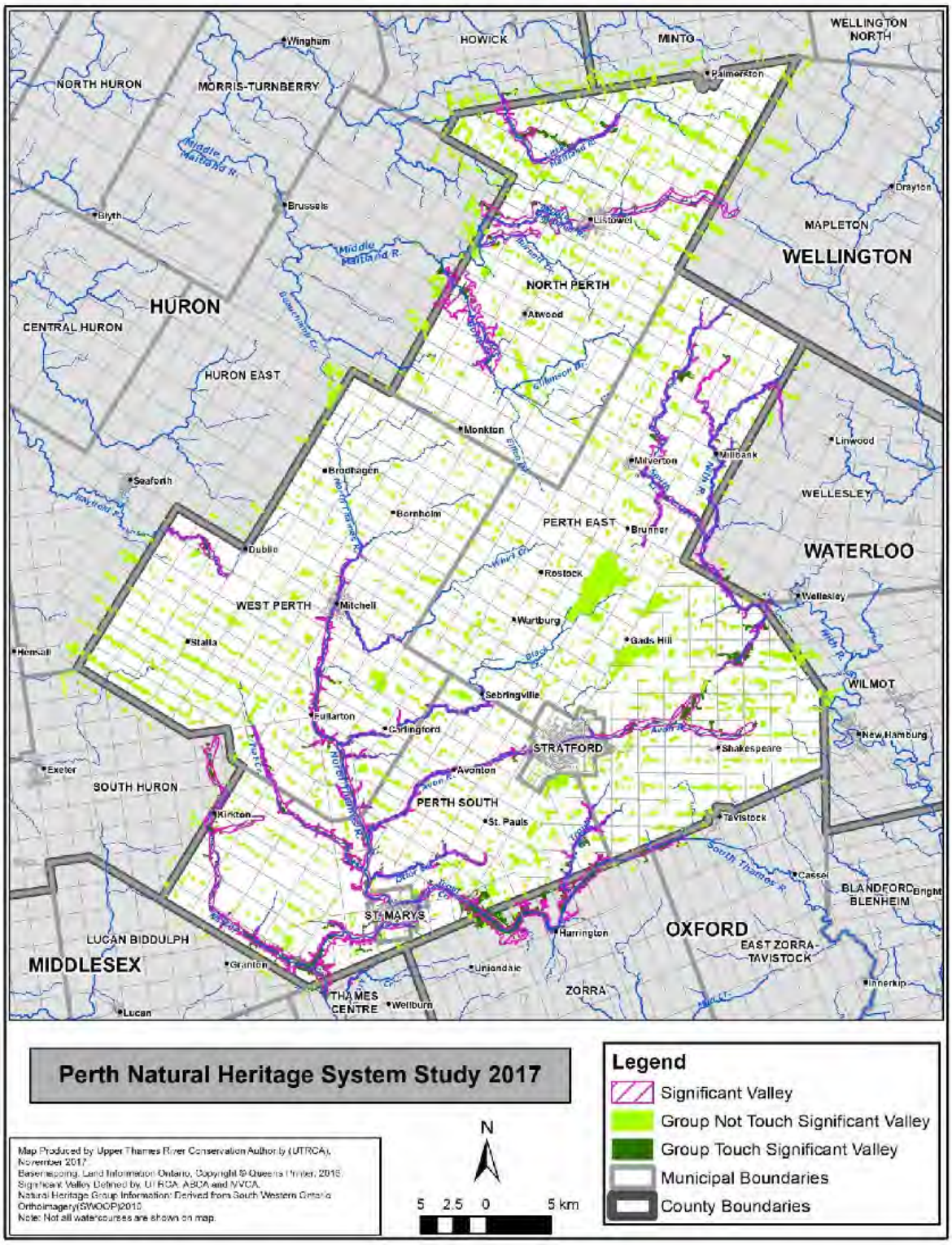
PC_Patch_2010 feature class was created from Perth_NHSS_Community_2010 Feature Class. All communities were dissolved using the Patch Field that is equal to 1.

Field Name	Type	Parameters
Cluster ID	Short	Unique Value, values over 7000 have been clustered
WDL_Cr_Significant	Short	0, 1
MDW_Cr_Significant	Short	0, 1
THK_Cr_Significant	Short	0, 1
WTL_Cr_Significant	Short	0, 1
WBY_CR_Significant	Short	0, 1
CNF_Cr_Significant	Short	0, 1
PTC_CR_Group	Short	0, 1
PTC_CR_Diversity	Short	0, 1
PTC_CR_Proximity	Short	0 ,1
PTC_CR_Total	Short	0, 1, 2
DIV_Community_Total	Short	0 to 15
DIV_Community_Total	Short	0 to 6
DIV_Ecosystem	Short	0 to 3
PTC_INF_GT_100ha	Short	0, 1
PTC_Group_CR_Total	Short	0 to 10

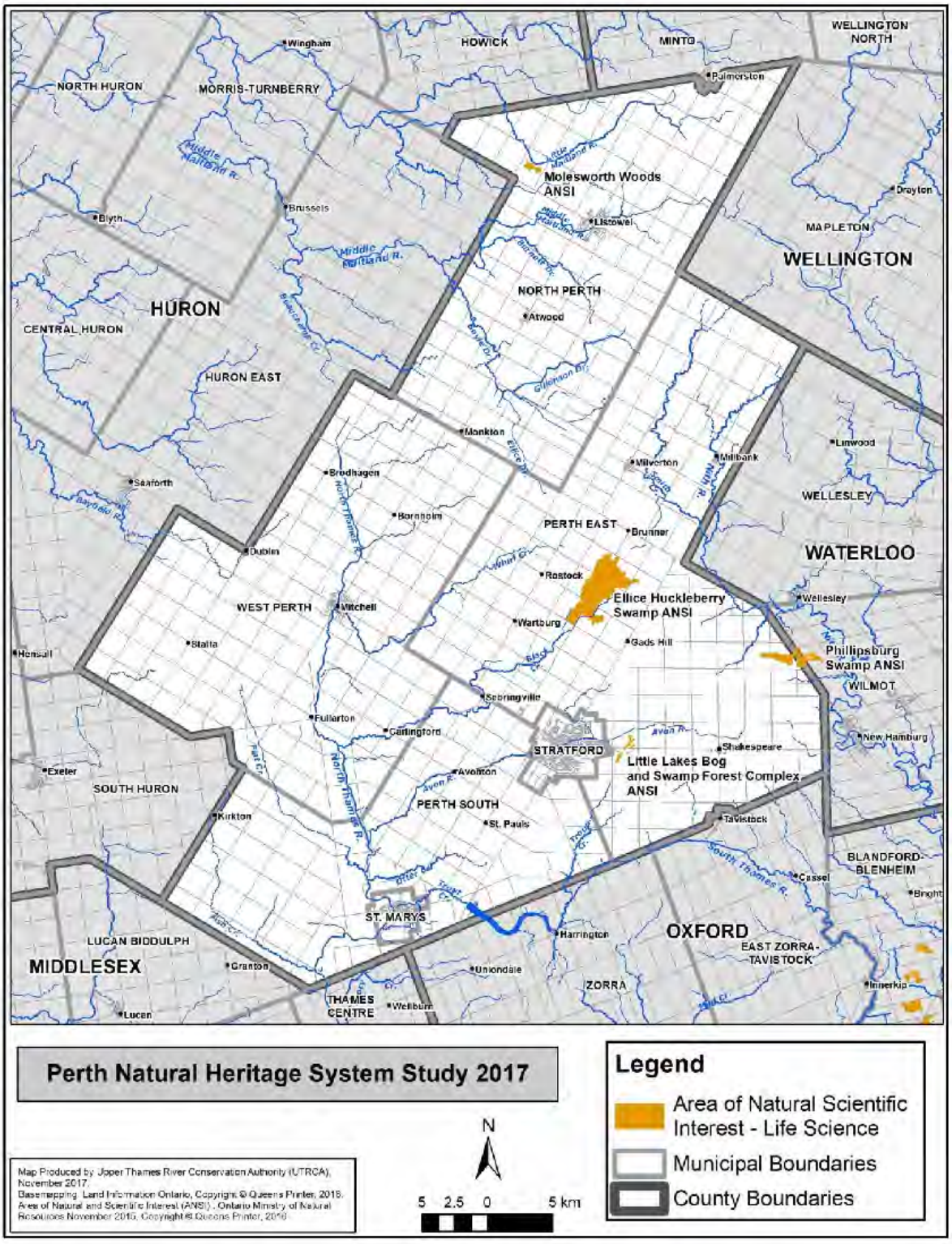
Appendix H-1. Criterion 1 Map, Significant Valleylands



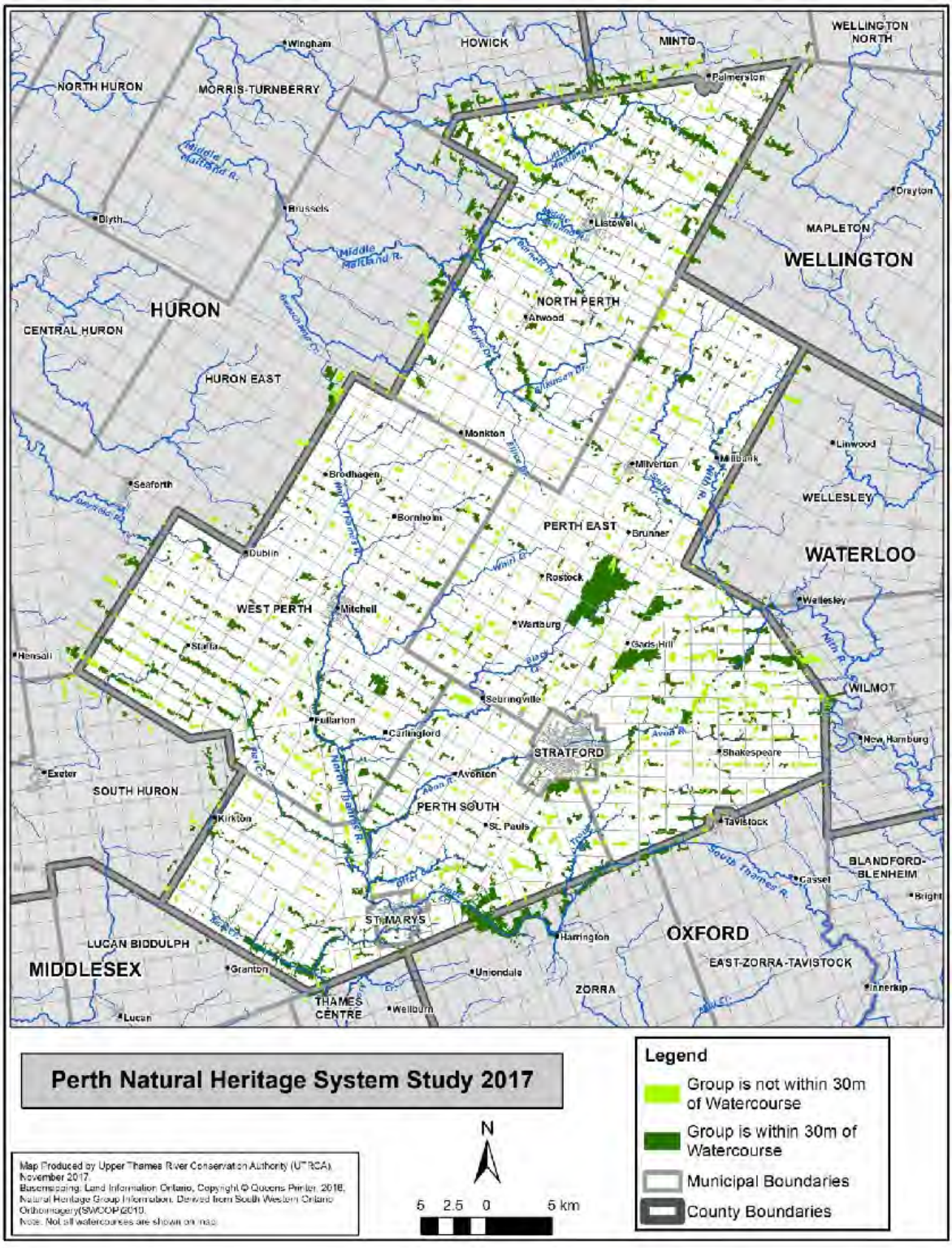
Appendix H-1-1. Criterion 1 Map, Vegetation Group within or touching a Significant Valleyland



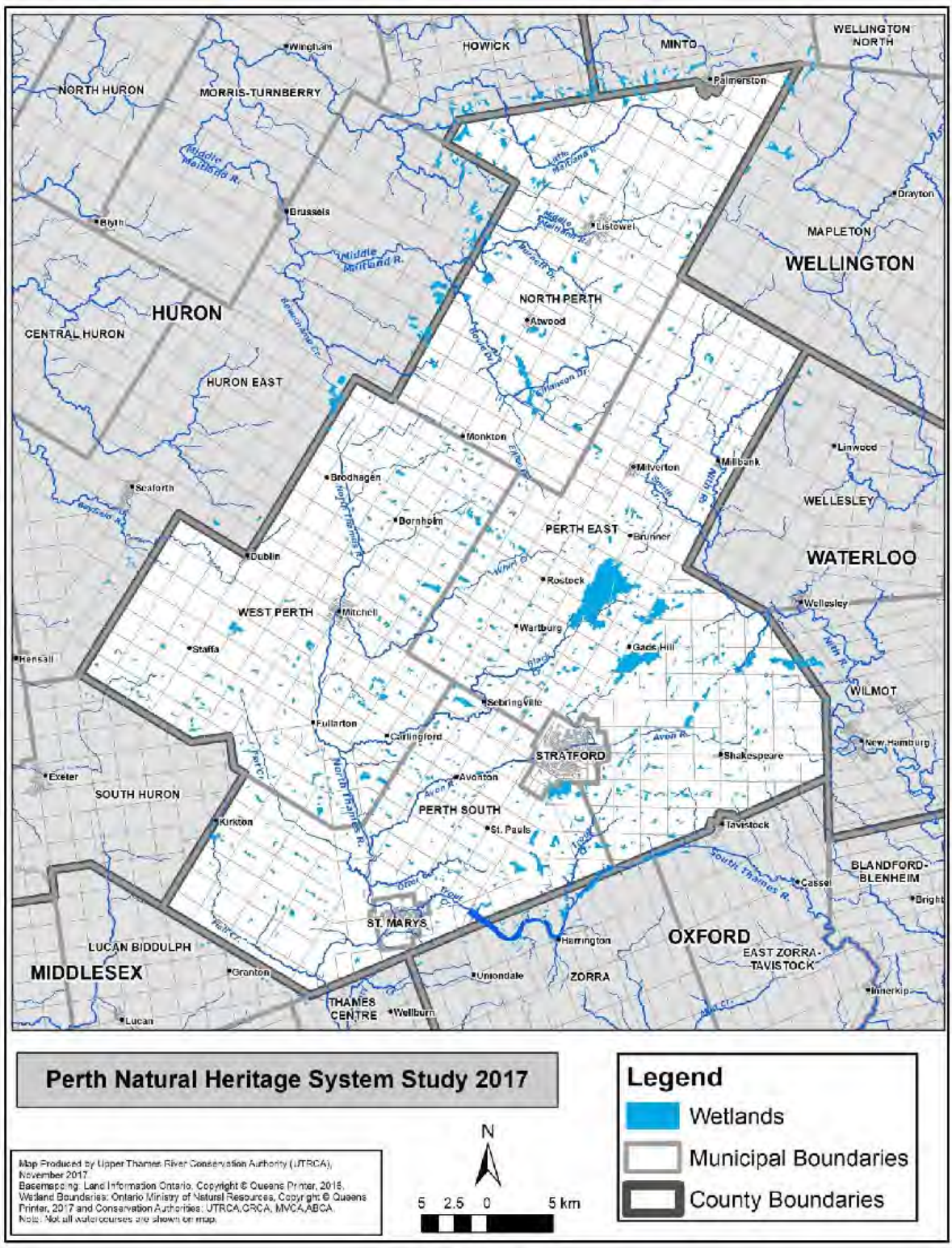
Appendix H-2. Criterion 2 Map, ANSIs



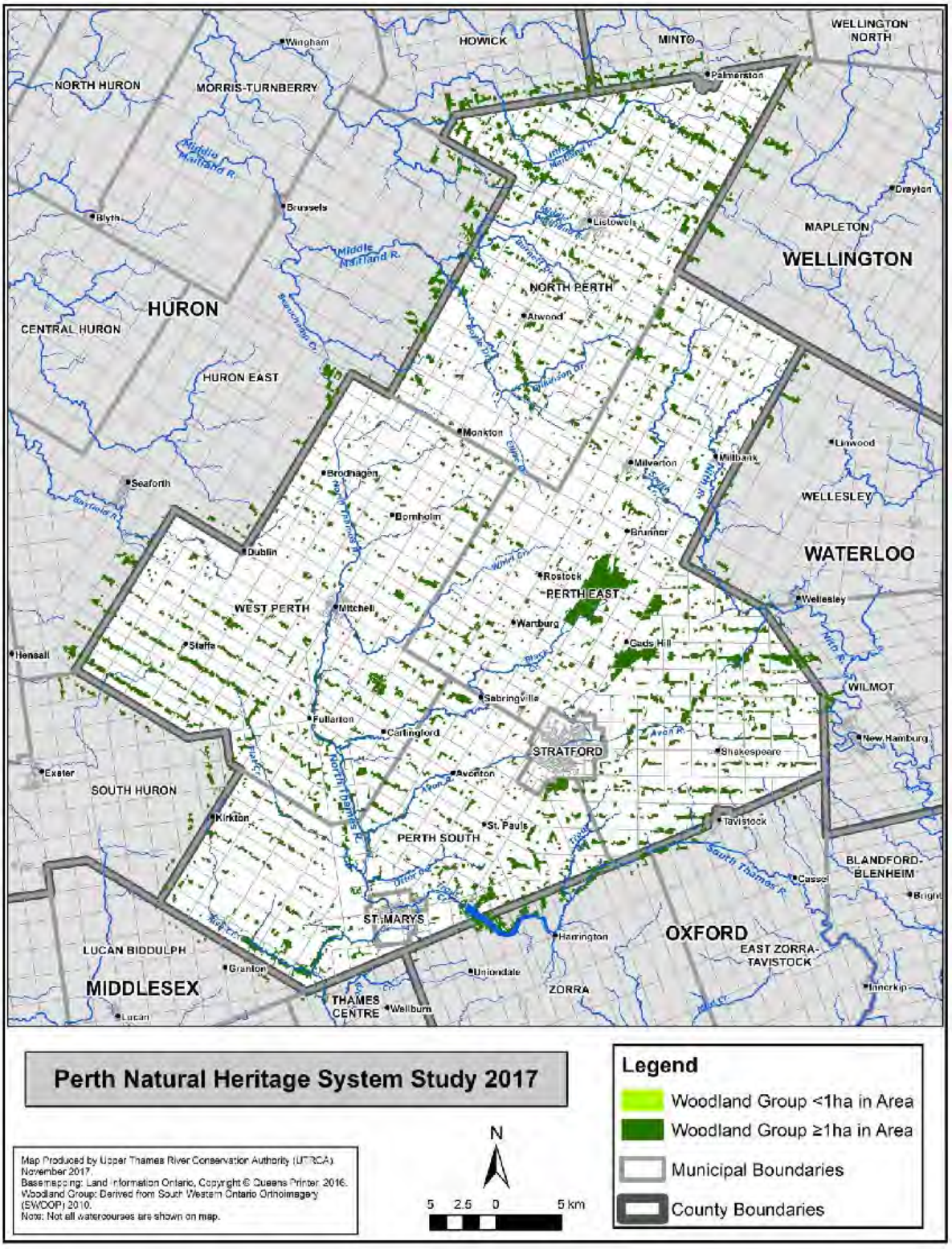
Appendix H-3. Criterion 3 Map, *Vegetation Groups* within 30 m of an open watercourse



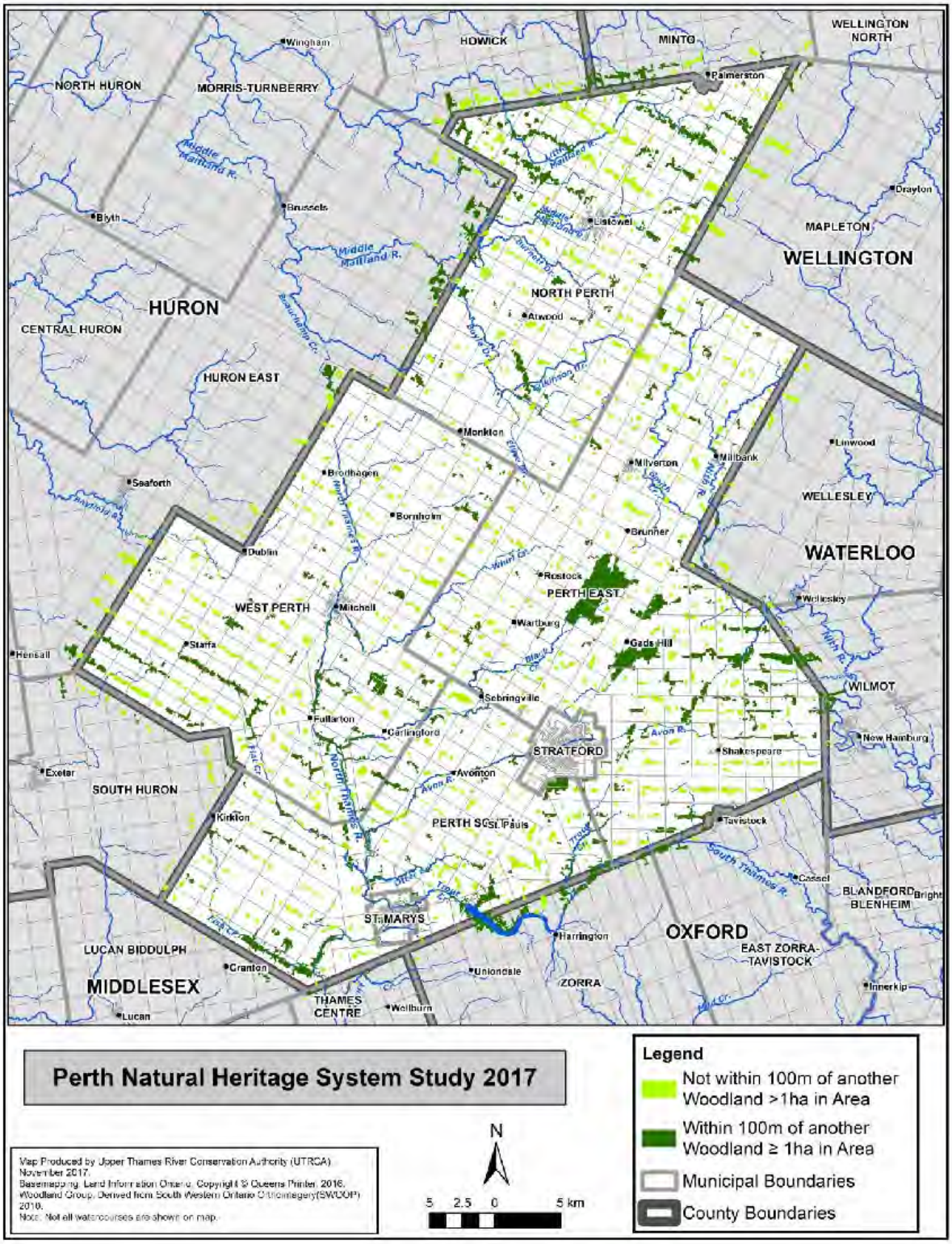
Appendix H-4. Criterion 4 Map, Wetlands



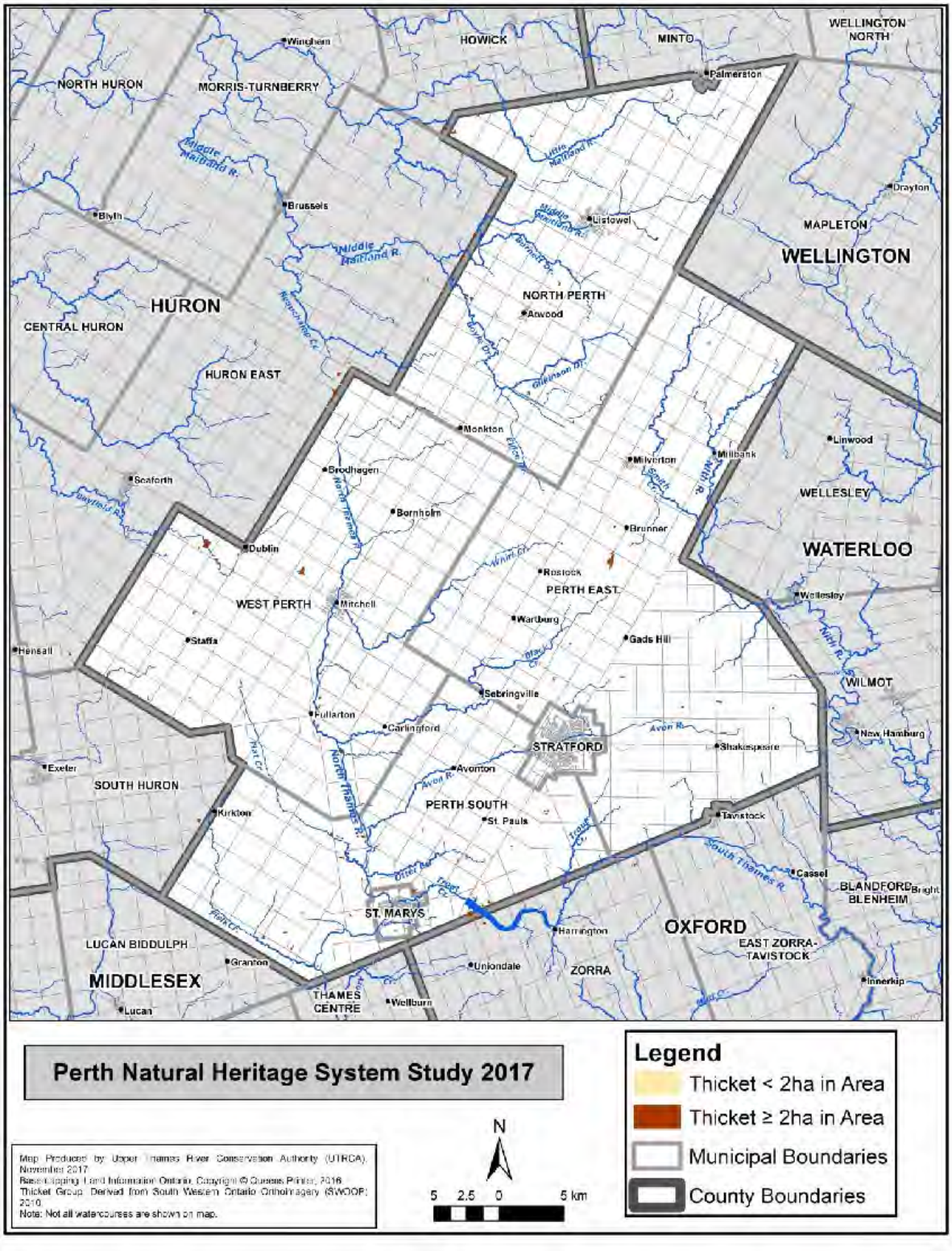
Appendix H-5. Criterion 5 Map, Woodland Size ≥ 1 ha



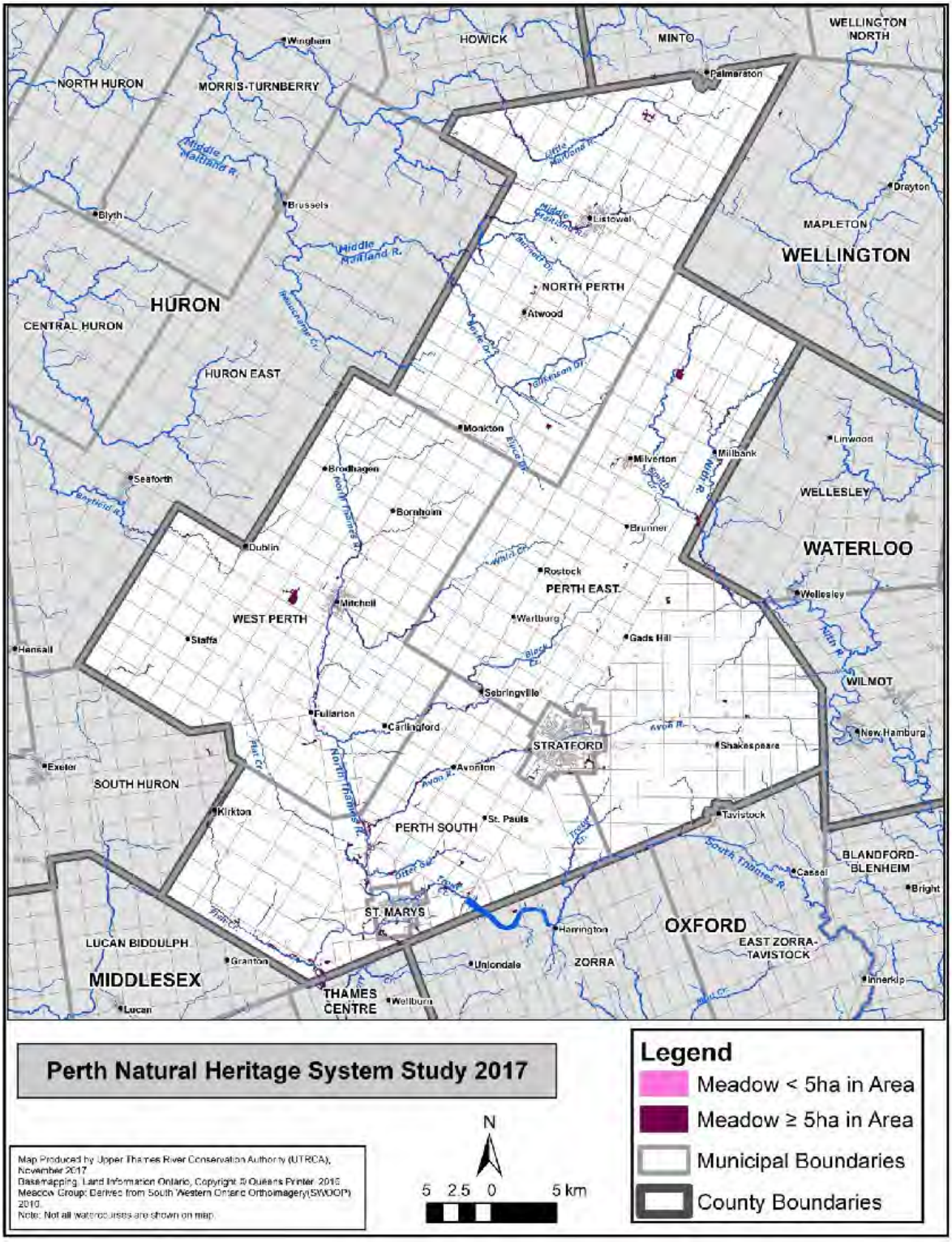
Appendix H-6. Criterion 6 Map, Woodland Proximity



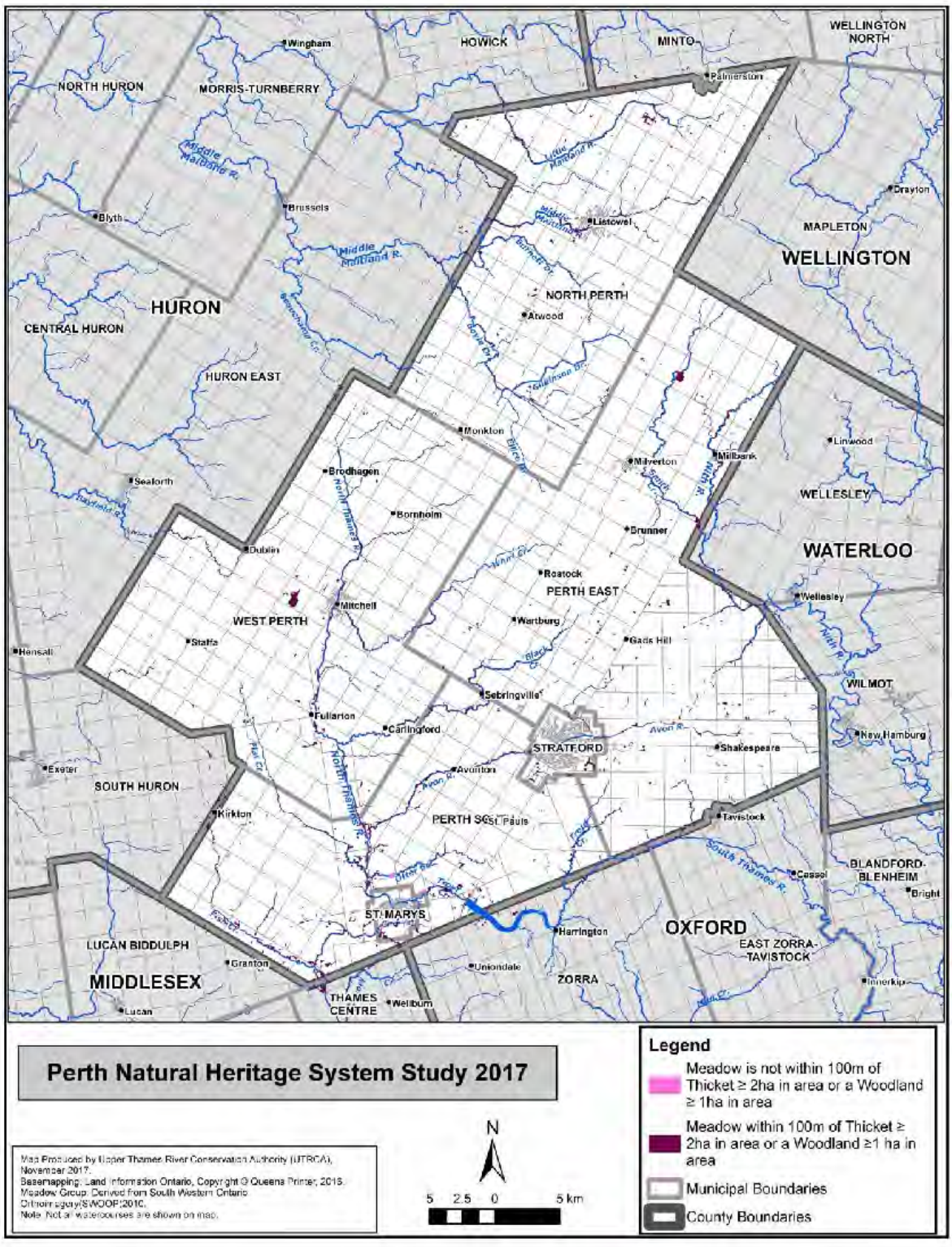
Appendix H-7. Criterion 7 Map, Thicket Size ≥ 2 ha



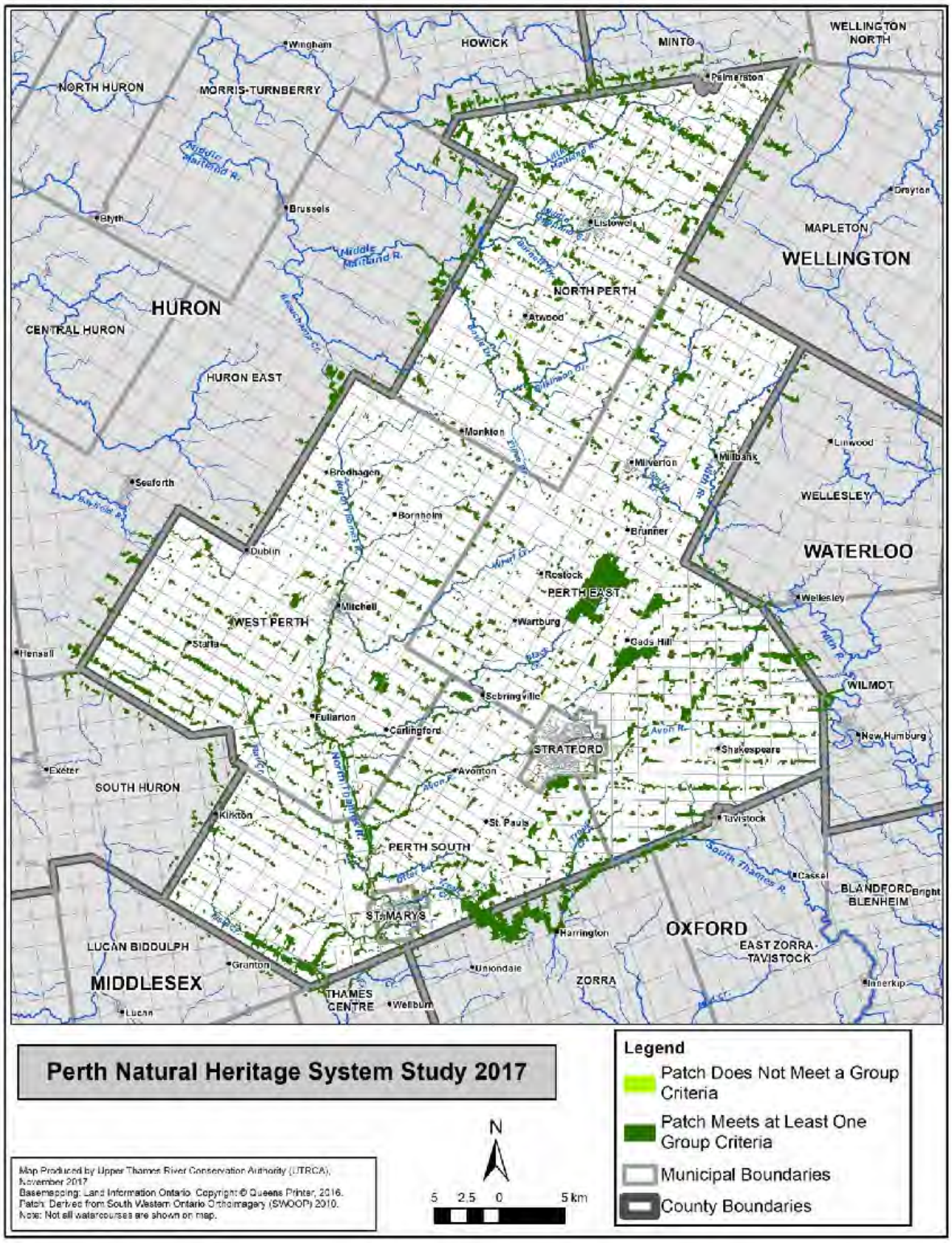
Appendix H-8. Criterion 8 Map, Meadow Size ≥ 5 ha



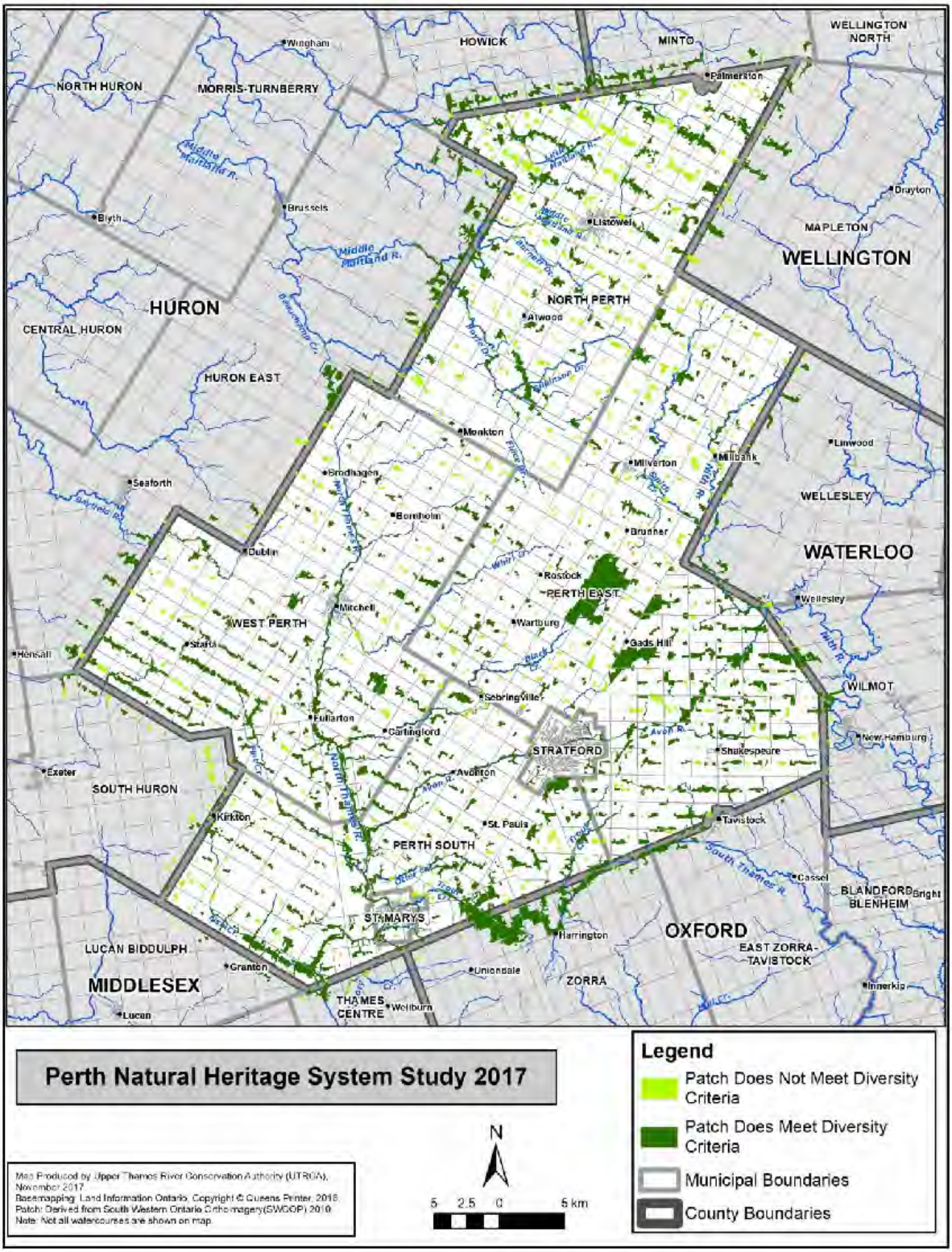
Appendix H-9. Criterion 9 Map, Meadow Proximity



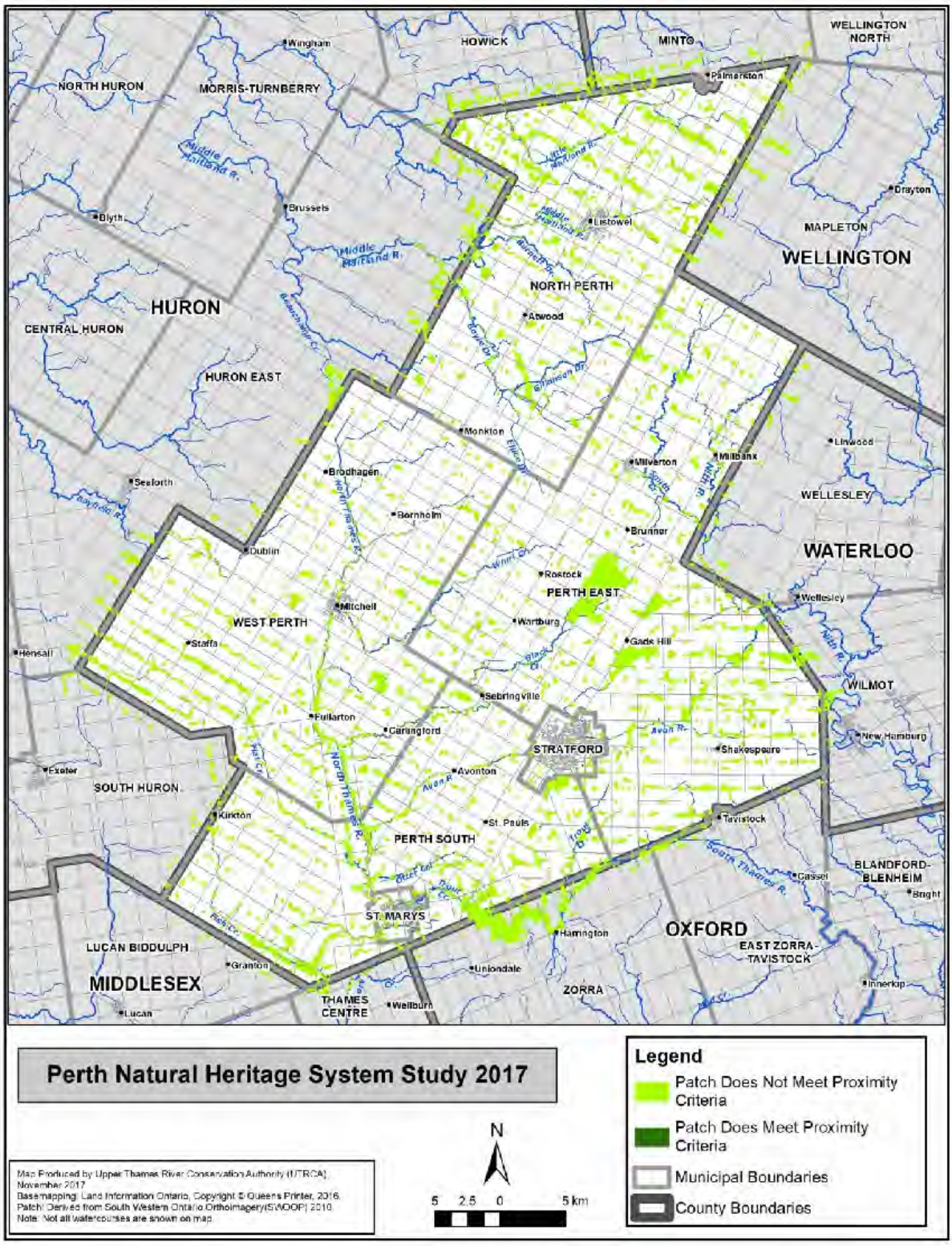
Appendix H-10. Criterion 10 Map, Patches that meet a Group Criteria



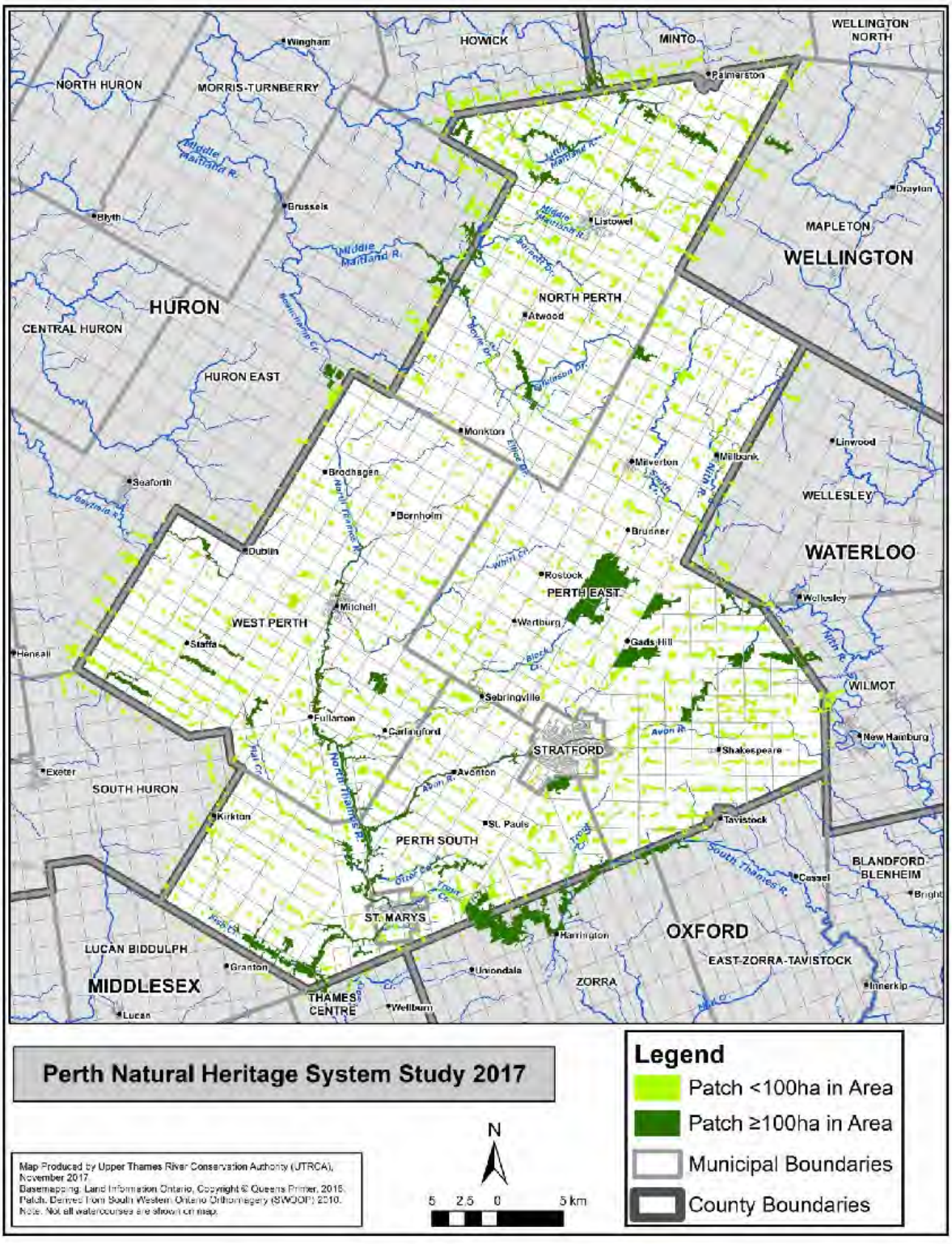
Appendix H-11. Criterion 11 Map, Diversity



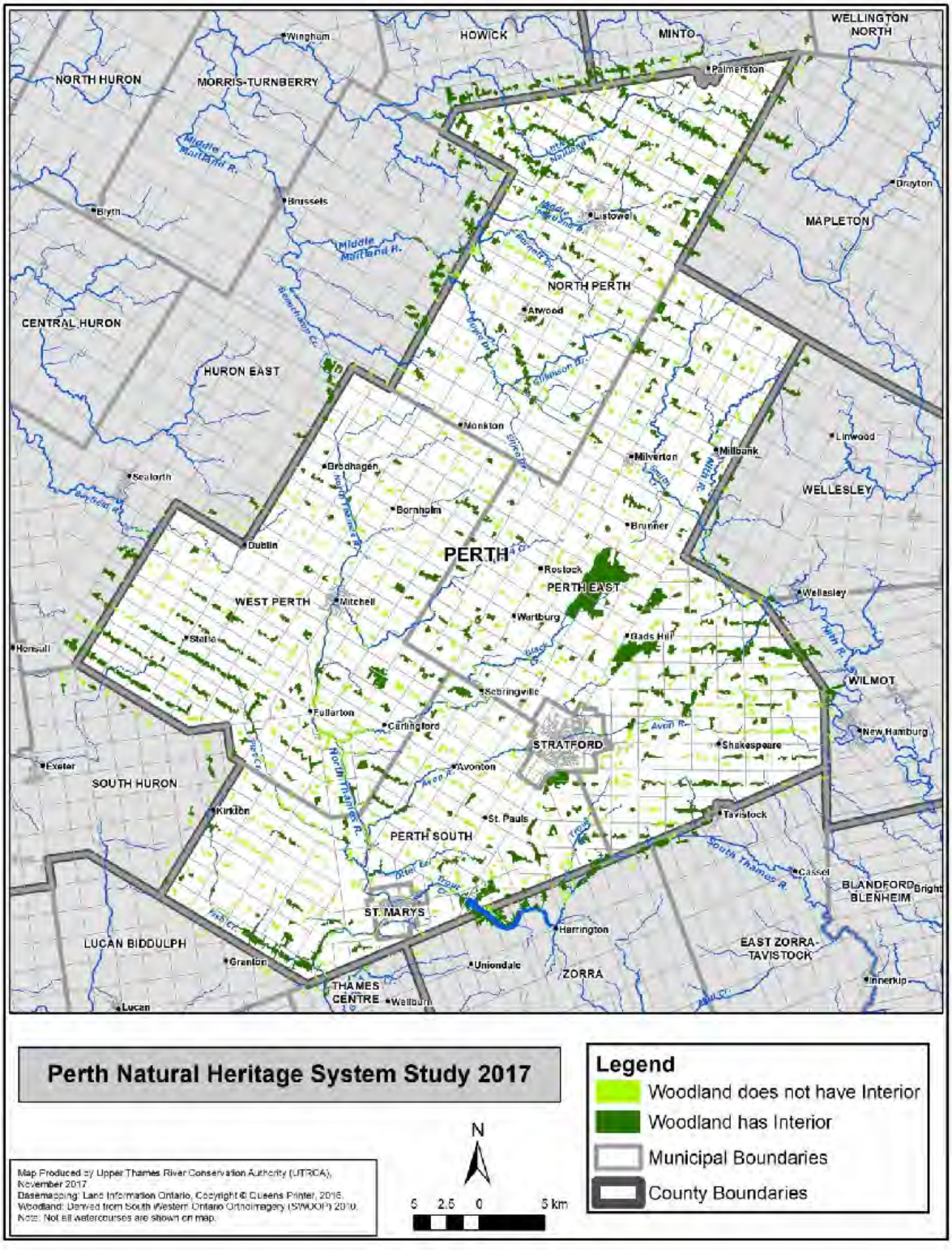
Appendix H-12. Criterion 12 Map, Patch Proximity



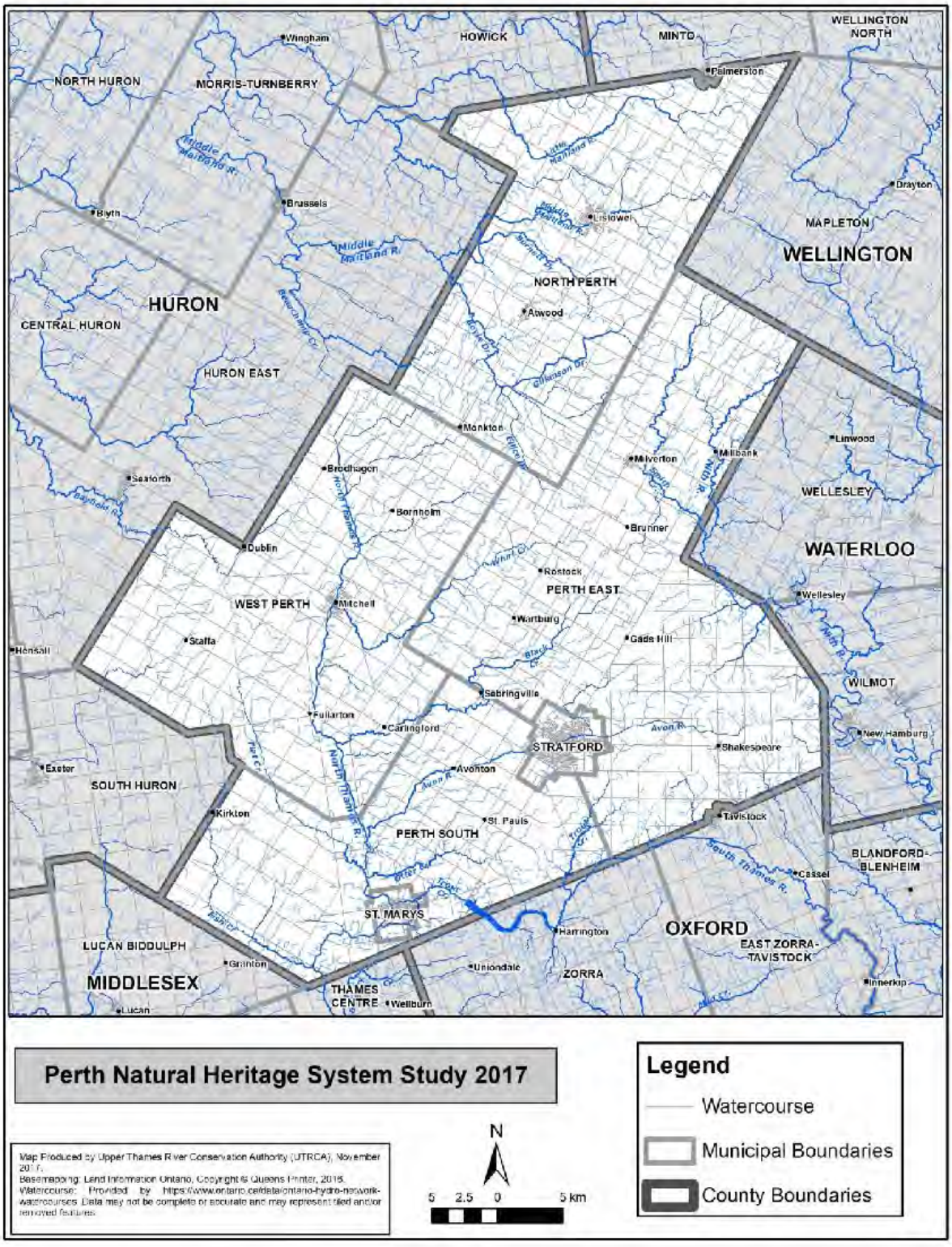
Appendix I-1. Map showing patches ≥100 ha



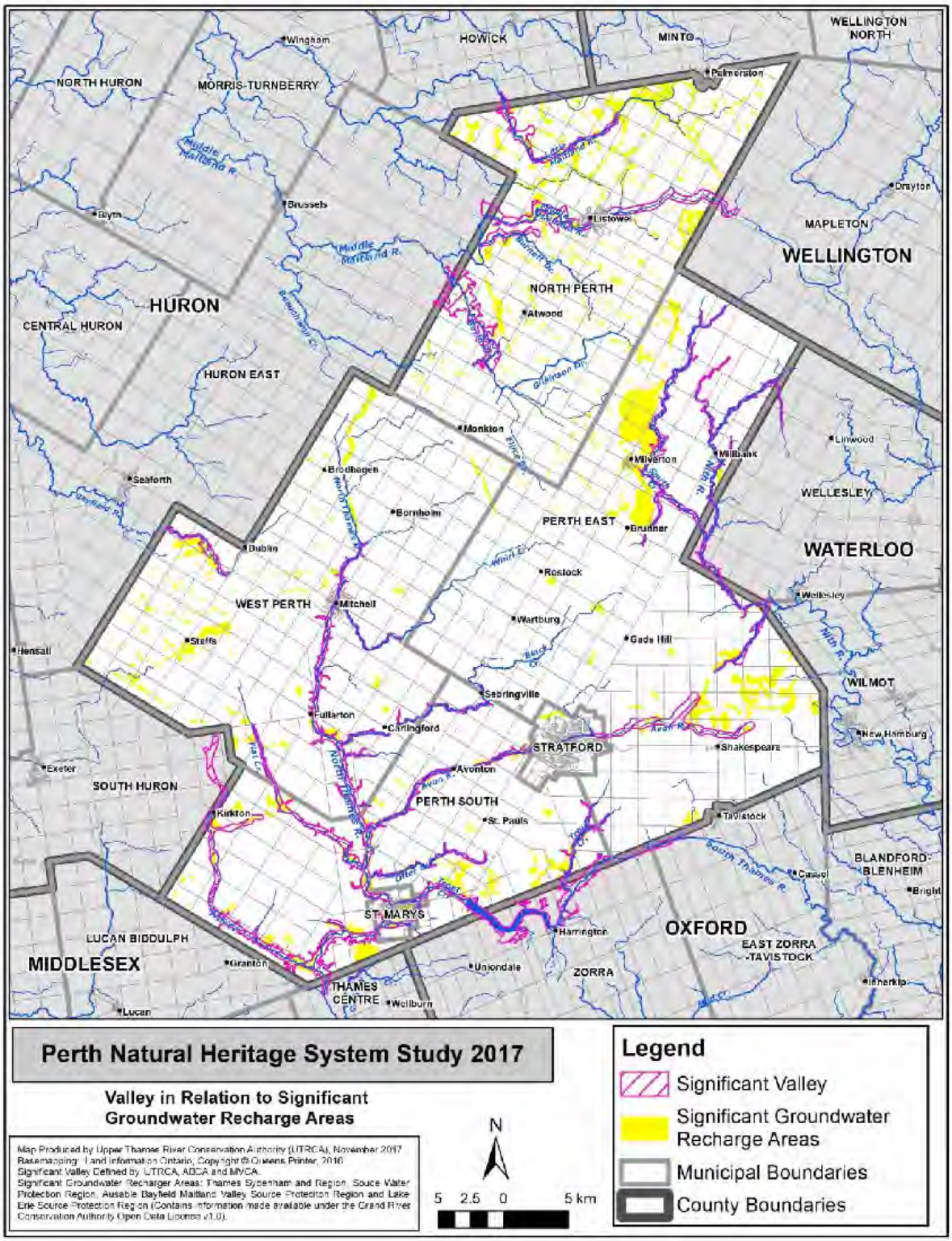
Appendix I-2. Map showing Woodlands that contain Woodland Interior



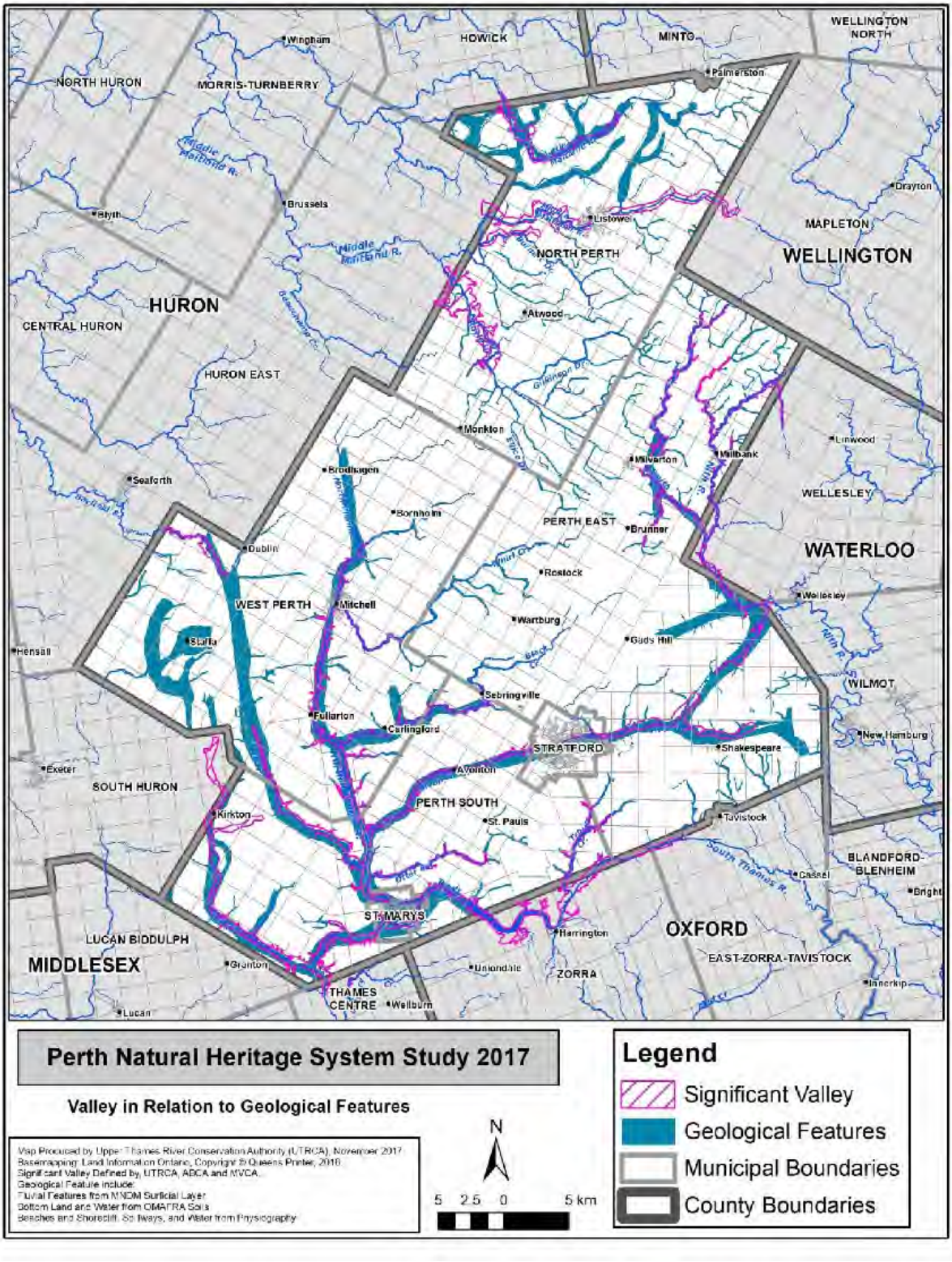
Appendix I-3. Map showing the watercourse layer (open and tiled)



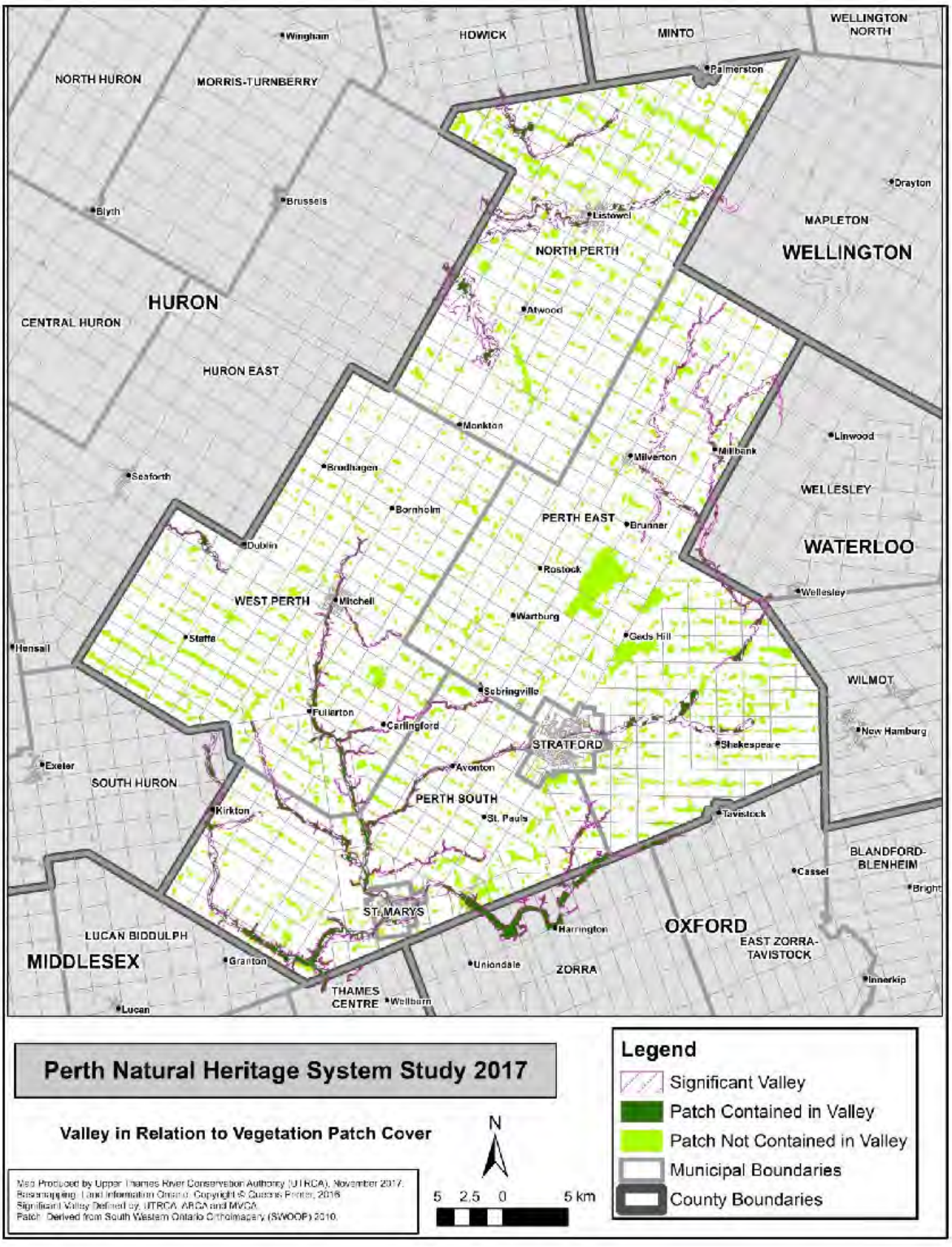
Appendix J-1. Valley in relation to Significant Groundwater Recharge



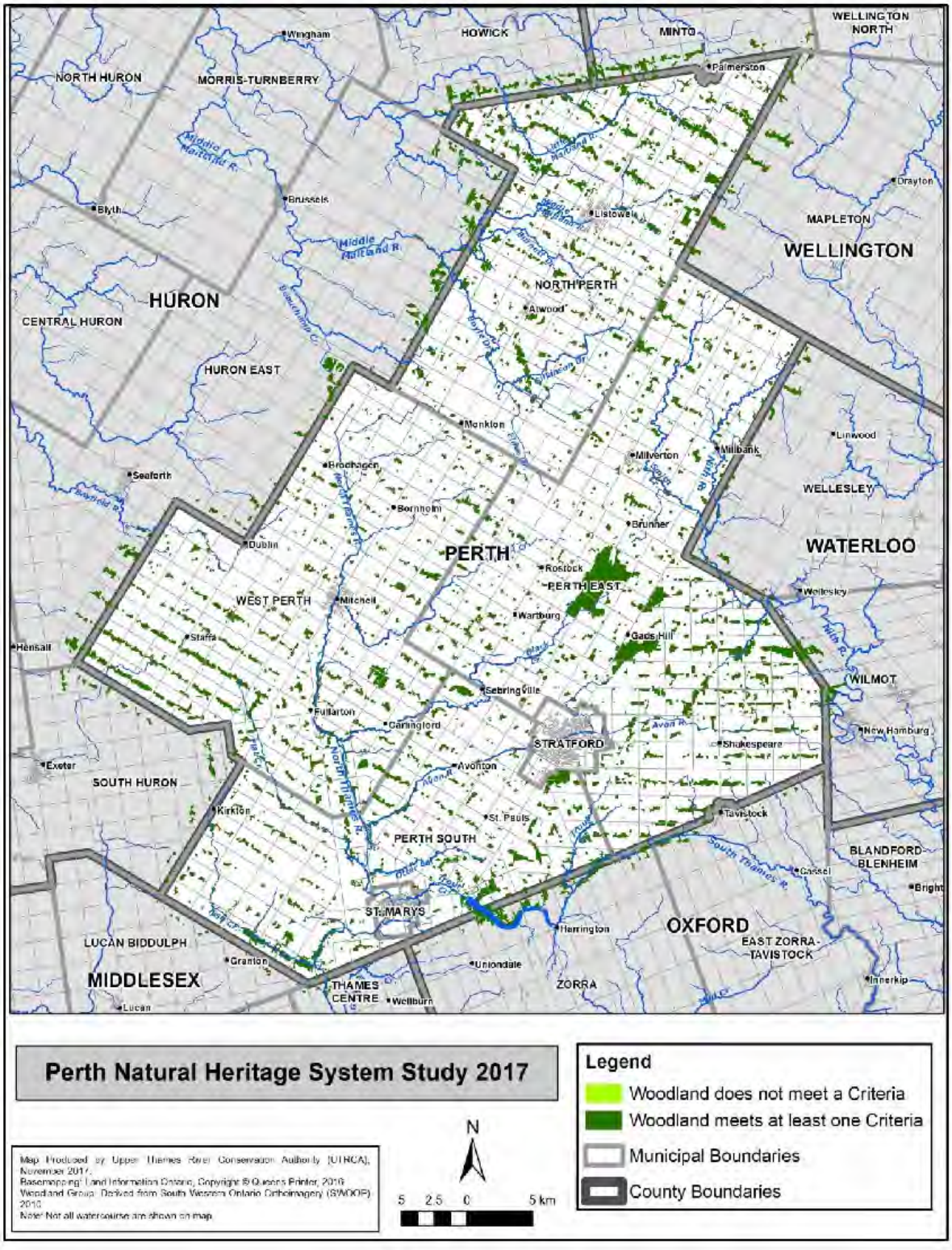
Appendix J-2. Valley in relation to Geological Features



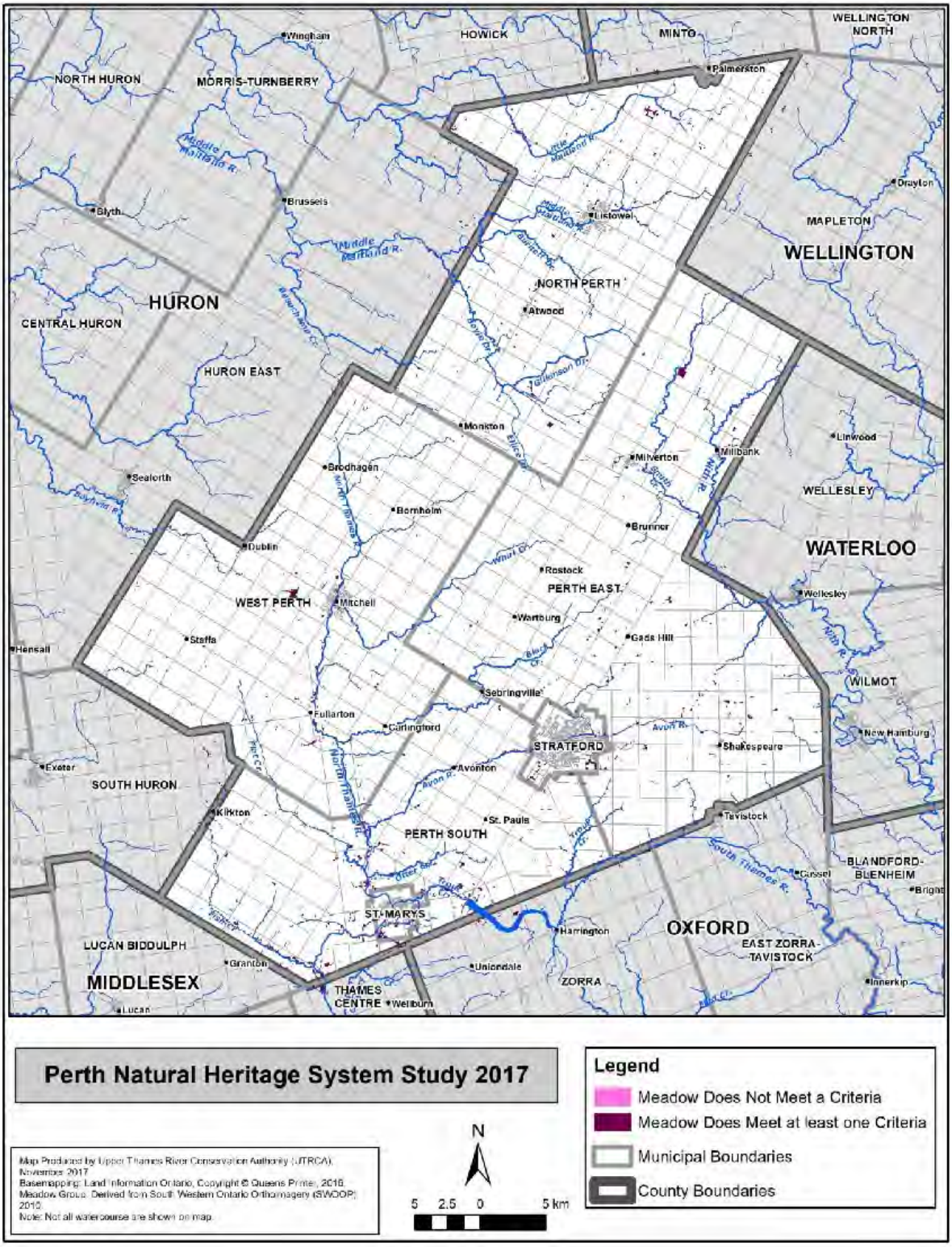
Appendix J-3. Valley in relation to vegetation patch cover



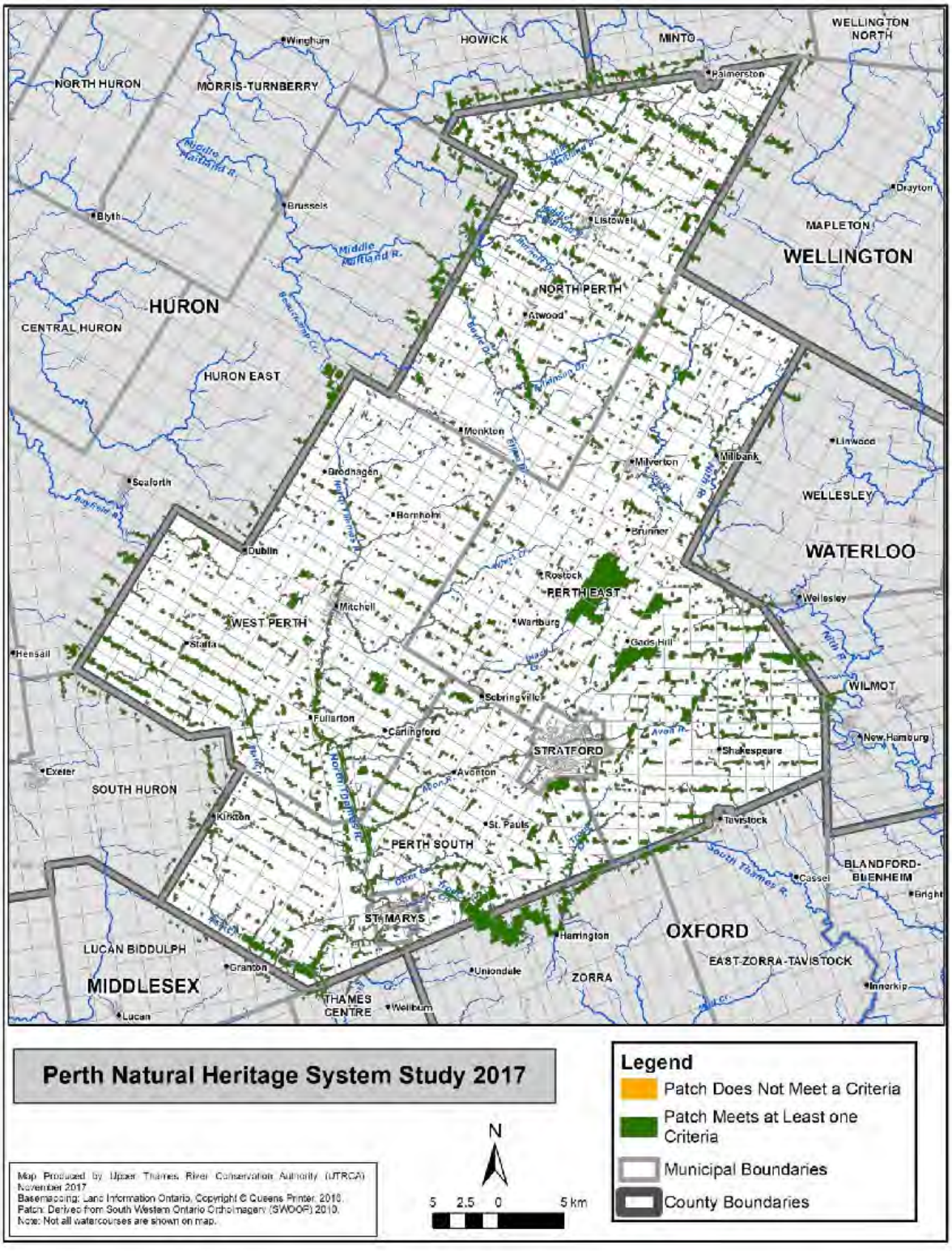
Appendix K-1. Woodland Groups that meet one or more criteria for Ecological Importance in Perth



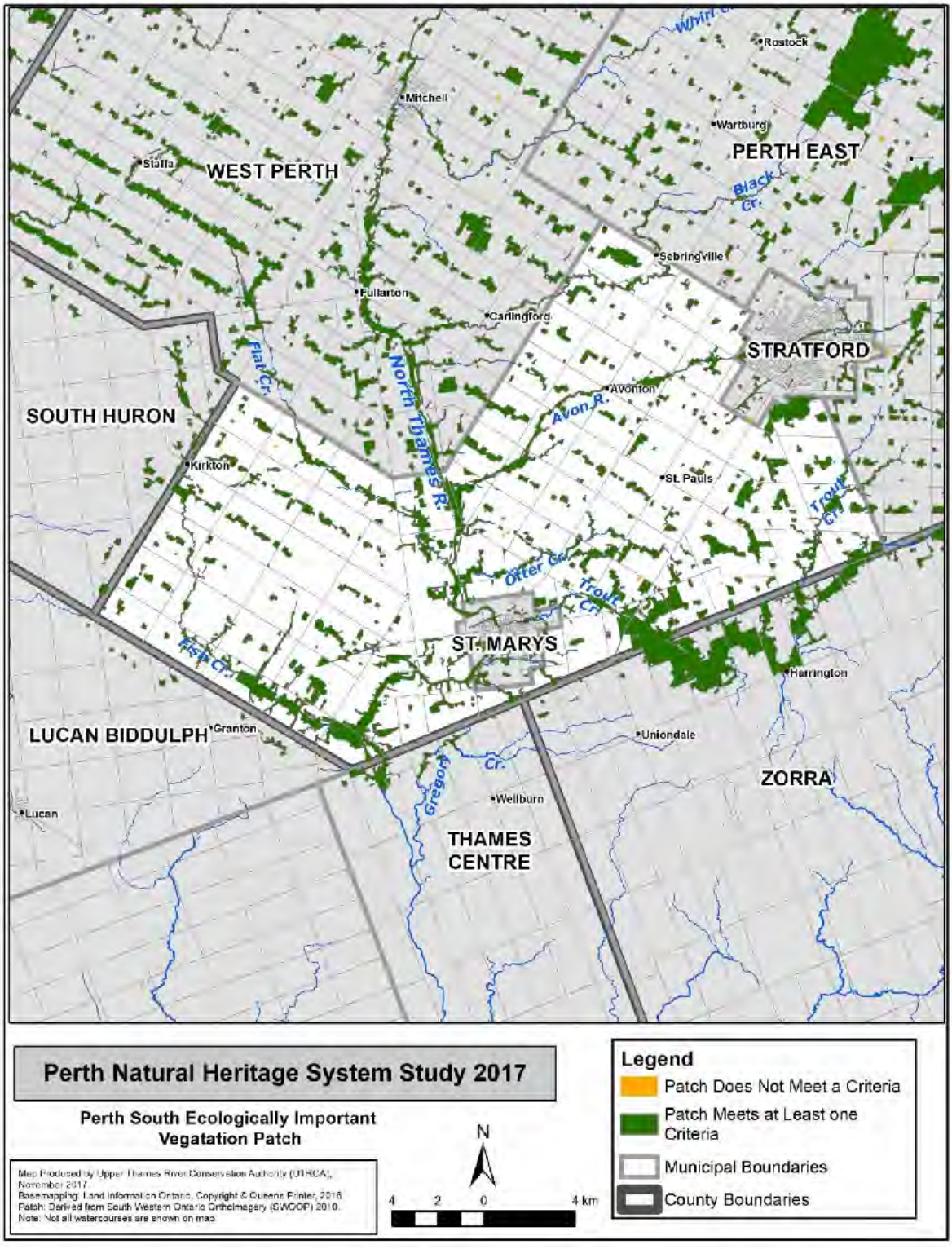
Appendix K-2. Meadow Groups that meet one or more criteria for Ecological Importance in Perth



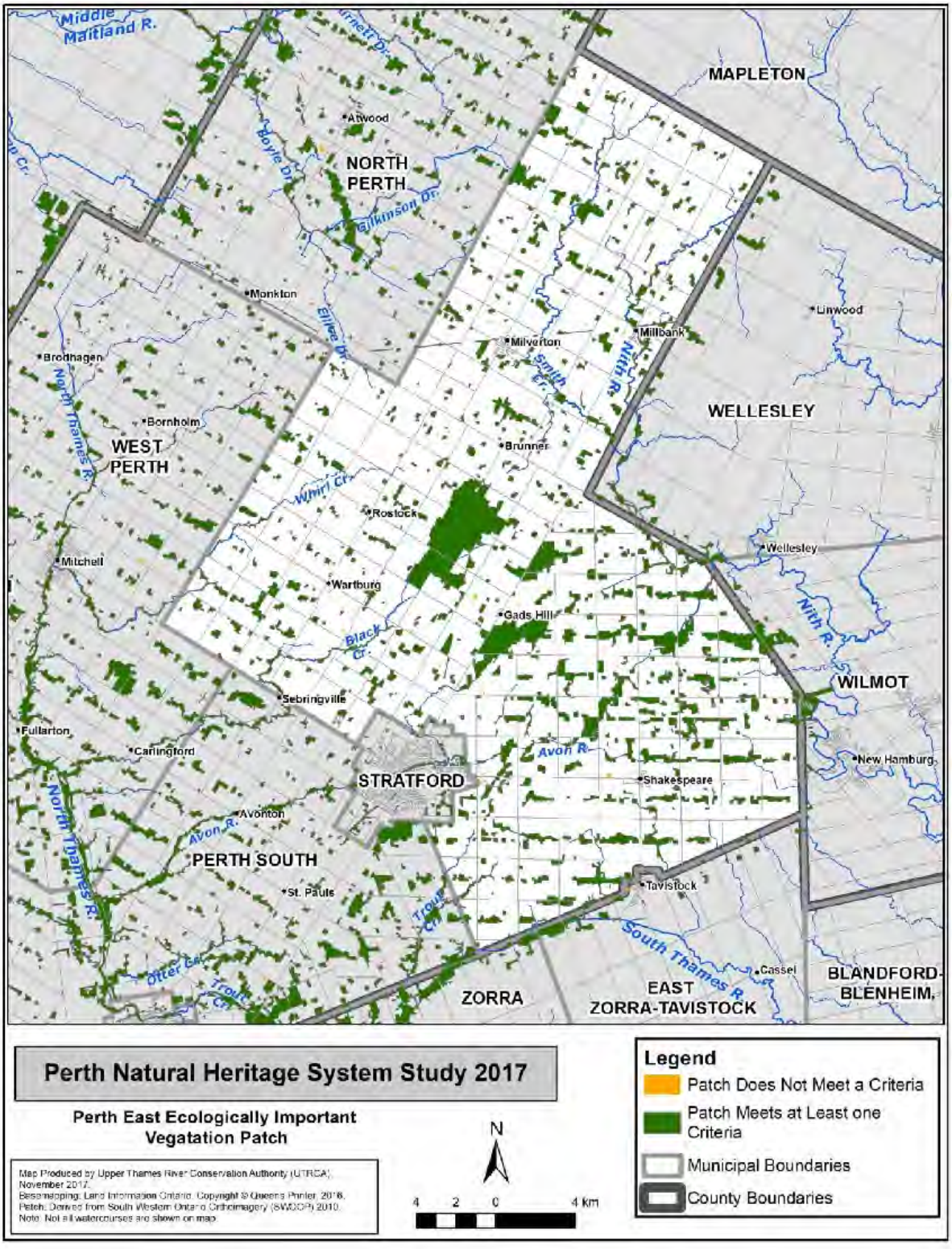
Appendix K-3. Patches that meet one or more criteria for Ecological Importance in Perth



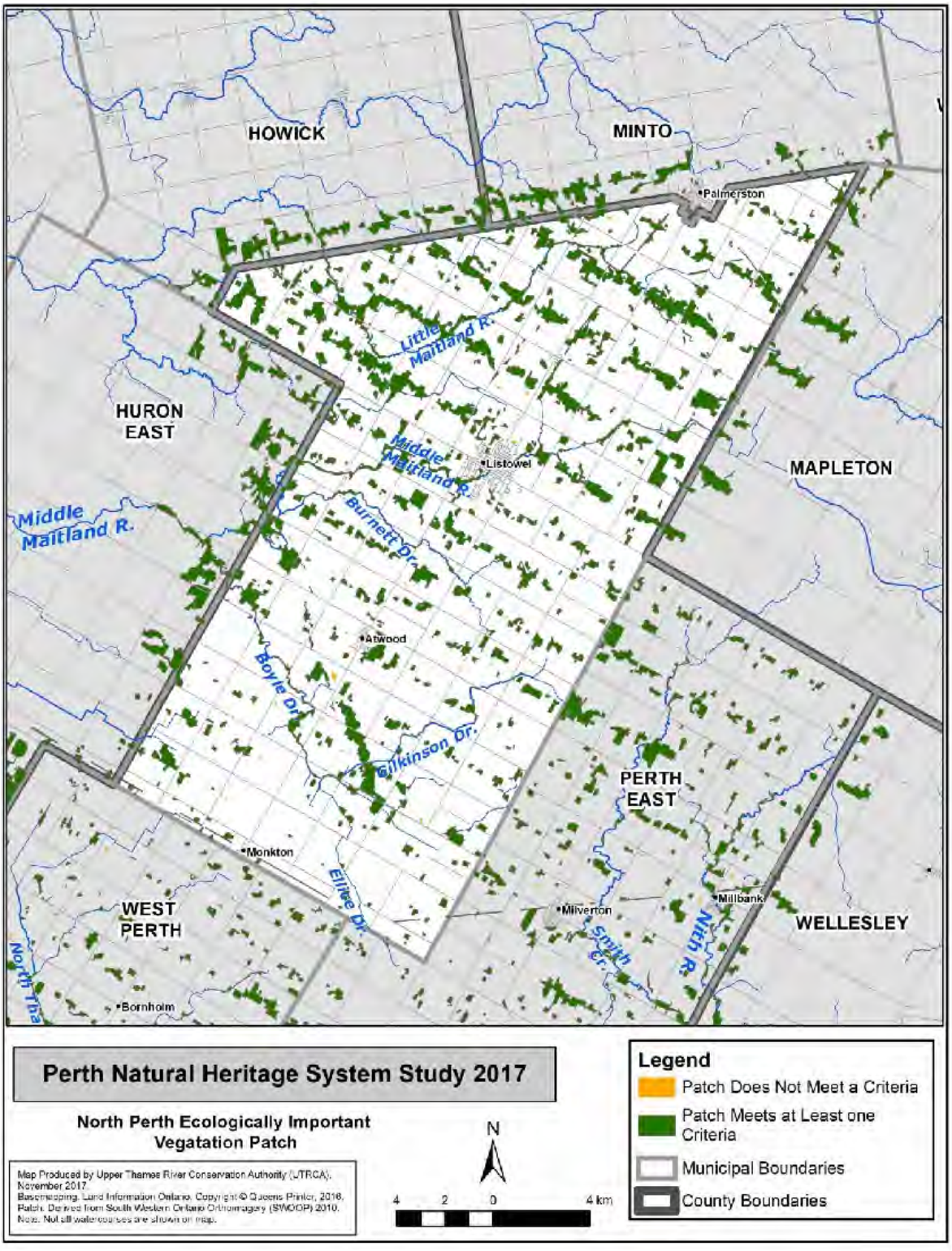
Appendix K-4. Patches that meet one or more criteria for Ecological Importance in Perth South



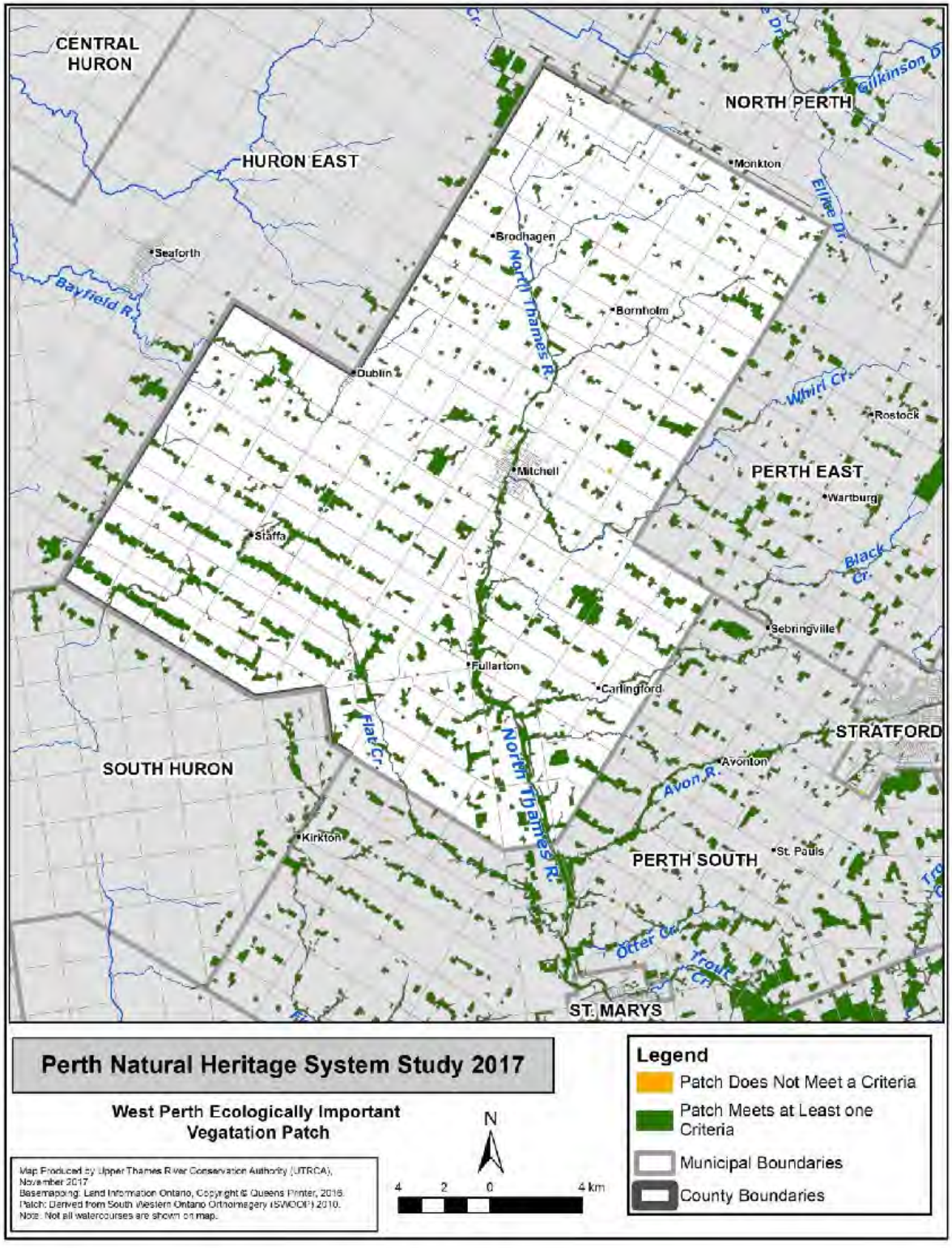
Appendix K-5. Patches that meet one or more criteria for Ecological Importance in Perth East



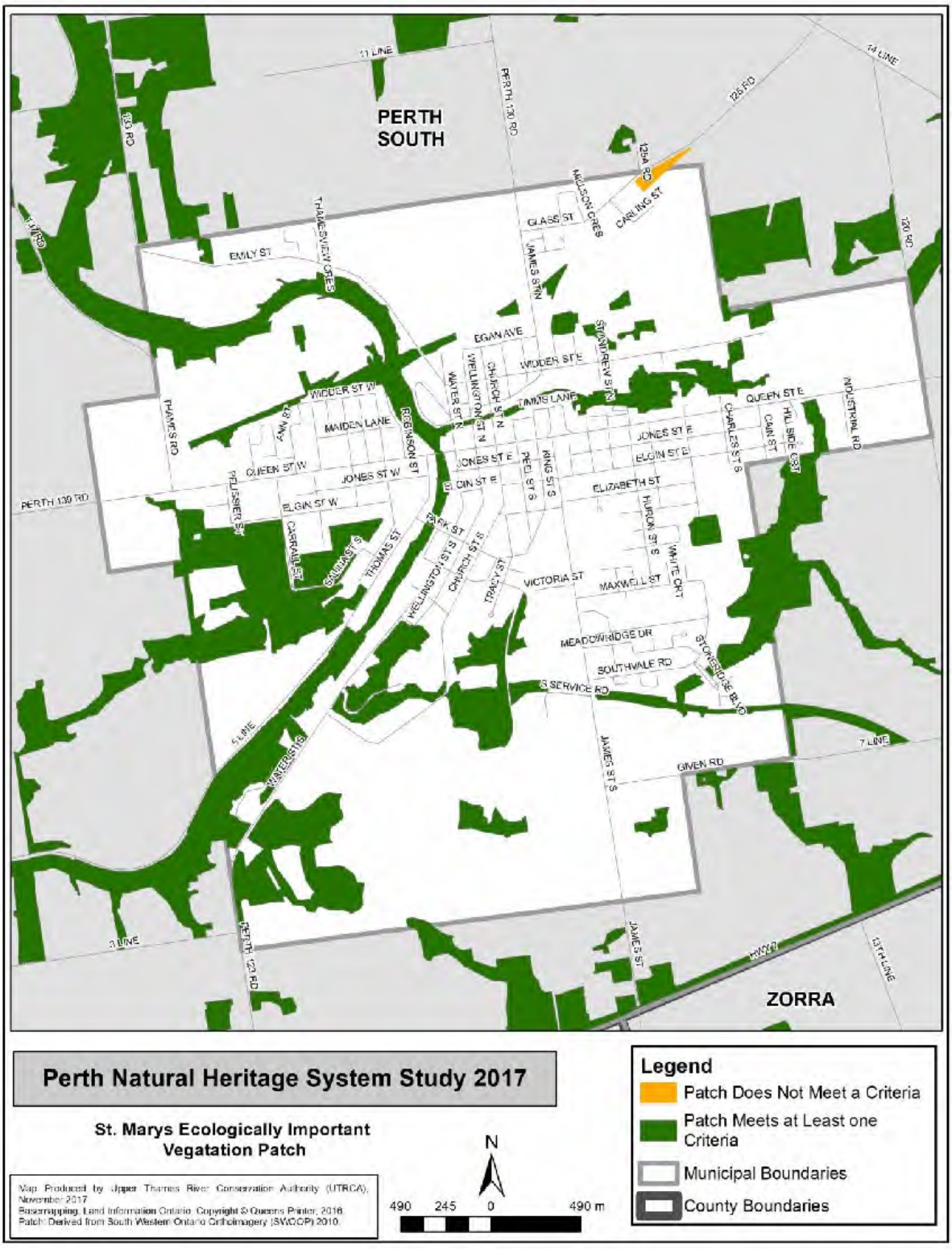
Appendix K-6. Patches that meet one or more criteria for Ecological Importance in North Perth



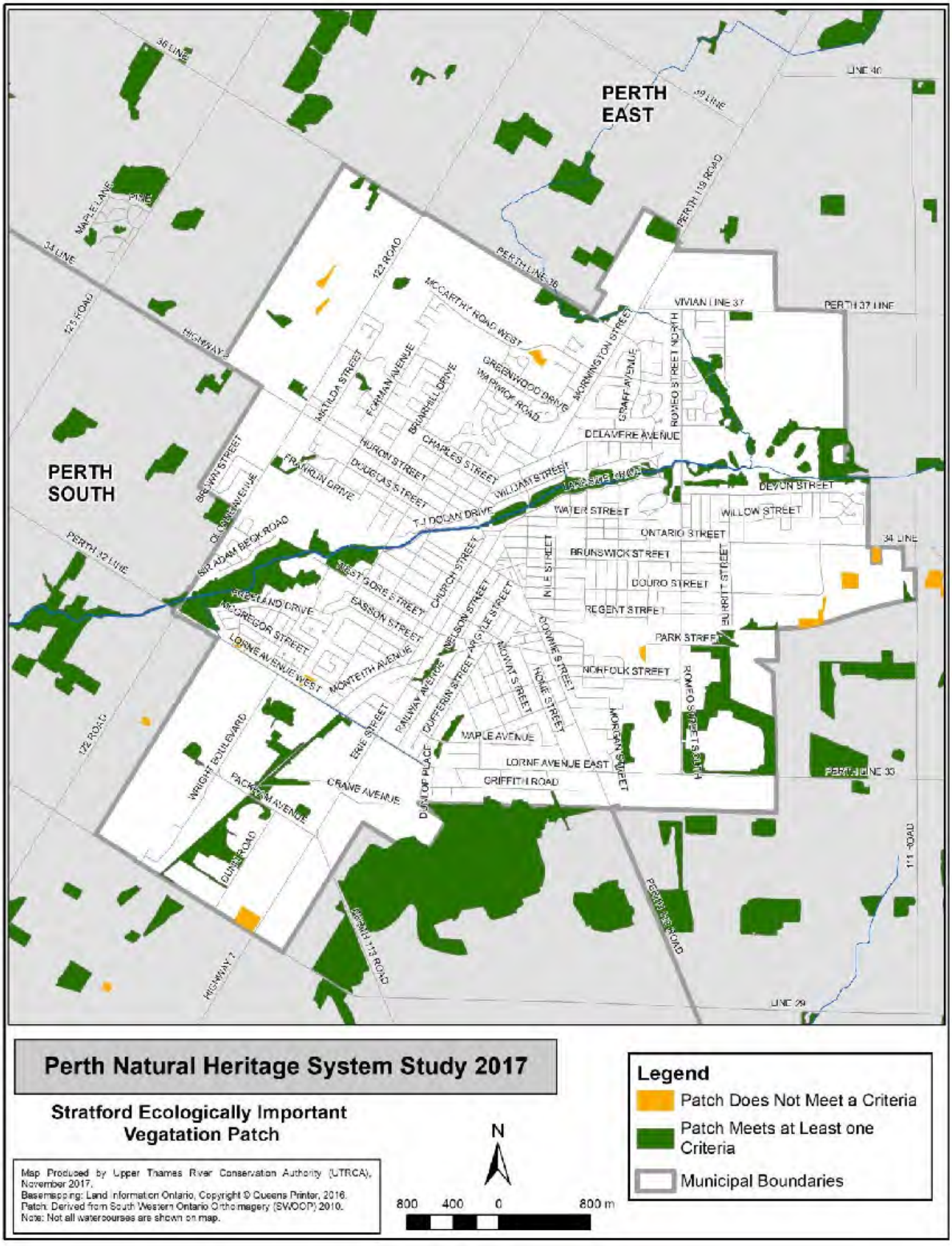
Appendix K-7. Patches that meet one or more criteria for Ecological Importance in West Perth



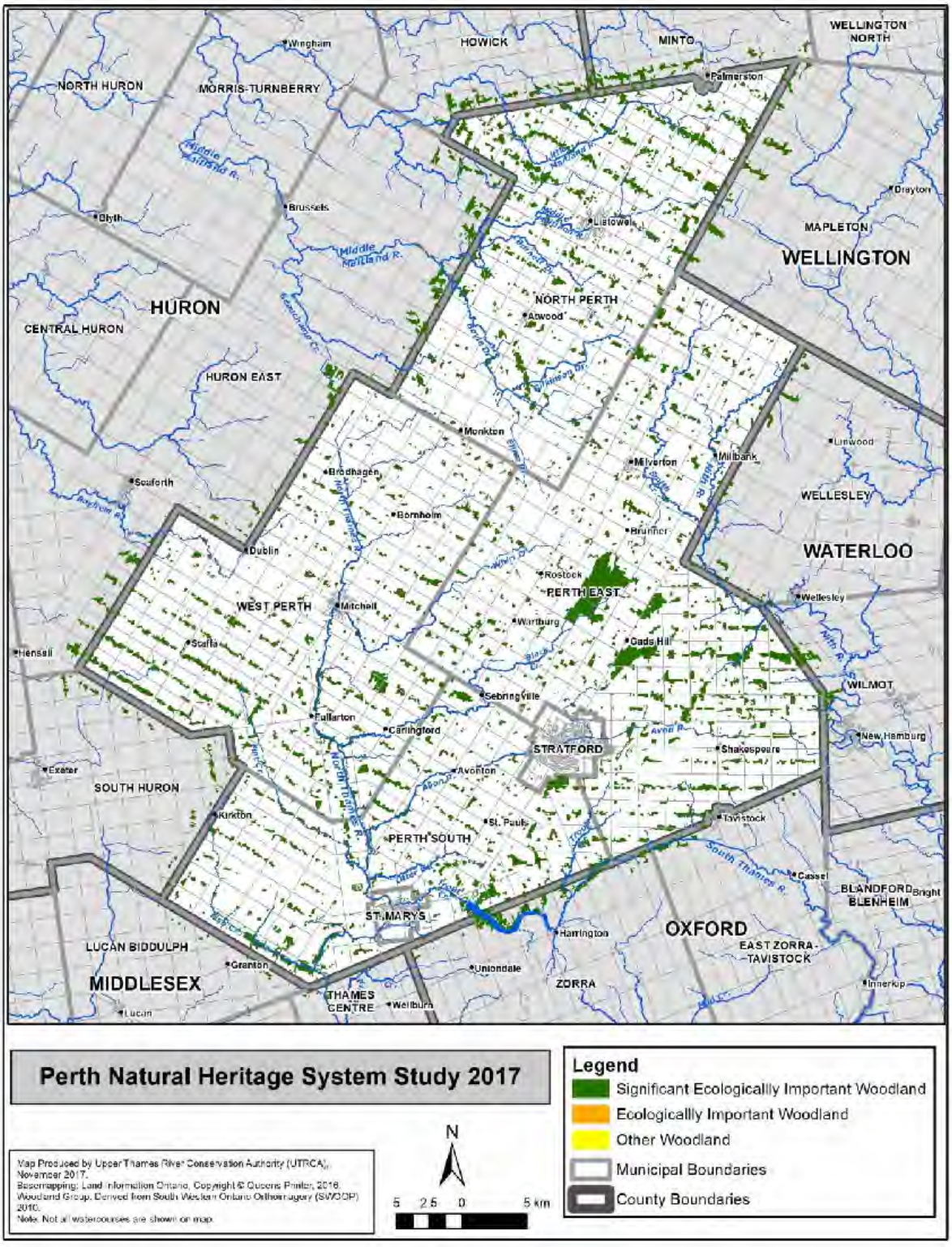
Appendix K-8. Patches that meet one or more criteria for Ecological Importance in St. Marys



Appendix K-9. Patches that meet one or more criteria for Ecological Importance in Stratford



Appendix L-1. Woodlands: Significant, Ecologically Important and Other in Perth County



Appendix M. 2006 Oxford Natural Heritage Study - Recommendations

(Taken from Chapter 6 of the 2006 ONHS report)

Recommendations for this study have been developed by the Implementation Advisory Committee (IAC) and the Steering Committee based on the technical guidance provided by the aquatic and terrestrial technical committees. The IAC reviewed options and developed numerous recommended actions which were then prioritized. The Steering Committee brought forward the IAC's recommendations, built on the IAC work, and also added a number of recommendations based on their comprehensive review and management of the project.

Recommendation 1: Incentives

Incentives were identified by the IAC as an important means of maintaining and enhancing natural heritage in Oxford County. Incentives are well received by the community and are viewed as being very effective. Incentives are voluntary and they reward operators who want to employ good stewardship. Incentives educate through example, promote community buy-in and allow projects to be completed sooner rather than later. Since environmental protection is a benefit to society as a whole, it is appropriate that society pay at least partially for this benefit through taxes rather than leave the financial burden to individual landowners.

The Clean Water Project (CWP) is partially funded by Oxford County ratepayers and has been very effective and well-received by the Oxford County community. Tax dollars stay in the County through projects completed by landowners and local contractors. Baseline funding is critical to the continuance of the project, but there has been success at leveraging additional funding, which should continue. Information on the CWP is found in Appendix G. The CWP is robust enough to adapt to new directions and targets.

IAC recommendations are as follows:

1a. It is recommended that the County expand the current Clean Water Project (CWP) to add categories that target terrestrial and aquatic natural heritage protection and enhancement. The main additions to the program will need to be targeted to terrestrial natural heritage protection (e.g. woodlot management, expanded native species plantings). The results of the ONHS can be used by the CWP Committee to adapt the project to get the best environmental value for the dollars available.

1b. It is recommended that opportunities for additional government and non-government funding support of the Clean Water Project continue to be pursued.

1c. It is recommended that the County continue to endorse other incentive programs provided by other agencies as a means of protecting and enhancing the natural heritage resources of Oxford County.

1d. It is recommended that the County investigate options for providing tax relief to the owners of designated patches.

The Steering Committee concurs with the IAC recommendations related to incentives and offers the following additional recommendations:

1e. It is recommended that the County contribution to the Clean Water Project (CWP) be increased from $70,000 per annum to $200,000 to support the expanded eligible categories (see Recommendation 1b).

Appendix M continued

Recommendation 2: Ongoing Support for Natural Heritage Activities
The IAC recommended the creation of a County Natural Heritage Advisory Committee to oversee the ongoing implementation of the ONHS and to monitor and report on success. It was suggested that the Natural Heritage Committee should report to County Council and be made up of a cross section of stakeholders somewhat similar to the make-up of the IAC.

2a. It is recommended that the County establish a Natural Heritage Advisory Committee that would report to County Council and oversee the ongoing implementation of the ONHS.

The Steering Committee supports the recommendation to establish a Natural Heritage Advisory Committee. The Steering Committee also discussed the need for ongoing staff support of natural heritage planning and implementation initiatives.

2b. It is recommended the County hire a permanent staff person to take the lead on natural heritage planning and implementation activities. This person would support the Natural Heritage Advisory Committee, coordinate other County efforts on natural heritage planning and implementation and assist the local municipalities with their natural heritage activities.

Recommendation 3: Education and Communication
The IAC identified Education and Communication as a high priority for action. Landowners need to be aware of the state of their local environment and what they can do to improve conditions. People will not be motivated to change or continue with good practices unless they are well informed.

There are a number of existing activities that can be built upon to increase the community's awareness of natural heritage issues and opportunities. It was noted that the rural non-farm audience should be specifically targeted in addition to the traditional target audiences (e.g. farmers, landowners).

3a. It is recommended that the County of Oxford develop a communications strategy on natural heritage that builds on, and links to, existing communications programs targeted to landowners.

The Steering Committee supported the IAC's recommendation on Education and Communications and offers the following additional recommendations:

3b. It is recommended that part of the communications strategy entail presentations to Oxford's local municipalities to raise awareness at this level.
3c. It is recommended that the County work with other agencies involved in communications regarding natural heritage issues.

Recommendation 4: Recognition of Landowners
Recognition of the owners of natural heritage was identified as a priority action by the IAC. The recognition may include formal acknowledgement of the contribution that their land makes to the areas natural heritage system.

4a. It is recommended that the County support the development of a recognition program for landowners who own and have conserved significant natural heritage areas.

Appendix M continued

Recommendation 5: Regulatory Measures

The use of regulatory measures, such as the Planning Act, to protect natural heritage was discussed by the IAC. There was agreement that the County must fulfill certain regulatory obligations but that the process should be considerate of landowner rights and the negative perception of regulation. While the IAC did conclude that designation of significant natural heritage areas in the official plan was acceptable, it was noted that this measure must be accompanied by incentive measures as outlined in Recommendation 1.

5a. It is recommended that the County of Oxford proceed to designate significant natural heritage areas (i.e. sites that meet one or more ONHS terrestrial criteria).

5b. It is recommended that the County directly advise affected landowners of the designation and provide an explanation of why their land is significant, outline permitted uses, identify incentives that are available and provide information on beneficial management practices that can be undertaken to further enhance natural features. This is part of the communications strategy that is referenced in recommendation 3a and needs to be provided prior to the Official Plan Amendment public meetings.

The Steering Committee supports the IAC's recommendations regarding Regulatory Measures. The Steering Committee also recommends that management activities that do not compromise natural heritage protection should be explicitly permitted (e.g. sustainable tree harvesting, maple syrup production, recreation trails, hunting, trapping and fishing in accordance with applicable legislation). It was also suggested that the impact of land designation which limits use should be offset by the development of new incentive opportunities for landowners. For example, the County could explore opportunities for tax exemptions for designated land or subsidize natural heritage management advice. The County is obligated to inform landowners about any designations and should take the extra step and provide additional information on services and incentives.

The Steering Committee also agrees with the IAC discussion that incentives for BMPs (Beneficial Management Practices) continue to operate on a voluntary basis when no change in land use is taking place (e.g. ongoing farm management). However, it is recognized that much of the pressure on natural heritage features occurs in urban areas where the pressure to clear and develop land is greatest. In this regard, the Steering Committee is recommending that BMPs should be mandated when there is a change of land use, primarily from rural to urban. Before the land is urbanized, natural heritage features (e.g. woodlands and watercourses) should be protected and buffered. For example, as part of the development approval process, vegetated buffers should be created on both sides of a watercourse to protect the aquatic habitat. It is recommended that additional work be carried out to develop such a policy framework.

5c. It is is recommended that the policy for the natural heritage designation in the County Official Plan explicitly permit uses such as sustainable tree harvesting, maple syrup production, recreational trails, hunting, fishing and trapping.

5d. It is recommended that designated properties receive first priority for incentives and tax relief . Cross reference recommendation 1e.

5e. It is recommended that official plan policy be developed to protect and enhance natural heritage features, such as existing watercourses, as urbanization occurs.

Appendix M continued

Recommendation 6: Public ownership

Public ownership of certain natural heritage resources was discussed by the IAC. It was agreed that public ownership continues to be an appropriate measure to protect natural heritage and to allow for public access recognizing that this is an expensive measure and that it may only be applicable to limited situations (e.g. very sensitive or significant properties or parts of properties). It was noted that the County already owns a number of County Forests which represent large tracts of natural heritage land. If situations arise where landowners face a loss of management control because of the unique environmental sensitivity of their land, the County should consider options for some form of public ownership or other compensation. It is noted that options can include outright ownership by various public bodies or restrictive covenants or easements with the land holding staying in private hands.

6a. It is recommended that opportunities for public ownership of significant natural heritage continue to be supported by the County of Oxford.

The role of the County as the owner of nine County Forest sites was discussed by the Steering Committee. It was agreed that an integrated plan for the County Forests should be developed. This plan should include consideration of the role of the County in owning County Forests, public access, risk management and natural resource management activities and opportunities.

6b. It is recommended that the County develop master plans for the County Forests and that as part of the process, the County determine its role in the protection of natural heritage as a landowner.

Recommendation 7: Urban Natural Heritage

The different challenges of identifying and protecting natural heritage in urban settings verses rural settings were discussed by the Steering Committee. The ONHS identifies significant natural areas on a County-wide, landscape scale, not a site-specific scale. Smaller patches in urban areas often do not meet the County-scale criteria and therefore, it is necessary to look at urban areas separately and at a finer scale.

The Woodstock Natural Heritage Inventory (2006) was discussed as an example of a detailed inventory that provides information about the natural heritage resources of an urban growth centre. It was acknowledged that there is public demand and expectation that the municipality will include natural areas in the City open space inventory but that there is limited planning in place about how these areas will be managed for natural heritage values, access, liability, etc.

It was also noted that while significant natural heritage patches need to be protected to be consistent with Provincial Policy, there is an expectation that areas of local and neighbourhood importance should also be protected from development. The expectation is that these areas should be protected for their natural heritage value, their visual amenity and community wellness value and for public access purposes. It is acknowledged that the desire or ability of the municipality to take on ownership of these areas and to manage them for these potentially conflicting goals is a complex issue.

7a. It is recommended that the local municipalities complete inventories of the remaining natural heritage areas within their urban growth centres.

7b. It is recommended that the local municipalities develop management strategies for the overall identification, ownership and management of significant and non-significant (locally important) natural heritage areas within their urban growth centres.

7c. It is recommended that local municipalities, at a minimum, have generic master plans for the ongoing management of publicly owned natural heritage areas, particularly in urban growth areas and that specific master plans be developed for each site as resources permit.

Recommendation 8: Woodland Conservation By-Law

The IAC and the Steering Committee discussed the role of sustainable forest harvesting practices in terms of maintaining quality woodlands in Oxford County. It is recommended that the County's Woodland Conservation Bylaw be reviewed within five years to incorporate current knowledge about the science of managing woodlands.

8a. It is recommended that the County review its Woodland Conservation Bylaw within five years.

Recommendation 9: Monitoring

The importance of monitoring data was discussed by the Steering Committee. It was agreed that monitoring data is very important for establishing benchmarks and measuring change over time. It was also agreed that regular reporting on the monitoring results is critical. Success depends on knowledge and this is gained through monitoring.

9a. It is recommended that the County of Oxford lobby the provincial government to continue to support the Provincial Water Quality Monitoring Network and Provincial Groundwater Monitoring Network programs.

9b. It is recommended that the County of Oxford request that the Conservation Authorities identify their specific monitoring services as a budget item and that the County continue to support the monitoring programs of the Conservation Authorities.

9c. It is recommended that the County of Oxford work with the Conservation Authorities to enhance the existing monitoring programs by adding new sites as appropriate and improving consistency of monitoring techniques between the Conservation Authorities.

9d. It is recommended that the Conservation Authorities provide a coordinated comprehensive report on monitoring for the County area on a regular basis.

Recommendation 10: Tourism

The high quality habitats within Oxford lend themselves to ecotourism and hunting/fishing opportunities. Woodlands, wetlands, meadows, streams and rivers have the potential to support sustainable economic ventures such as eco-tourism (hiking, birding, cross-country skiing) as well as fishing, hunting and trapping. Oxford does posess many excellent quality habitats that could be promoted to bring in tourist dollars that could in turn, assist landowners with maintaining their resources. This idea was explored by both the IAC and Steering Committee. The market needs to be examined.

10a. It is recommended that the County explore tourism opportunities related to natural heritage, such as hunting and fishing outfitting, examining models from other parts of North America.

ATTACHMENT 1