LAND USE ADJACENT TO WETLANDS IN SOUTHERN ONTARIO

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ABSTRACT

Wetlands can be greatly affected by their adjacent land uses. Existing regional databases on land use and evaluated wetland location were analysed for the amount of various land uses abutting evaluated wetlands in southern Ontario. A sample of 27 National Topographic System map sheets was chosen based on a set of criteria to ensure representation of land use conditions. Wetland boundaries overlaid on land use maps were measured for the different abutting land uses. Evaluated wetland perimeters totalling 6,704.6 kilometers were measured within a sample study area of 21,445 square kilometers. Half the abutting uses were natural, dominated by forest. Agriculture accounted for 40% of the wetland perimeter - 11.4% Row Crop; 9.4% Traditional Mixed and Grain systems; 18.2% Hay, Pasture and Grazing systems; 0.6% Specialty crop systems.Built-up uses abutted 5% of the evaluated wetland perimeter, dominated by rural road and non-farm residential uses. Water occurred along 4.4% of wetland perimeters. Minor differences are noted with a smaller sample set and between wetland class groupings. The spatial distribution of land uses abutting evaluated wetlands shows a wide range of wetland perimeter occurrence. Natural and agricultural uses dominate in 25 of the 27 sample areas. Agricultural system types adjacent to wetlands generally reflect their distribution in southern Ontario.

ACKNOWLEDGEMENTS

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LAND USE ADJACENT TO WETLANDS IN SOUTHERN ONTARIO

1.0 Introduction

Wetlands can be greatly affected by their adjacent land uses. This has been recognized in the Ontario Wetlands Policy Statement which places conditions on development within a 120 metre buffer around wetlands. Planning of future programs and policy directed at land use interactions with wetlands in southern Ontario would benefit from knowing some basic data on the extent of the interactions. Existing regional data tends to focus only on wetlands or on other land uses. Usually links are not made. Interpretation of available data from each field can be combined to offer useful regional trends on linkages.

2.0 Purpose

The project provides spatial trends of the proportion of evaluated wetland perimeter adjacent to various types of each of agricultural land, built-up uses, natural areas, and other land uses in southern Ontario.Total southern Ontario estimates of proportions are also made.

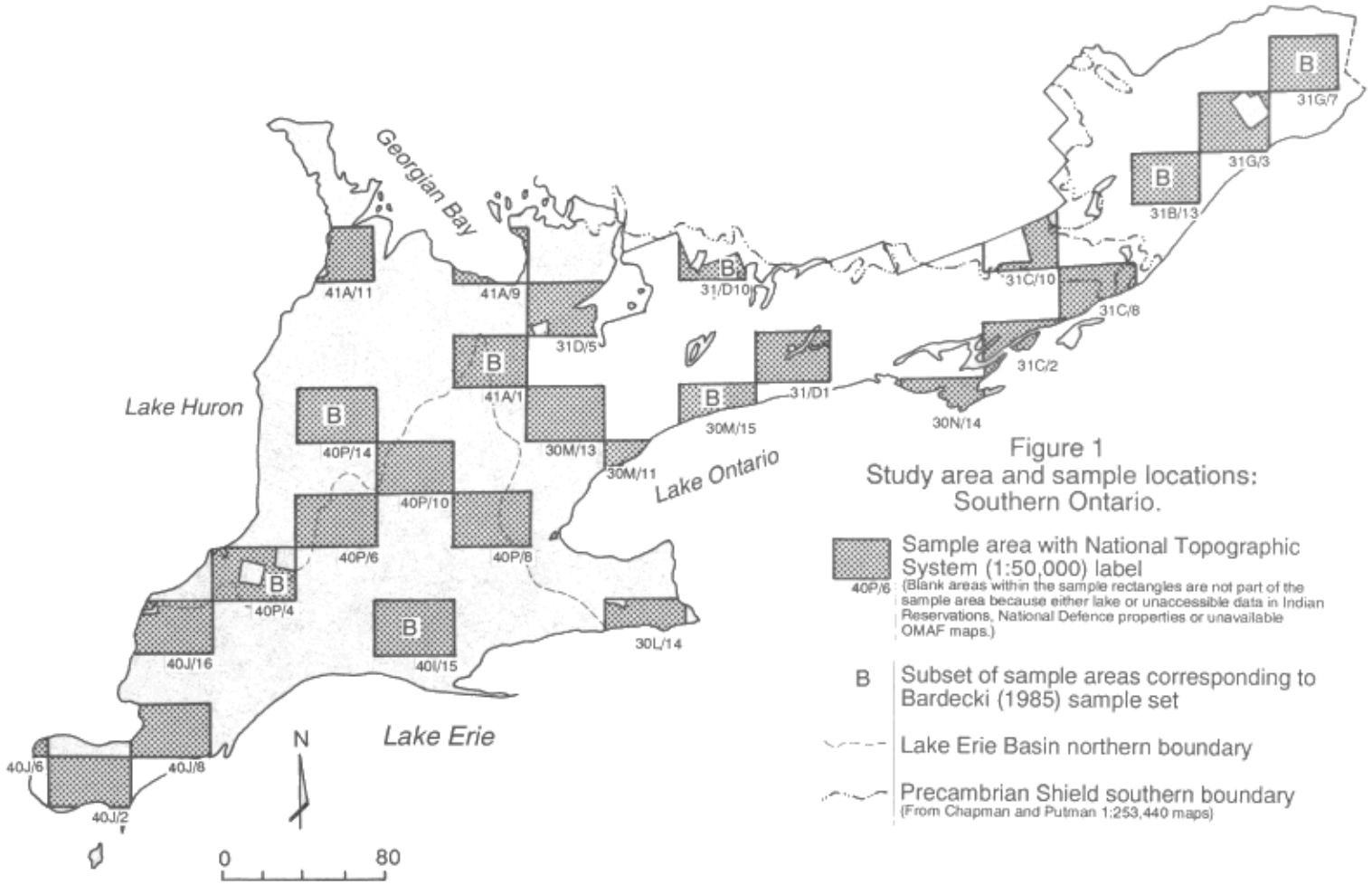
3.0 Study Area

Southern Ontario is subject to some of the most intense land use pressures in Canada. The mixed-wood plain ecozone of Southern Ontario (approximately south of the Precambrian Shield) had a population density of 85 persons/sq.km. in 1986. Only the same ecozone in Quebec ranked as high. Next highest was the Atlantic Maritime ecozone in Prince Edward Island at only 22 persons/sq.km. In addition, southern Ontario mixed-wood plain ecozone is second only to the Prairie ecozone in extent of Class 1 to 3 agricultural land (Statistics Canada, 1991).

Existing land use databases are also concentrated in this part of the province. Degree of land use pressure and availability of databases coincided to define the study area outlined in Figure 1.

4.0 Method

The general approach was to select a representative sample of study areas within the overall study area. Within these, existing data were used to identify land uses abutting wetlands. The length of wetland boundary of each land use was measured and totalled.


Georgian Bay
Lake Huron
Lake Ontario
Lake Erie
N
0
80
41A/11
41A/9
31D/5
31/D10
31C/10
31C/8
31C/2
31G/7
31G/3
31B/13
41A/1
40P/14
40P/10
40P/6
40P/8
40P/4
30M/13
30M/11
30M/15
31/D1
30N/14
30L/14
40J/16
40I/15
40J/6
40J/8
40J/2
B
Figure 1
Study area and sample locations:
Southern Ontario.
Sample area with National Topographic System (1:50,000) label
(Blank areas within the sample rectangles are not part of the sample area because either lake or unaccessible data in Indian Reservations, National Defence properties or unavailable OMAF maps.)
Subset of sample areas corresponding to Bardecki (1985) sample set
Lake Erie Basin northern boundary
Precambrian Shield southern boundary
(From Chapman and Putman 1:253,440 maps)

4.1 Existing Relevant Databases

For valid comparison across southern Ontario, databases for both wetlands and land use must cover the study area at comparable scales and dates. The following databases were found:

Wetlands

The most precise mapping of wetlands over the study area is that done as part of the wetland evaluation process by Ontario Ministry of Natural Resources (MNR).Mapping is site by site, includes field visits and is usually at 1:10,000.Most mapping was carried out in the mid 1980's. These thousands of site maps have been compiled into summary maps by MNR District. The summary maps are at a variety of scales, most commonly 1:50,000 or 1:100,000. Summary maps are not necessarily precise at the site level but are appropriate for regional overviews.

It should be noted that the evaluated wetlands do not include all wetlands in southern Ontario. The Wetland Mapping Series does estimate all wetlands by combining an analysis of wet soils and natural land cover. To create this coverage, existing regional soils and land cover maps were used rather than site visits.

It was decided to estimate land use adjacent to evaluated wetlands. While incomplete, they are the standard wetland data set referred to in the Ontario Wetland Policy and in planning decisions. Each one has been visited and its boundaries confirmed. Since several thousand have been evaluated throughout southern Ontario, it is assumed that evaluated wetlands represent southern Ontario wetlands in adjacent land use.

Land Use

The most recent, comprehensive and detailed map coverage of southern Ontario land use is the Agricultural Resource Inventory - Land Use. It was mapped by Ontario Ministry of Agriculture and Food - OMAF (now Ontario Ministry of Agriculture and Food and Rural Affairs) and Agriculture Canada representing conditions around the early 1980's. It covers southern Ontario south of the Shield. Data are presented by township at 1:50,000 (except Niagara Region at 1:25,000).The coverage presents agricultural land systems which reflect farm operation types. Each farm is classified on the basis of crop mixes and proportions from two years of data. One year's data was from air photo interpretation; the other year's data was from a roadside field visit. The intention was to create a map of longer term validity than one based solely on crop distribution in any one year. There have been some changes in operation types since the early 1980's, especially from tobacco systems, but for an overview of regional farming trends, the data are considered appropriate (B. Van den Broek, pers. comm.).

Besides farm systems, other land uses such as idle land, woodlots, extraction, recreation and built-up areas were mapped. The legend includes wetlands but the polygons usually correspond only to non-treed types - marshes and bogs. Treed wetlands (eg. swamps) are often within the woodland category. Since the Land Systems emphasis was on upland land uses and because swamps were excluded, MNR's wetland boundaries are much more accurate.

The Land Systems legend is presented in Appendix A. Minor variations in legend occurred in several counties.

Topographic maps (National Topographic System 1:50,000) provide non-agricultural land use information very accurately. They are more precise for woodlot location than the Agricultural Land Systems. They locate urban areas as well as all rural buildings, distinguishing between houses and barns. They also note various other land uses such as parks, airports, golf courses, dumps. For southern Ontario, most map dates are mid 1980's.

Combined Wetland and Land Use

Over several years, Ontario Ministry of Agriculture and Food undertook a project to collect all the MNR District summary maps of evaluated wetlands (up to 1991) and transfer all wetland outlines onto the township Agricultural Land Systems maps. The resulting map set provides a tool for interpreting land use adjacent to wetlands. Because of the 1:50,000 scale and the processes of reduction and transfer of the wetland data from the site mapped 1:10,000 scale, the accuracy of individual wetland boundaries onto the land use cannot be guaranteed. The maps are considered appropriate, however, for a regional scale of interpretation, when the results for many wetlands are combined (D. Rouleau, pers. comm.).

For the Lake Erie basin (see Figure 1), federal and provincial environmental agencies have created GIS databases which include Land Systems data and evaluated wetland location (as well as soil, slope, overland delivery ratio, and wetland watershed data). Wetland location was derived from the MNR District summary maps but refined using interpretation of the National Topographic System map data (Snell and Cecile Environmental Research, 1992b). While the intention is to link these databases, which would provide immediate analysis of land use adjacent to the 546 evaluated wetlands in the Lake Erie basin, unexpected project delays have prevented this step (K. Willson, pers. comm.).The hardcopy of wetland location at 1:50,000, however, was available.

Ontario Ministry of Natural Resources (MNR) has documented land uses adjacent to some individual wetlands. A province-wide compilation is not possible, however, since time constraints have limited the numbers completed (G. Hooper, pers. comm.).

Representative Sample Areas

A sample of 8 1:50,000 National Topographic System (NTS) map sheets in southern Ontario produced results of proportions of recent (1966 - 1978) wetland conversions (Bardecki, 1984) very close to those found in a study of data covering all of southern Ontario from 1967 to 1982 (Snell, 1987).Both found that agriculture accounted for 85% of losses. This correspondence would suggest that Bardecki's sample is representative of southern Ontario conditions for at least recent wetland loss.

4.2 Choice of Representative Sample Areas

The measurement of adjacent land uses for all evaluated wetlands in southern Ontario (many thousands of polygons) was considered neither feasible within the project time and cost constraints nor necessary. Comparison of results from Bardecki (1984) and from Snell (1987) suggest the validity of using samples to provide an estimate of wetland/land use interactions for southern Ontario. Bardecki's 8 sample areas,however, limit the ability to determine spatial differences across the study area. It was decided to pick a sample set intermediate in size between Bardecki's and the complete study area, with enough representation across the study area to indicate spatial trends.

Sample units were set as 1:50,000 NTS sheets. They were considered a more manageable size for choice of samples than the much smaller townships or much bigger counties. Townships would require many more samples to be representative; counties would each cover too great an area for effective sampling. Use of NTS map sheets parallels the Bardecki approach which worked well for recent wetland loss analysis. It also facilitates application of the method which refers to NTS maps.

To assist the choice of a representative sample of NTS sheets, reference was made to maps summarizing the agriculture and wetland situation in southern Ontario by township (Snell and Cecile Environmental Research, 1992a: for Eastern Habitat Joint Venture - EHJV).

A plastic overlay of an NTS index map was created to place over the EHJV township summary maps. Occurrence proportions were made using a dot grid. For the analysis, the EHJV maps' extent was adjusted to be roughly similar to the study area. Renfrew County was dropped from the analysis since it was not on the wetland map. The large low density population area roughly corresponding to the Shield was omitted from the Rural Non-Farm Residential Development analysis.

The following criteria were used for choice of sample NTS sheets:

- sample set wetland occurrence approximately that of southern Ontario;
- sample set generalized agriculture land useoccurrence approximately that of southern Ontario;
- sample set rural non-farm residential development distribution approximately that of southern Ontario;
- inclusion of urban areas of varying size and from different parts of southern Ontario;
- representation of recreational uses (within the constraints of the overall study area south of the Shield);
- inclusion of sample lakeshore marshes;
- map sheets spread across southern Ontario;
- inclusion of Bardecki's set to allow comparison of results.

These criteria were considered together, juggling choice of map sheets to maximize them all. To avoid introduction of any bias to the findings, no reference was made to the township land. systems maps of land uses abutting wetlands.

The sample areas were tested for their representativeness with respect to agriculture by comparing the total sample coverage of agricultural occurrence with that of all southern Ontario townships.

4.3 Method for Mapping and Measurement of Land Uses Adjacent to Wetlands

The method used the OMAF Land Systems with the MNR Evaluated Wetlands summary maps. These summary maps had been transferred by OMAF or, for the Lake Erie/St. Clair Basin, by Snell and Cecile Environmental Research (1992b). These data were supplemented by NTS information.

Outside the Lake Erie/St. Clair basin, a mylar sheet was overlaid on the OMAF combination maps.Each wetland was outlined using coloured pencils coded to each adjacent land use. OMAF Land Systems units were combined into:

Row Crop (Continuous Row Crops, Corn, and Tobacco Systems)
Mixed and Grain (Mixed and Grain Systems)
Hay and Pasture (Hay, Pasture and Grazing Systems)
Specialty (Vegetables, Nursery and Fruit Systems)

Forest (Woodland, Pastured Woodland and Reforestation) Idle
(Idle 5 - 10 years or more).

Also noted for the remaining boundary were Built-Up, Extractive, Sod Farms, Recreation, Water and OMAF's estimate of Wetland.

The mylar with the colour coded outlined MNR wetlands was then overlaid on NTS maps to locate dense urban, rural non-farm residential and roads, and other uses - eg. golf course, conservation area, water.

Within the Lake Erie basin (shown on Figure 1), earlier reference to the NTS maps was possible using the existing mylar of revised wetland boundaries. There, forest extent was based on NTS data. This change and the revised wetland boundaries mean Lake Erie basin data are likely to be more accurate at the site level than the remainder but both areas fall into the regional accuracy class.

The method was developed over several drafts, testing each and revising for improved accuracy and ease of application.

Each colour coded boundary stretch was measured using a map measurer and compiled by wetland. To maintain consistency, one person measured all the 1:50,000 maps.

For the detailed Method, see Appendix B. The Appendix also includes the list of areas within the sample NTS map sheets but not covered by the OMAF map set and therefore excluded from the study area. Their extent is indicated by the blank areas within the sample area polygons in Figure 1.

Owen Sound District had submitted their wetland map to OMAF at a very small scale (D. Rouleau, pers. comm.). It was decided to minimize its representation while maintaining the criteria of the sample selection. For those included (41A/9, 41A/11 and a small part of 41A/9) the wetland boundaries were refined based on NTS information (flat contours, wetland symbols or natural areas). This was most evident on 41A/11.

The area of the sample areas was based on the total land area for which there was available data plus wetlands in water bodies. A planimeter was used.

5.0 Results

5.1 Sample Choice

Twenty-seven NTS sheets were chosen, about 1/4 of the total number of map sheets covering southern Ontario. They were:
30L/14 (Welland),
30M/11 (Toronto), 30M/13 (Bolton), 30M/15 (Oshawa),
30N/14 (Wellington),
31B/13 (Merrickville),
31C/2 (Bath), 31C/8 (Gananoque), 31C/10 (Tichborne),
31D/1 (Rice Lake), 31D/5 (Barrie), 31D/10 (Fenelon Falls),
31G/3 (Winchester), 31G/7 (Alexandria),
40I/15 (Tillsonburg),
40J/2 (Essex), 40J/6 (Windsor), 40J/8 (Chatham), 40J/16 (Sarnia),
40P/4(Parkhill), 40P/6(St. Marys), 40P/8(Cambridge),
40P/10 (Conestogo), 40P/14 (Wingham),
41A/1 (Dundalk), 41A/9 (Nottawasaga Bay), 41A/11 (Wiarton).

They are located by NTS map numbers on Figure 1. The 8 map sheets labelled with a B on Figure 1 were the sample set used by Bardecki (1984).

5.1.1 Attainment of Selection Criteria

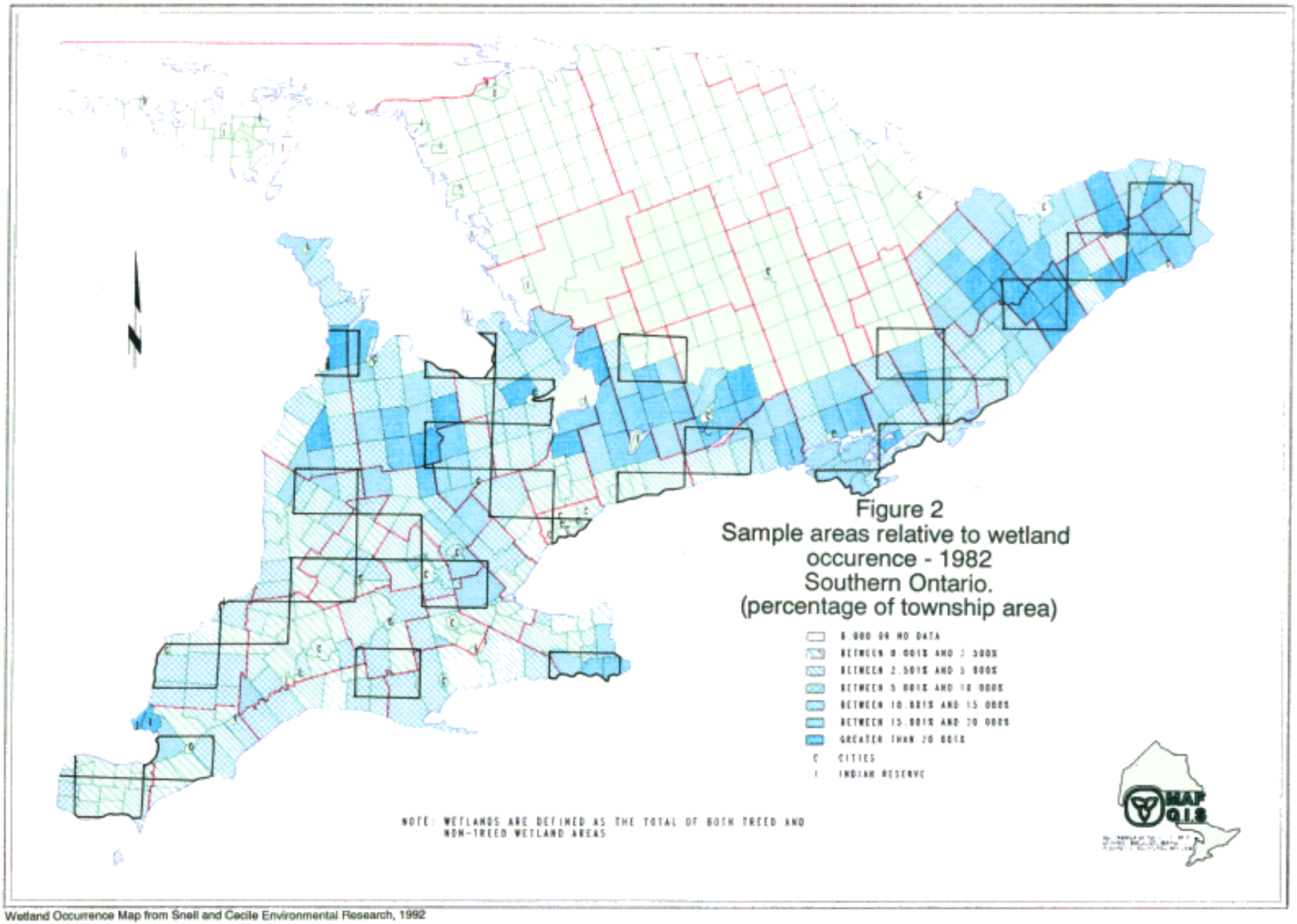
The fulfilment of each of the selection criteria listed in Section 4.2 is discussed below.

Representativeness of Wetland Occurrence

Review of Figure 2 suggests very close sample representation to that of total wetland occurrence in southern Ontario (see Table 1).

Table 1: Representativeness of Wetland Occurrence (by Township)

Wetland Occurrence	% of Southern Ontario	% of Sample
< 5% of area	30	29
5.01-10%of area	30	33
>10% of area	40	38



Wetland Occurrence Map from Snell and Cecile Environmental Research, 1992

Representativeness of Generalized Agricultural Land Use

Review of Figure 3 supports very close sample representation of the distribution of township classification of agricultural land use (see Table 2).

Table 2: Representation of Generalized Agricultural Land Use (by Township)

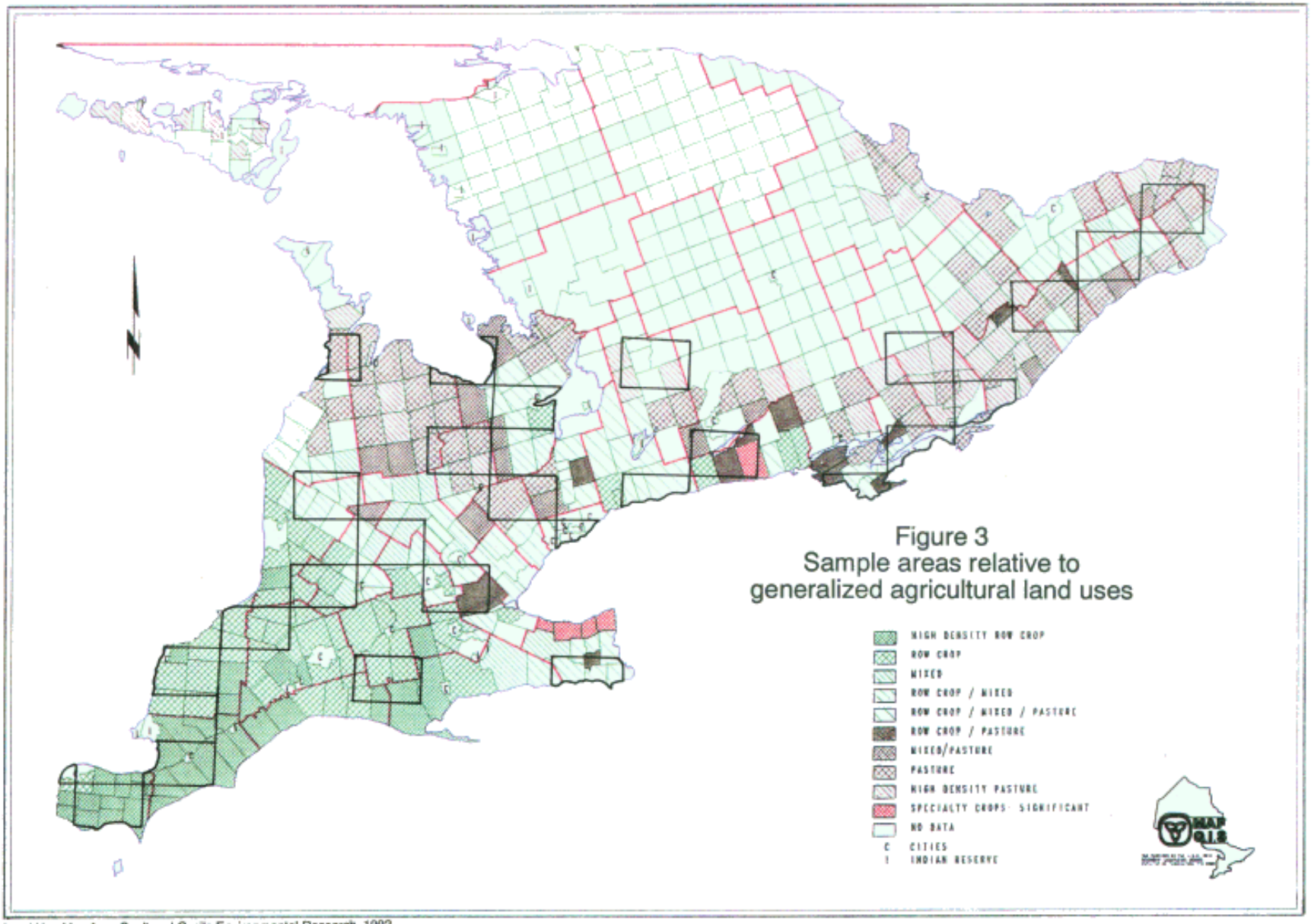
General Agricultural Land Use	% of Southern Ontario	% of Sample
High density row	12	12
Row Crops	20	18
Mixed	5	6
Row/Mixed	4	5
Row/mixed/Pasture	17	18
Row/Pasture	3	4
Mixed/Pasture	5	4
Pasture	24	21
High density Pasture	10	12

Representation of Rural Non-Farm Residential *Development*

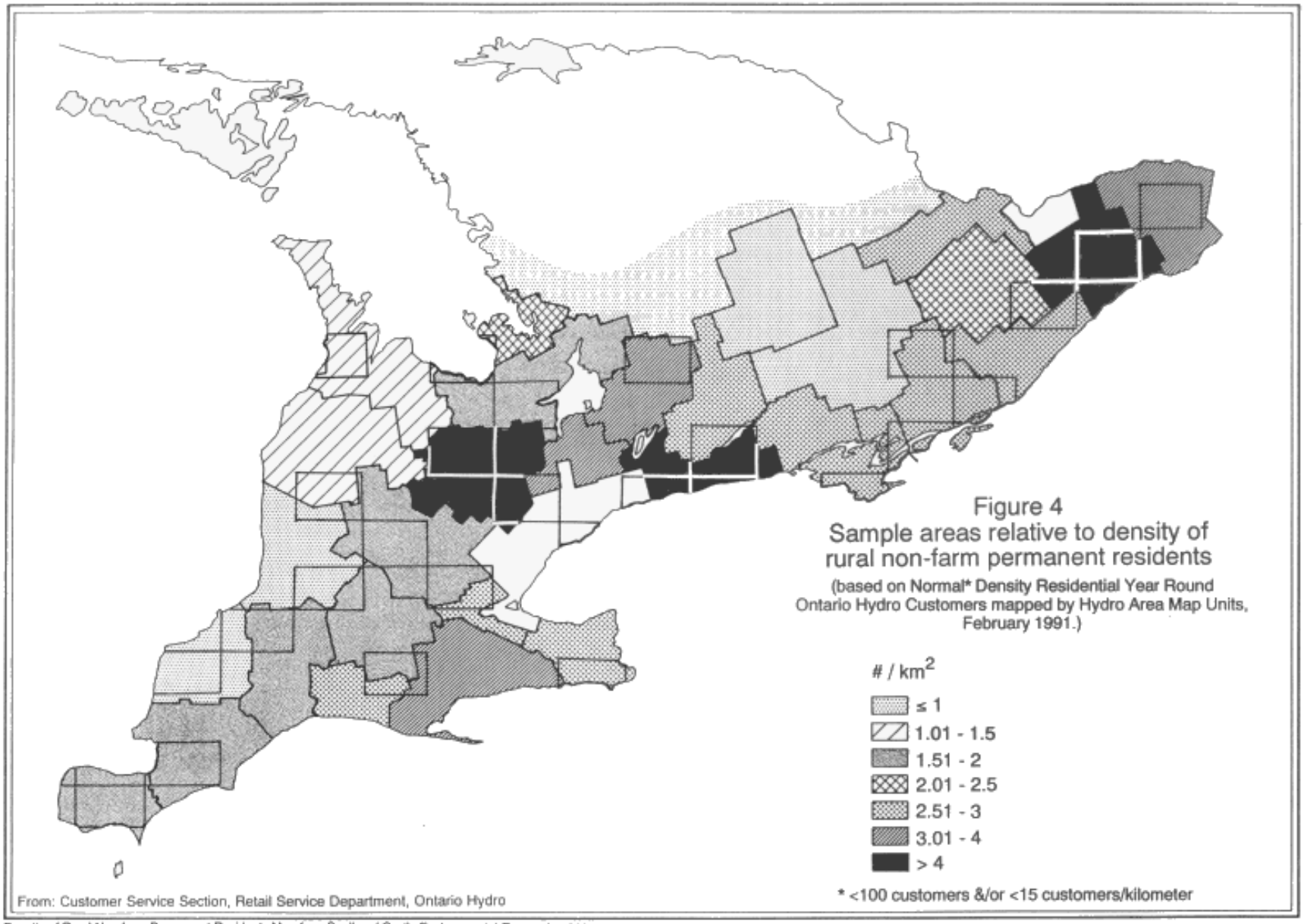
Table 3 shows that rural non-farm residential development is represented in approximate proportion to that of southern Ontario (see Figure 4). Given the low resolution of Figure 4's map units, this correspondence was judged adequate.

Table 3: Representativeness of Rural Non-Farm Residential Development (by Hydro Units)

Density (#/sq. km.)	% of Southern Ontario	% of Sample
< 1	8	11
1 - 1.5	12	7
1.5 - 2	26	30
2 - 2.5	5	2
2.5 - 3	22	22
3 - 4	15	12
> 4	12	16



Land Use Map from Snell and Cecile Environmental Research, 1992



Density of Rural Non-farm Permanent Residents Map from Snell and Cecile Environmental Research, 1992

Inclusion of Urban Areas, Recreational Uses, and Lakeshore Marshes

Urban areas of varying size and from different parts of southern Ontario are part of the sample including at least part of: Windsor, Chatham, Stratford, Kitchener/Waterloo, Guelph, Toronto, Welland, Barrie, Oshawa, Kingston.

Recreational uses (within the constraints of the overall study area generally south of the Shield) are represented by Fenelon Falls, Prince Edward County, and Collingwood areas.

Sample lakeshore marshes are covered including at least parts of Oliphant Marshes (Lake Huron); Lake St. Clair marshes; Hillman Marsh, (Lake Erie); Oshawa Second Marsh, Prince Edward County and Hay Bay Marshes (Lake Ontario); and St. Lawrence River marshes in the Gananoque area.

The samples probably over-represent urban areas and lakeshore marshes (i.e. >1/4 in each case).This will ensure no bias in over-representing agricultural influences. Results will be a conservative estimate of agriculture contact with wetlands in southern Ontario.

Spatial Distribution

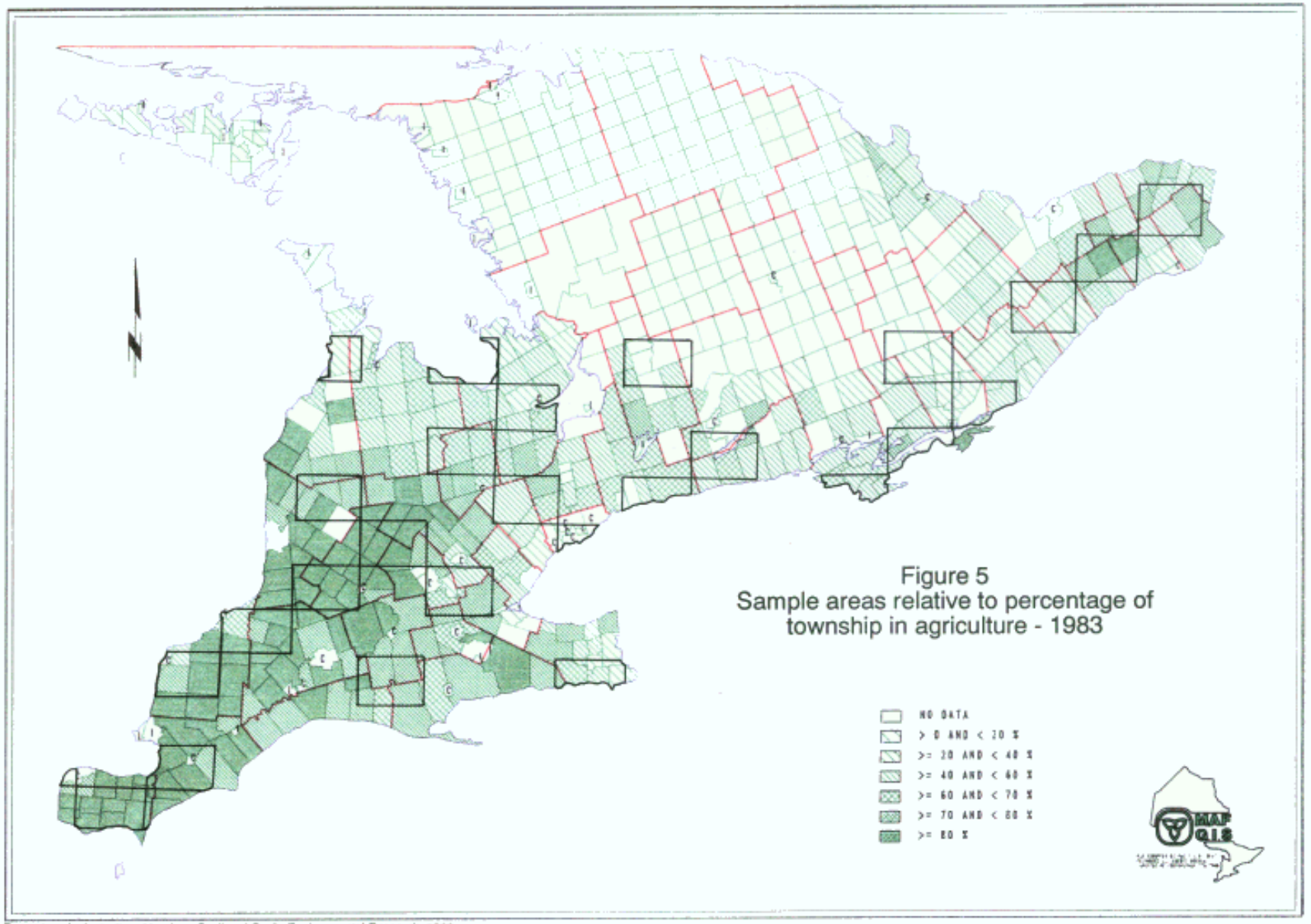
No two sample map sheets have a common side; yet no two sample map sheets have more than one intervening unsampled map sheet in some direction (north, south, east, west, or diagonally across an intervening map sheet). This distribution helps ensure one part of the province is neither over-represented nor under-represented.

5.1.2 Test of Sample Areas Representation of Agricultural Occurrence

Review of Figure 5 offers the results of the representation of sample areas for agricultural occurrence presented in Table 4.

Table 4. Representation of Agricultural Occurrence (by Township)

Agriculture Occurrence	% of Southern Ontario	% of Sample
0 - < 40	15	14
40 - <60	18	24
60 - <80	41	39
80 and greater	26	24



Percentage in Agriculture Map from Snell and Cecile Environmental Research, 1992

The results show good correspondence. The slight over representation of the 40 - 60 % class at the expense of higher classes supports the contention that the results may be a slightly conservative estimate of agricultural contact with wetlands.

5.2 Land Uses Abutting Evaluated Wetlands

5.2.1 Total Results for All Sample Areas

In total, 6704.6 kilometres of wetland perimeter were measured within a study area of 21,445 square kilometres.

Figure 6 presents the percentage of wetland perimeter by land use for all samples. Forest dominates at 39%. It is followed by Hay/Pasture/Grazing Systems (18%), Row Crop Systems (11%), and Mixed/Grain Systems (9%). Idle Land, Water and OMAF mapped wetland are each in the 4 to 6% range. Of the Built-up types, Rural Development: Roads and Non-farm Residences dominates.
The land use types were summarized into general types as follows:
Natural Land combines Forest, Idle and OMAF Wetland

Agriculture	combines Row Crop, Traditional Mixed/Grain, Hay/Pasture/Grazing, and Specialty
Built-Up	combines Dense Built-Up, Dispersed Built-Up and Rural Roads and Non-Farm Residential
Other	combines Extraction, Sod and Recreation

The percentage of wetland perimeter by general land use types (Figure 7) shows half of the measured wetland perimeter abutted natural land uses. Agriculture was the other major adjacent land use, accounting for 40% of the perimeter. Built-Up uses were adjacent to wetlands 5% of the perimeter; Water accounted for 4% of the total wetland perimeter.

Perimeter, percentage of the total perimeter and relative occurrence (perimeter per square kilometer of study area) data for each land use type are presented in the All Samples row at the bottom of the Tables in Appendix C.

5.2.2 Results by NTS Sample Areas

The data are illustrated in Figures 8 to 11.The relative occurrence (meters of perimeter per square kilometer of study area) presents the data independently of sample area. This assists spatial comparison in a map format. Comparison among sample areas indicates the relative density of that land use abutting wetlands. Each histogram also indicates the relative proportion of abutting landuses within the sample area.

Figure 6: Percentage of Wetland Perimeter by Land Use for all Samples

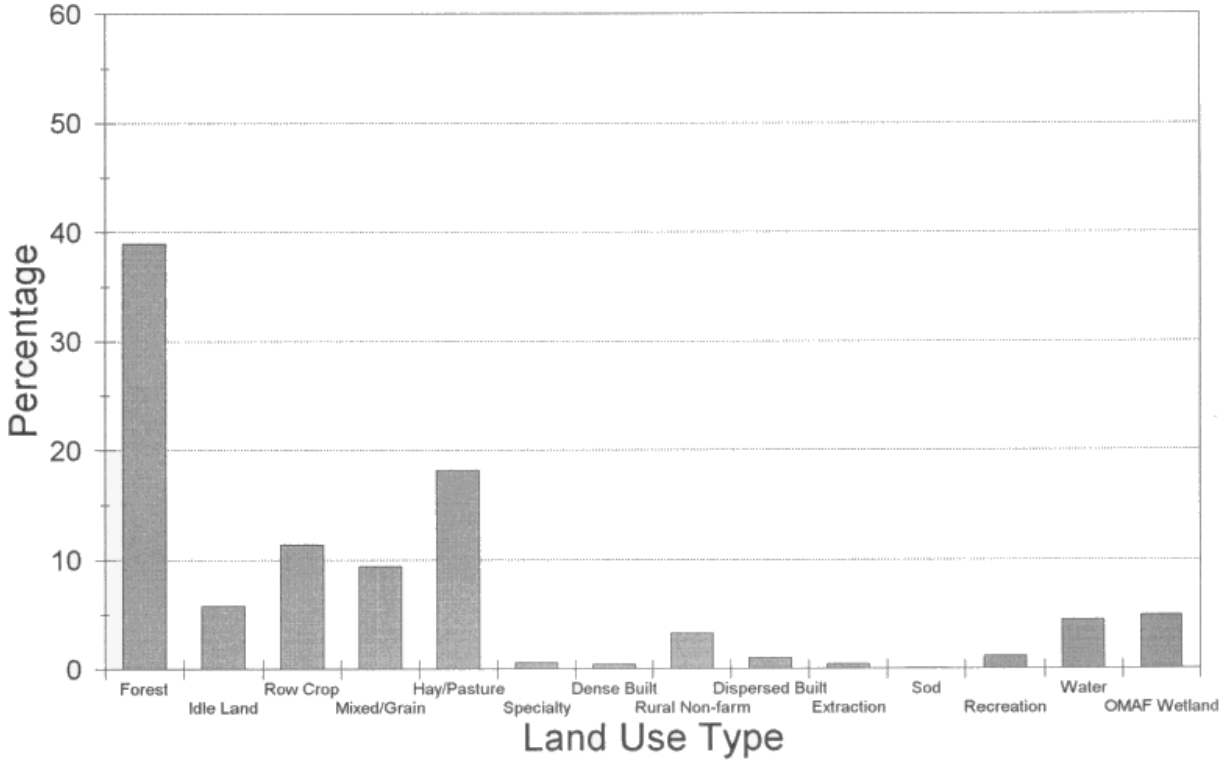
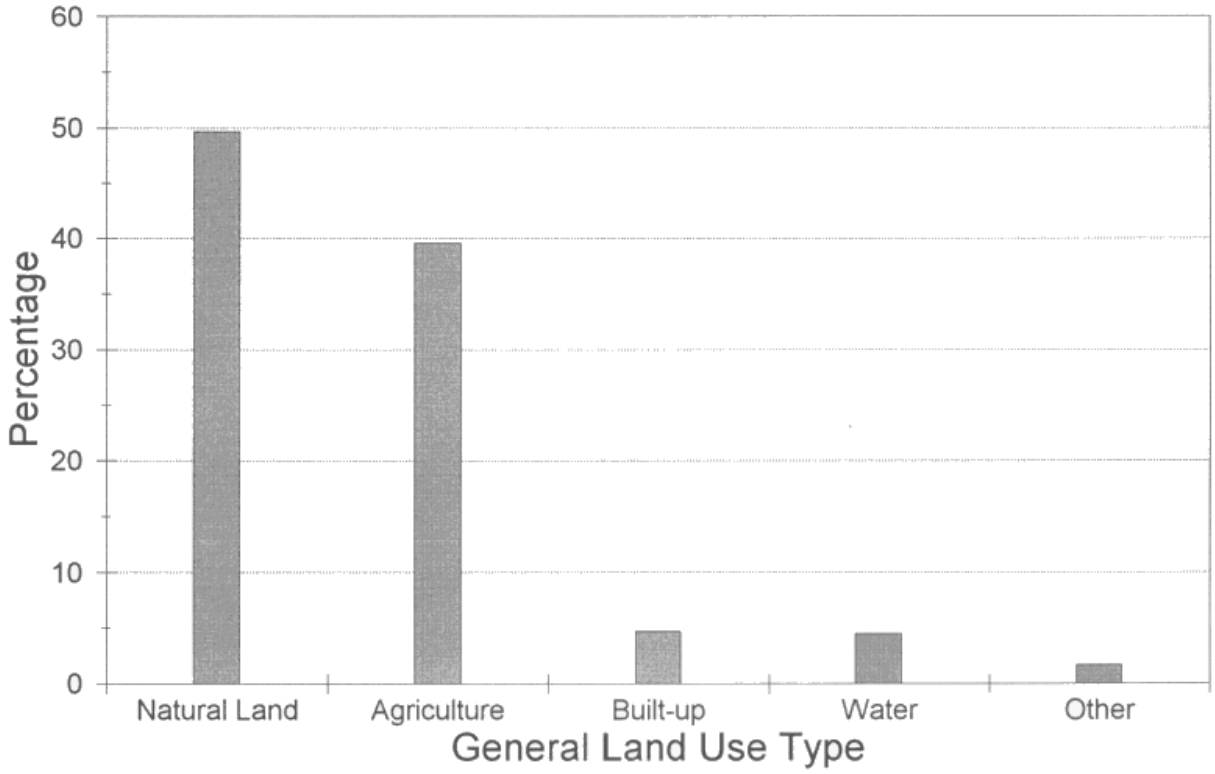


Figure 7: Percentage of Wetland Perimeter by General Land Use for all Samples



(Comparison between maps is not suggested since the occurrence scales differ.)

Numerical data for each NTS sample area are presented in Appendix C. These include measured perimeters of each land use type (Table C-1), perimeters as a percentage of the total perimeter (Table C-2), and relative occurrence data (Table C-3). In Table C-4, the specific land uses are summarized into the general land use types, presenting the perimeter, percentage and relative occurrence data for each.

5.2.1.1 General Land Use Types

Figure 8 presents the distribution of general land use types abutting evaluated wetlands.

Total occurrence of evaluated wetland is indicated by the total bar length for each NTS sample area. Evaluated wetlands were least concentrated in extreme southwestern Ontario and Toronto samples and most concentrated in the areas of Welland (30L/14), Cambridge (40P/8), Wingham(40P/14), Wiarton (41A/11)and Merrickville (31B/13).

Natural uses and Agriculture dominated the abutting use profile everywhere except Toronto (30M/11) and Windsor (40J/6). Built-up uses adjacent to wetlands were most evident in the areas of Welland (30L/14) and Cambridge (40P/8). Water occurrence is associated with shoreline samples.

5.2.1.2 Natural Land Types

Figure 9 presents the distribution of specific abutting land uses within the Natural general land use category. Forest dominates in all cases but Chatham (40J/8) where almost none occurs. Idle land has very little occurrence beside wetland in southwestern Ontario but shows significant occurrences in the Welland (30L/14), Cambridge (40P/8) and Merrickville (31B/13) areas. OMAF mapped wetland appears most notably in the Merrickville (31B/13) area. This area has a high density of wetland and forest area but a low density of agriculture. OMAF land use mapping emphasis was on agriculture so in such an area as Merrickville, wetland was very generally outlined. MNR mapping was more precise and often within the OMAF wetland polygon.

5.2.1.3 Agricultural System Types

Figure 10 presents the distribution of specific system types within the Agriculture general land use category. The distribution of occurrence reflects the general occurrence of agricultural types (see Figure 3) as well as of evaluated wetland. In Figure 10, Hay/Pasture/Grazing Systems occurred most often abutting evaluated wetlands. Relative to other agriculture, it tends to

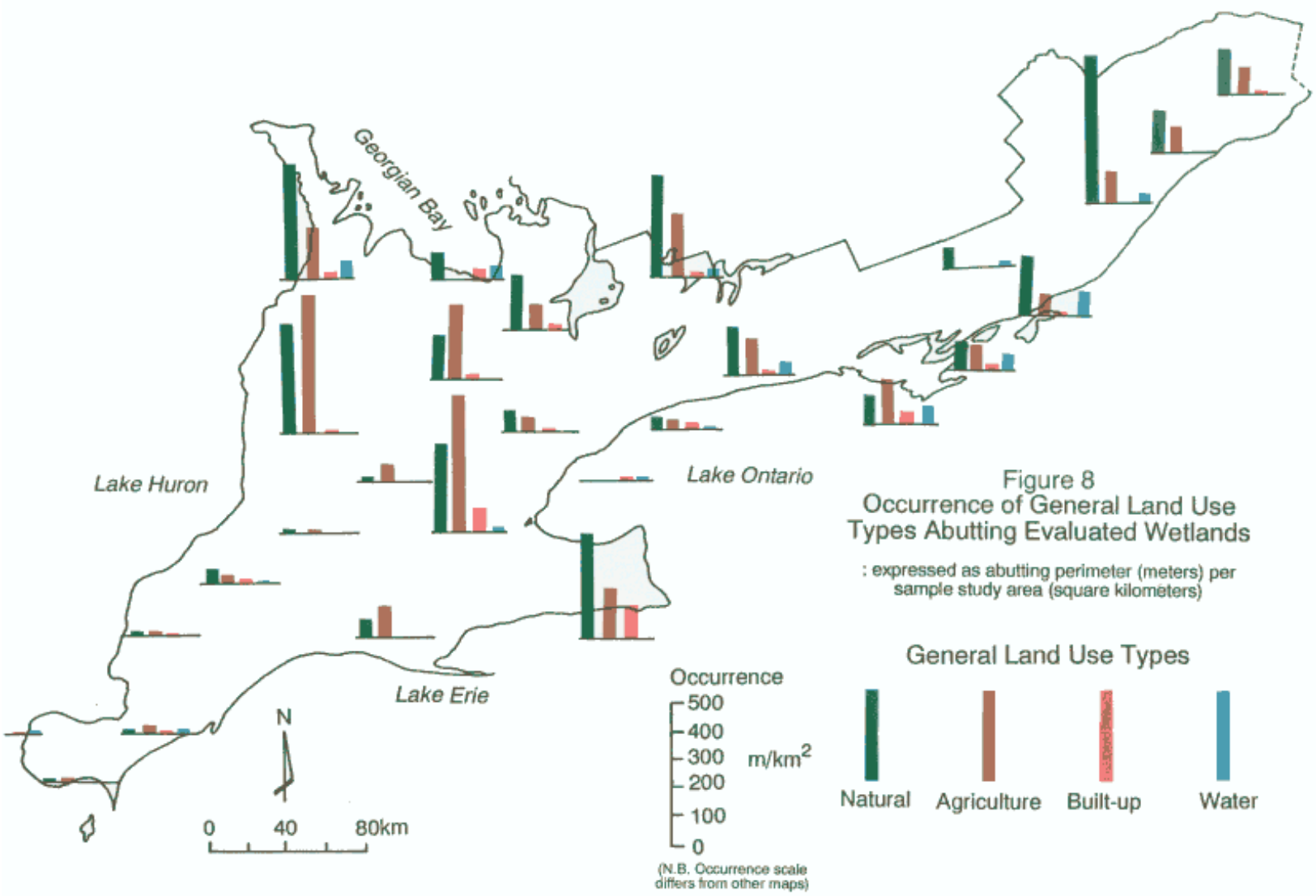


Figure 8
Occurrence of General Land Use Types Abutting Evaluated Wetlands

: expressed as abutting perimeter (meters) per sample study area (square kilometers)

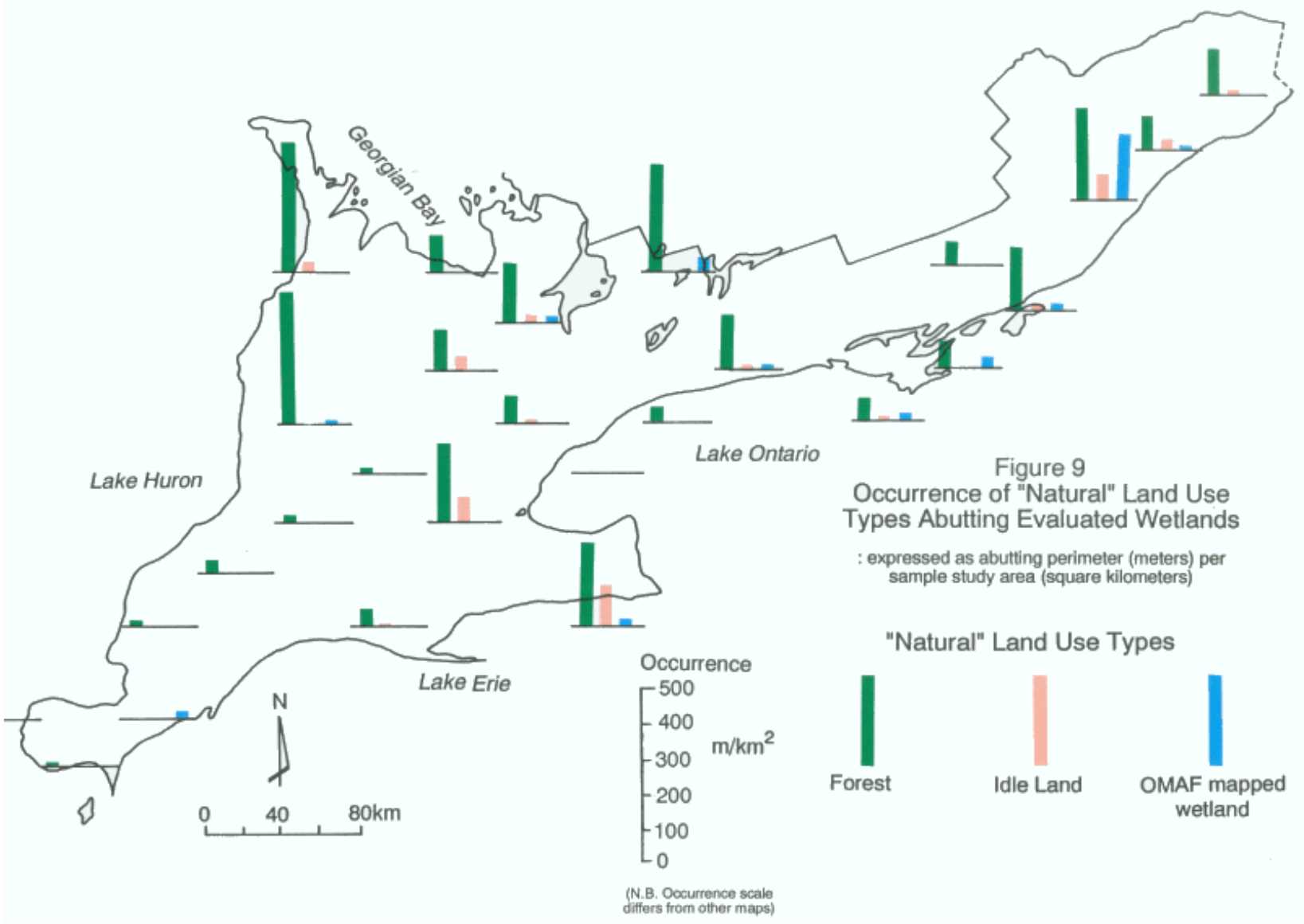


Figure 9
Occurrence of "Natural" Land Use Types Abutting Evaluated Wetlands

: expressed as abutting perimeter (meters) per sample study area (square kilometers)

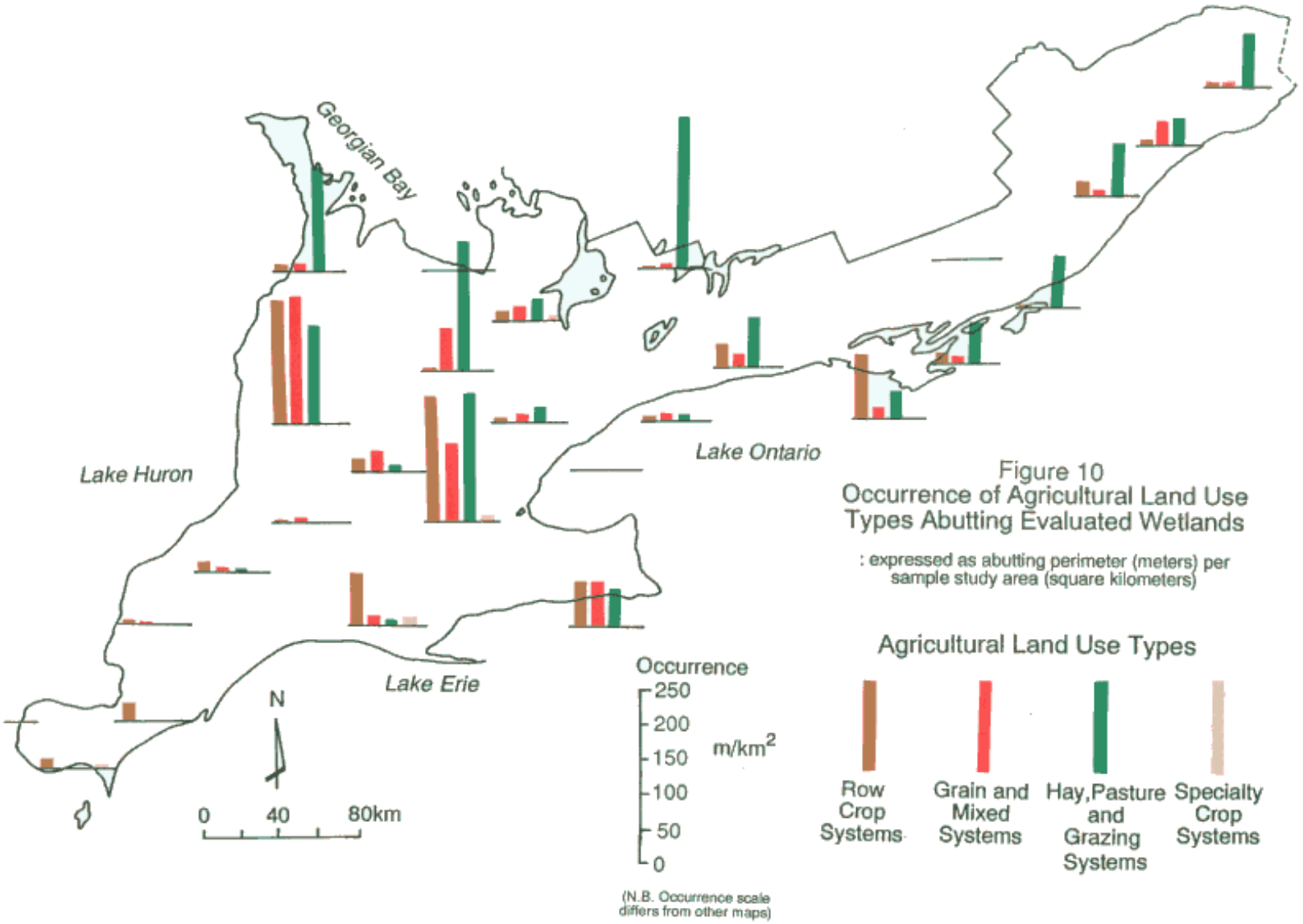


Figure 10
Occurrence of Agricultural Land Use Types Abutting Evaluated Wetlands

: expressed as abutting perimeter (meters) per sample study area (square kilometers)

dominate towards the north and eastern sets of samples. Cambridge also rates high in occurrence. Relative to the other agricultural types for each sample, Row Crops dominated in southwestern Ontario and Wellington (Prince Edward County).Wingham and Cambridge had the highest occurrences. These two sample areas also had the highest occurrences of Traditional Mixed and Grain Systems. Only in Wingham and Welland areas did this system type occur more often than any of the others.

5.2.1.4 Built-Up Types

Figure 11 presents the distribution of specific system types within the Built-Up general land use category. Rural built-up (i.e. roads and non-farm residential) dominated the three types everywhere but Toronto, Windsor and Sarnia. It showed high occurrences adjacent to wetlands in Welland, Cambridge, Nottawasaga Bay (Collingwood) and Wellington (Prince Edward County) areas. Urban (dense built-up) and sub-urban (dispersed built-up) development adjacent to wetlands appeared most densely in Welland, Cambridge, Barrie, Oshawa and Bath areas.

5.3 Comparison of Sample Set with Bardecki Sample Set

Figures 12 and 13 compare the results of study sample set with those if only the Bardecki set were used. Figure 12 illustrates all land use types; Figure 13 illustrates the general land use types. In both cases the trends of the two sample sets are similar. The study sample set includes more built-up and water perimeter at the expense of natural and agricultural perimeter. This could be expected from the sample choice criteria. Both built-up and water were stressed to ensure agriculture was not over-represented. On the other hand, Bardecki's sample set avoided all cities and Great Lakes shoreline except in the Oshawa area.

5.4 Variation of Abutting Land Use by Wetland Class

Provincially significant wetlands show similar trends of abutting land use as shown by regionally/locally significant wetlands (Table 5).Natural and agricultural land uses predominate for both. Within each general land use type, provincially significant wetlands have slightly higher percentages for all types but agriculture. This is likely influenced by factors in the evaluation which assign value based on near-by land use (eg. social values higher near cities; biological values higher with natural links). Parkland (included in Recreation land use type) may tend to be established near provincially significant wetlands.

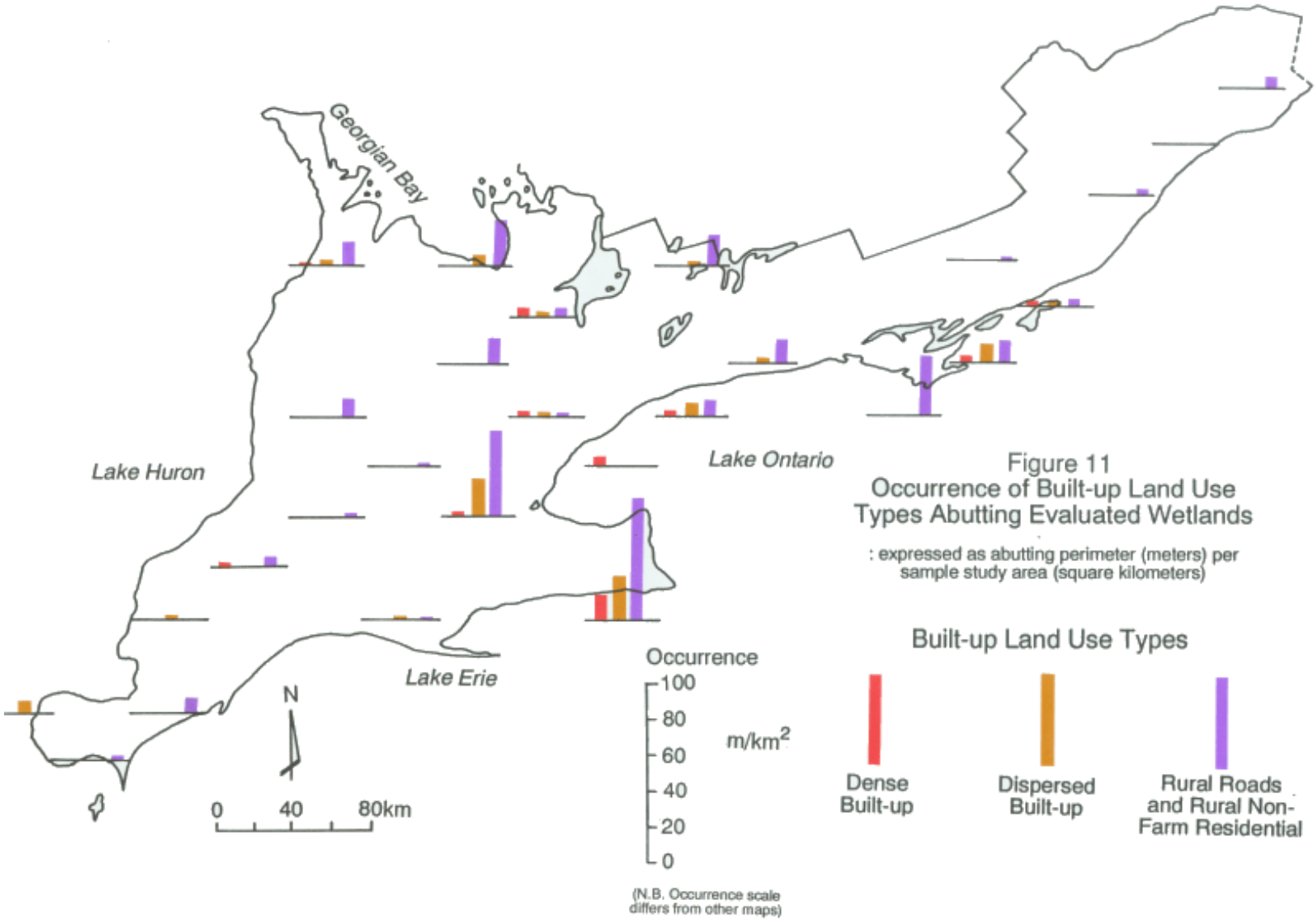


Figure 11
Occurrence of Built-up Land Use Types Abutting Evaluated Wetlands

: expressed as abutting perimeter (meters) per sample study area (square kilometers)

Figure 12: Percentage of Wetland Perimeter by Land Use and by Sample Set

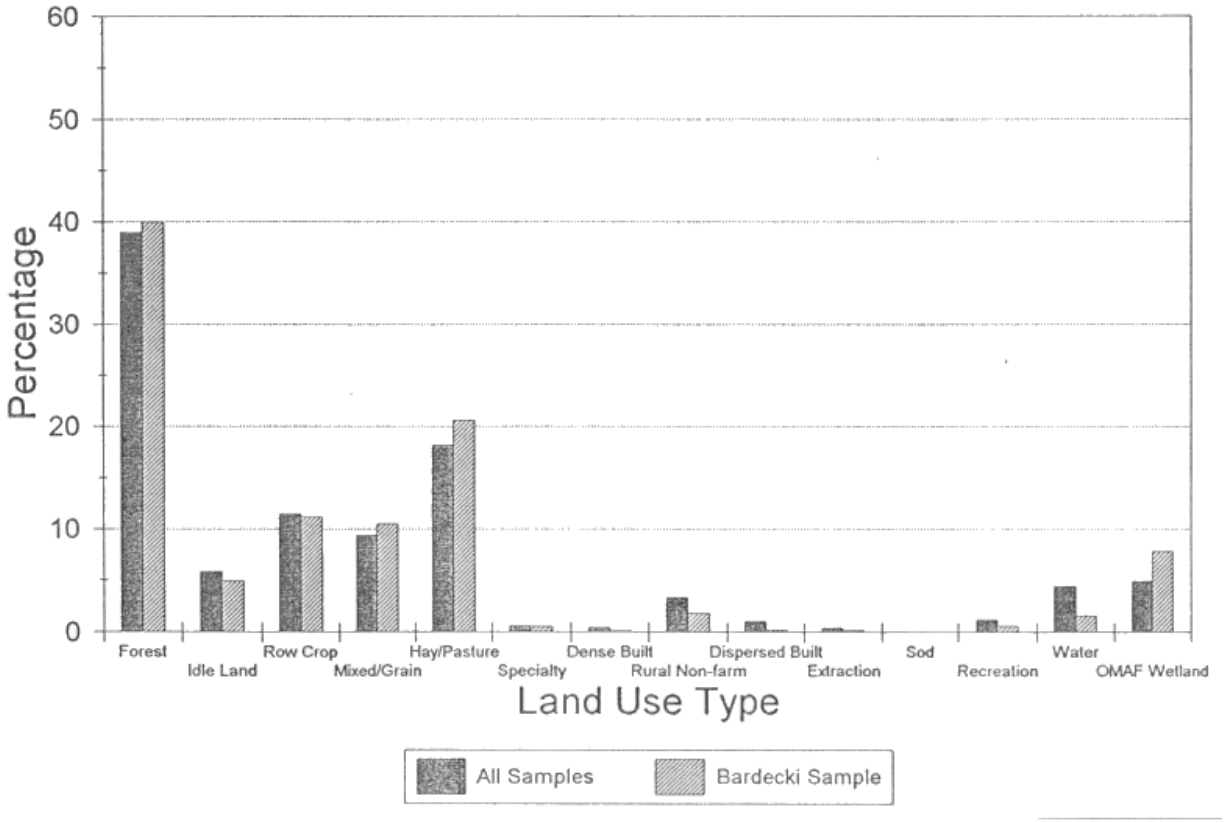


Figure 13: Percentage of Wetland Perimeter by General Land Use and by Sample

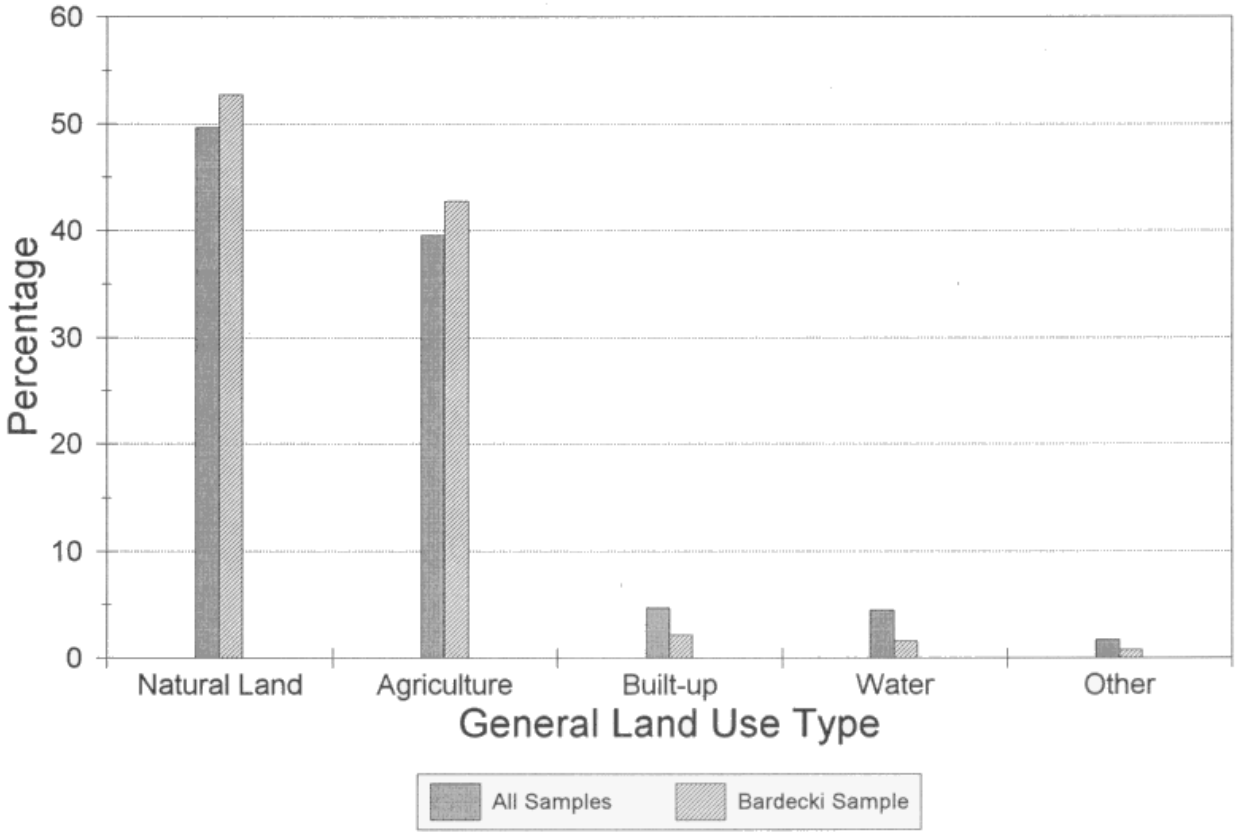


Table 5: Percentage of Wetland Perimeter for Each General Land Use: by Wetland Significance

Wetland Significance	Total Perimeter	Natural Land	Agriculture	Built-up	Water	Recreation	Extraction
Provincial (Classes 1-3)	4450.2	50.1	37.3	5.4	5.0	1.6	0.6
Regional/Local (Classes 4 -7)	2123.5	47.8	45.6	3.3	2.7	0.3	0.1

The large peat extraction operation in the Class 1 Wainfleet Bog affects the Extraction percentages.

Table 5 is expanded to distinguish each wetland class and each land use type in Appendix D.

5.5 Accuracy

The representativeness of the sample discussed in Section 5.1.1 and 5.1.2 is confirmed by its close correspondence to the Bardecki results. The inclusion of approximately 1/4 of southern Ontario offers a large sample, also helping to assure accuracy of the final percentage results.

The method used the strengths of the interpreted databases to maximize accuracy. The Agricultural Land Systems maps were used for agriculture, the NTS maps for built-up and water as well as forest where feasible. It is felt the accuracy fits the needs of the study.

Measurements were recorded *by* wetland polygon but the scale of the maps (mostly 1:50,000) would indicate that individual site results may not always be precise. The addition of tens and sometimes hundreds of polygons for any one NTS sample area, however, produces results suitable to the map scales and accurate for regional and southern Ontario trends and totals.

One person measured almost all the maps, minimizing inconsistencies. A check of the measurements indicates good accuracy but suggests that very short perimeter stretches were slightly underestimated due to limitations of the perimeter measuring device. This would most affect the Built-Up and Extraction categories. The outcome would be slightly underestimated results for these types. On the other hand, this tendency will be counterbalanced by the method of map interpretation which exaggerated these uses. While NTS data, because of its greater accuracy for non-agricultural uses, took precedence over Land Systems data for Built-Up, Extractive, Recreation and Water where they were indicated on NTS maps, if the Land Systems showed those uses elsewhere, they were also included. Dispersed built-up category is the most common example of this phenomenon, representing 196 of the total wetland perimeter. The intention was to ensure that no such use would be overlooked. The net effect may be close to actual percentages at a provincial level.

Checks included review of record tables against computer records to assure correct input. Each colour coded perimeter map was briefly reviewed to confirm the totalled proportions and amounts by NTS sample area appeared correct, and to confirm that measurements had not missed any wetlands.

Welland (30L/14) data was largely 1:25,000 with more built-up use resolution on the land use coverage than elsewhere. While this may explain a small part of why this sample area had higher built-up occurrence, the 1:50,000 map NTS confirms the higher concentration of built-up uses. The Welland River wetland alone accounts for a great deal of the built-up category with the city of Welland, rural non-farm residences and roads along much of its lengthy perimeter. The 1:50,000 NTS map also confirms that wetlands along Black Creek and beside Port Colborne include high proportions of built-up. It is concluded that the scale and land use coverage differences for 30L/14 do not greatly alter the results.

The level of accuracy is considered appropriate for the regional trends and total proportions required by the study.

6.0 Conclusions

The sample study areas set appears to be broadly representative of southern Ontario conditions based on the selection criteria used.

The results indicate that half of southern Ontario evaluated wetland boundaries are protected by at least a narrow natural or semi-natural vegetation buffer.

For the remaining half, agriculture is the dominant wetland neighbour. Within agriculture, Hay/Pasture/Grazing systems are most common, but Row Crop systems and Traditional Mixed/Grain systems also abut wetlands in substantial amounts. The results indicate that the inclusion by farm organizations of a wetlands unit in the Environmental Farm Plan was appropriate.

Built-up uses are adjacent to wetlands for only 5% of the sample perimeter. Within built-up uses, much of the wetland perimeter abuts rural roads and residences.

Quantifying adjacent land use interactions solely on the basis of perimeter omits factors of intensity of adjacent effects. Such an inclusion would likely raise the importance of adjacent built-up use interactions with wetlands.

Adjacent land uses are only one of many ways wetlands are influenced by human activity. Long-range impacts can occur from a whole watershed through stream quality and quantity. Other interactions include lake effects, atmospheric effects, and direct intrusion. This study does not address any of these influences nor the land uses involved.

7.0 References

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APPENDIX A:

OMAF Agricultural Resource Inventory:
Agricultural Land Use Systems and Non-System Land Uses

FIELD CROPS

P) CONTINUOUS ROW CROPS Single intensive crop type, i.e. corn or beans. Also includes any combination of corn, white beans, soybeans or other varieties of beans in rotation. the entire area except for topographically limited portions and non-systems use must be row crop. corn dryers and elevator storage systems are good indicators. Often barns are absent except for a machine shed(s). There must be no grain crops or hay. Usually very large fields often with on fence boundaries.

C) CORN SYSTEM A rotation system in which corn and/or beans occupy more than 40%, but less than 100% of the area. The remainder is composed of grain and hay. A small proportion (less than 10%) may be pasture. Usually silos and corn cribs are good indicators of this system. There may also be a complex of barns which indicate feeding of dairy, beef or hogs.

M) MIXED SYSTEM A rotational system composed of grain, corn or beans and hay in roughly equal proportions. No crop dominates the system and fields are generally small. Barns are usually the older type and silos are smaller and less numerous. Associated with a traditional farming system. Sod crops cover more than 20% of the area. Corn and beans together occupy less than 40% of the area.

MG) GRAIN SYSTEM A combination of sod crops and grains in which grain is predominant, occupying more than 85% of the area and in some cases as much as 100%. the field sizes are usually large with fences often absent. A lower intensity cash cropping system. There are no row crops; good quality hay or pasture may compose up to 15% of the area.

H) HAY SYSTEM A rotational system in which good quality hay and pasture predominate. Very small amounts of corn may be present, typically less than 5 acres. Hay must be the largest proportion of the system.

HG) PASTURE SYSTEM Sod crops constitute the whole area with little or no rotation. Poor quality weedy hay and/or pasture cover more than 50% of the area. Associated with extensive or unconfined grazing of livestock. There should be minimal evidence of recent cultivation.

G) GRAZING SYSTEM Native grass pasture where topography precludes the use of machinery. Usually on poorer land where slopes, river valleys, rock outcrops or shallow soils occur. Most often seen in association with another system.

FRUIT AND GRAPE SYSTEMS

PE) PEACHES Primarily tender fruit production with cherries dominant. Peaches occupy more than 50% of the area, cherries less than 20% of the area. The remainder is a combination of other fruit and grapes.

CH) CHERRIES Primarily tender fruit production with cherries dominant. Cherries occupy more than 50% and peaches less than 20% of the area. The remainder is other fruit or grapes.

PC) PEACHES-CHERRIES Primarily tender fruit production with peaches and cherries together being dominant. Peaches plus cherries occupy more than 50% of the area, but neither by itself is more than 50%. the remainder is other fruit and/or grapes.

OR) ORCHARD Primarily hardy fruit production, usually with a combination of pears, plums and apples dominant. Orchard must occupy more than 90% of the area. If peaches and/or cherries occur, they must occupy less than 50% of the area.

V) VINEYARD Primarily grape production with vines occupying more than 90% of the area.

OV) ORCHARD-VINEYARD A combination of fruit and grape production with hardy fruit dominant. Hardy fruit occupies more than 40% but less than 90%, peaches and/or cherries less than 50%, the remainder is grapes.

VO) VINEYARD-ORCHARD A combination of grape and fruit production with grapes dominant. Grapes occupy more than 60% but less than 90% of the area. The remainder is fruit.

BE) BERRIES Strawberry, raspberry, blueberry or other bush-berry production including associated fallow or plough-down crops. Does not include berries interplanted with fruit trees.

SPECIALTY AGRICULTURE

KF) EXTENSIVE FIELD VEGETABLES Large fields of cucumbers, broccoli, tomatoes, peas, etc. Includes associated fallow or plough-down crops.

KM) MARKET GARDENS/TRUCK FARMS Small intensive plots of lettuce, onions, carrots, celery and the like. In general, these operations will be less than 30 acres in size.

KT) TOBACCO SYSTEM Tobacco occupies more than 50% of the area, but corn in rotation may occur. Includes associated plough-down or fallow crops.

KN) NURSERY Intensive production of trees, shrubs, vines or flowers for transplant or sale. Includes associated fallow or plough-down crops.

NON-SYSTEM LAND USES

A1) IDLE AGRICULTURAL LAND Land idle for 5-10 years and in a state of reversion to natural vegetation. Small alders, willows or thorn bushes are several feet in height.

A2) IDLE AGRICULTURAL LAND Land idle for more than 10 years and supporting native vegetation. The re-growth is larger than that which can normally be cleared by farm machinery.

Z) WOODLAND Forest cover with a minimum of 45% crown closure density and not less than one hectare in area.

Zp) PASTURED WOODLAND Woodlands that are grazed by livestock. Typical characteristics are evidence of browsing, cow-paths, manure, distinct cut-offs of vegetation on the lower branches of trees.

Zr) REFORESTATION Land supporting a stand of artificially stocked trees.

B) BUILT-UP Urban related uses, including churches, cemeteries, rural strip developments of four or more houses, transformer stations, sewage lagoons or water treatment facilities.

X) SWAMP, MARSH OR BOG Swamp, marsh or boggy areas supporting vegetation characteristic of a poorly drained area.

E1) EXTRACTION TYPE 1 Sand and/or gravel pits and quarries.

E2) EXTRACTION TYPE 2 Topsoil removal.

T) SOD FARMS Public or commercial sale of grass sod.

R) RECREATION Recreation facilities such as parks, picnic areas, campgrounds, drive-in theatres and conservation areas. Recreation facilities inside urban areas not to be identified.

W) WATER Large bodies of flowing or standing water, sufficiently large to require mapping. In general, these bodies should occupy three hectares or more.

APPENDIX B:

Detailed Method for Mapping and Measurement of Land Uses Adjacent to Wetlands

DETAILED METHOD FOR MAPPING AND MEASUREMENT OF LAND USES ADJACENT TO EVALUATED WETLANDS

B.1 Method for wetlands in the Lake Erie/St. Clair Basin (see Figure 1)

Equipment Required:
ruler, eraser, masking tape, map measurer, pencil sharpener, pencils: pink, red, orange, yellow, dark green, light blue, dark blue, purple, brown, black, and 6H; Record Sheets (2 kinds), mylar.

1. For a sample NTS sheet, obtain:
   - the 1:50,000 NTS map
   - OMAF Land systems maps for all townships all or partially on the NTS map
   - the mylar of the Lake Erie basin wetland locations

2. Cut a piece of mylar just large enough to cover the relevant part of the NTS sheet (i.e. not Great Lakes or non-Ontario land)

3. Tape the outlined wetlands mylar onto the NTS map carefully lining up reference points, concentrating on the ones in the township being checked. Then tape the new mylar over. With a black pencil carefully draw the map frame. Transfer the township boundaries, label the townships, and transfer a few reference road intersections in each township - all using the paper NTS reference.

4. Go around the outline of each wetland, tracing that boundary in dark green wherever a green (forested) polygon on the NTS map extends at least 1 mm beyond the wetland boundary.

5. For the remaining wetland boundary, where the wetland abuts or is within 2 mm (100 m) of a pink (built-up) area or of large buildings (black polygons) on the NTS map, trace the boundary with dark blue.

6. Checking only the remaining uncoloured boundary, where the wetland has non-farm buildings (small square black polygons without:
   - an associated small black rectangle i.e. barn, or
   - silo, or
   - greenhouses or kilns (usually labelled);

   within 2 mm (100 m) of the boundary draw, trace the boundary with red. Also include under red any part of the boundary within 2 mm (100 m) of a road or railroad.

7. Checking the remaining uncoloured boundary, if any other land use is specified (e.g. golf course, conservation area, river, lake) draw purple over that part of the boundary. Label the use.

8. Remove both mylars and place them on each township Land System, carefully aligning them using the township boundary and road intersections.

   For each wetland, for remaining uncoloured boundary, trace the outline of the wetland, using the following colour codes to indicate the land use directly abutting the wetland:

   A1, A2 - light blue (Idle)
   P, C, KT - orange (Row Crop)
   M, MG - pink (Traditional Mixed and Grain)
   H, HG, G - yellow (Hay and Pasture)
   PE, CH, PC, OR, V, OV, VO, BE, KF, KM, KN - light brown (Specialized Agriculture)

   Any remaining gaps in the wetland boundary, except Z, Zr or Zp, outline in 6H pencil and label as shown on the Land Systems (with notches between 2 that are adjacent).

   Where the OMAF map shows Z, Zp, Zr (Wooded) along uncoloured boundaries (i.e. the NTS did not show green), colour the boundary the colour of the non-forested land use judged the closest (or use 6H and a label if that's the closest). If the polygon is a definite Zp make the boundary yellow; if a definite Zr, make it light blue.

   Remember to include islands of upland within the wetland.

   If the Land Systems were not mapped (eg. National Defence properties or Indian Reservations), outline the area in red and the wetlands in purple.

9. For wetland complexes with numerous polygons, divide the complex into units of "manageable" numbers using a dashed line, labelling each sub-unit with a letter.

10. With the black pencil indicate a "starting point" on each wetland polygon boundary. For ease of finding it, place it near the north end at a colour change point if possible.

11. This step may be easiest with the mylar on a blank white background. Pick a wetland or sub-unit of a complex. Fill out the record sheet with the wetland identifier, including the letter if it is a sub-unit of a complex. Omit the class column. Check the measurer is set to zero. Starting at the starting point of each polygon, go around each polygon carefully measuring with the map measurer the length boundary abutting the dark green, stopping once the starting point is reached again. Always go the same direction with the measurer i.e. go counterclockwise with the face of the measurer always facing inside the polygon. (This ensures continual accumulation of distance without inadvertent subtractions). Be careful not to bump the setting wheel. If there is more than one polygon in the sub-unit, do the same with the other polygons without adjusting the map measurer. Once the green boundary is all measured for the sub-unit, note the distance on the measurer and enter it into the record sheet under "Dark Green".

Set the measurer to zero. Repeat the measurement procedure for each of the other colours, (Light Green will be zero), setting the measurer to zero before starting a different colour and noting the distance when a colour is completed. When the colours are completed repeat the same procedure for any 6H line segments, measuring one letter at a time.

For a few very short stretches in one colour or code, a quick visual estimate of length using the scale bar can be done instead of using the measurer.

If the wetland extends off the NTS sheet do not measure the boundary along the map frame. Also ignore a common boundary with another wetland or the same wetland at a township boundary.

For purple coded perimeter, assign uses to categories as follows:

Extraction for Pits, Quarries, Tailings, Dumps, Gas Wells
Recreation for Parks, Campsites, Golf Courses, Conservation Areas, Trailer Parks, Bird Sanctuaries
Built-Up for Communications Towers, Airports, Community Centres, Lumber Yards, Junk Yards, Conveyors, Sewage Treatment Plants, Cement Plants, Cemeteries

12. When one township portion of the NTS sheet is completed, repeat for the other township portions. For each new NTS sheet or township, start a new record sheet, labelling it accordingly.

B.2 Method for wetlands outside the Lake Erie/St. Clair Basin

Equipment Required:
ruler, eraser, masking tape, map measurer, pencil sharpener, pencils: pink, red, orange, yellow, light green, light blue, dark blue, purple, brown, black, and 6H; Record Sheets (2 kinds), mylar.

1. For a sample NTS sheet, obtain:
   - the 1:50,000 NTS map
   - OMAF Land Systems/MNR Wetlands maps for all townships all or partially on the NTS map

2. Cut a piece of mylar just large enough to cover the relevant part of the NTS sheet (i.e. not Great Lakes or non-Ontario land)

3. Tape the mylar to the NTS map, and with a black pencil carefully draw the map frame. Transfer the township boundaries, label the townships, and transfer a few reference road intersections in each township. Remove the mylar.

4. Place the mylar on each township Land System, carefully aligning it using the township boundary and road intersections. For each wetland, outline the wetland using the following colour codes to indicate the land use directly abutting the wetland:

   A1, A2 - light blue (Idle)
   P, C, KT - orange (Row Crop)
   M, MG - pink (Traditional Mixed and Grain)
   H, HG, G - yellow (Hay and Pasture)
   PE, CH, PC, OR, V, OV, VO, BE, KF, KM, KN - light brown (Specialized Agriculture)
   Z, Zp, Zr - light green (Wooded)

   If any is less than 1 mm wide go with the next abutting polygon.
   Any remaining gaps in the wetland boundary, outline in 6H pencil and label as shown on the Land Systems (with notches between 2 that are adjacent). Remember to include islands of upland within the wetland.

   If the Land Systems were not mapped (eg. National Defence properties or Indian Reservations), outline the area in red and the wetlands in purple.

   If anomalies occur at township boundaries which cannot readily be lined up by a slight shift when referring to NTS information, map the perimeter in each township as shown on the OMAF maps.

5. Move the mylar to the NTS sheet, carefully lining up reference points but also, if required, slightly shifting the wetland to fit NTS information. For each wetland in the township:

5a. Where the wetland is bounded by or is 2 mm (100 in) away front a pink (built-up) polygon or large buildings (large black polygons), draw a dark blue line over any existing colour or pencil line. Fix the pencil labels if these steps make them unclear.

5b. Where the wetland has non-farm buildings (small square black polygons without:
- an associated small black rectangle i.e. barn, or
- silo, or
- greenhouses or kilns (usually labelled);

within 2 mm (100 m) of the boundary draw, dark red over any existing colour or pencil line except green. Also include under red any part of the boundary within 2 mm of a road or railroad.

5c. If any other land use is specified (e.g. golf course, conservation area, river, lake) draw purple over that part of the boundary except green and red and label the use on the mylar.

If a township boundary corresponds with a river and wetland occurs on both sides, link the wetland into one unit unless the river is >2 mm (>100 m) wide and has no marsh symbols. In that case, draw a purple line along the river boundary on both sides.

6. For wetland complexes with numerous polygons, divide the complex into units of "manageable" numbers using a dashed line, labelling each sub-unit with a letter.

7. With the black pencil indicate a "starting point" on each wetland polygon boundary. For ease of finding it, place it near the north end at a colour change point if possible.

8. This step may be easiest with the mylar on a blank white background. Pick a wetland or sub-unit of a complex. Fill out the record sheet with the wetland identifier on the OMAF map, including the letter if it is a sub-unit of a complex. Note the class using the colour code on the OMAF maps. Check the measurer is set to zero. Starting at the starting point of each polygon, go around each polygon carefully measuring with the map measurer the length boundary abutting the green, stopping once the starting point is reached again. Always go the same direction with the measurer i.e. go counterclockwise with the face of the measurer always facing inside the polygon.(This ensures continual accumulation of distance without inadvertent subtractions). Be careful not to bump the setting wheel. If there is more than one polygon in the sub-unit, do the same with the other polygons without adjusting the map measurer. Once the green boundary is all measured for the sub-unit, note the distance on the measurer and enter it into the record sheet under "Light Green". Dark Green will be a zero entry.

Set the measurer to zero. Repeat the measurement procedure for each of the other colours, setting the measurer to zero before starting a different colour and noting the distance when a colour is completed. When the colours are completed repeat the same procedure for any 6H line segments, measuring one letter at a time.

For a few very short stretches in one colour or code, a quick visual estimate of length using the scale bar can be done instead of using the measurer.

If the wetland extends off the NTS sheet do not measure the boundary along the map frame. Also ignore a common boundary with another wetland or the same wetland at a township boundary.

For Indian Reservations and National Defence properties, keep a separate Record Sheet for the red bounded area, noting only the total wetland perimeter under the purple column.

For purple coded perimeter, assign uses to categories as follows:

Extraction for Pits, Quarries, Tailings, Dumps, Gas Wells
Recreation for Parks, Campsites, Golf Courses, Conservation Areas,
Trailer Parks, Bird Sanctuaries

Built-Up for Communications Towers, Airports, Community Centres,
Lumber Yards, Junk Yards, Conveyors, Sewage Treatment Plants,
Cement Plants, Cemeteries

9. When one township portion of the NTS sheet is completed, repeat for the other township portions. For each new NTS sheet or township, start a new record sheet, labelling it accordingly.

B.3 Method for Adjusting for Variations in the Land Use Legends

Niagara (all but Dunnville on 30L/14)

Cut mylar to fit each township map (1:25,000). You probably won't need quite as many landmarks because there won't be switching between maps. Outline the wetland boundary using:

A1, A2 - light blue
J, CW - orange
M, SW - pink
H, HG, G - yellow
P, C, PC, O, V, OV, VO, K, N - light brown
Z, Zr - light green

With gaps, outline in pencil and label as on the land use map.
To link labels to those used on the other maps, for correct record entry:

R and 1 are Rural non-farm Residential = Red
U and T are Dispersed Built-Up = B
E is Extractive = E1/E2
S is Sod = T
Rec is Recreation = R.

Then referring to both the mylar overlaid on the land use map and to NTS, estimate the wetland position on the NTS and scan the boundary for any possible pink (urban), red (rural residential and roads) or "other land uses". If some look possible, sketch the wetland boundary for that section onto the NTS map using roads, streams etc. to locate the reduced boundary. From this information, colour the mylar boundary dark blue where pink polygons are within 2 mm (NTS scale), red where there are rural roads or non-farm residences within 2 mm, and purple where "other land uses" occur, labelling accordingly.

Measurement steps should keep in mind the 1:25,000 scale for reading the distances. Use the attached table to record measurements.

Haldimand-Norfolk (Delhi and Norfolk on 40I/15, and Dunnville on 30L/14)

Erase the orange and brown. Map as orange J, CW, T. Add SW to pink. Map P, C, 0, K and N as light brown. Depending how you noted the extra categories, this might be possible to adjust on the tables without measuring. For other uses:

Map Label	becomes	Study Label
U		B
E		E1, E2
S		T
Rec		R

Eastern Ontario (31G/3, 31G/7, 31B/13 except Elizabethtown, Kitley and Montague townships)
Please note that the light brown K labels do not have 2 letters but are just K; i.e. K is light brown.

B.4 Areas Within the NTS Map Sheets But Lacking Complete Data and Therefore Omitted from the Study Areas (shown as blank in Figure 1)

30L/14:	West Lincoln township
30N/14:	a very small property of Department of National Defense (DND)
31C/10:	Hinchinbrooke, Sheffield, Kennebec, Olden, Oso, South Sherbrooke, North Crosby townships
31D/1:	Percy township; Hiawatha, Alderville and Sugar Island Indian Reservations
31D/5:	CFB Borden
31D/10:	Carden, Bexley, Laxton Digby & Longford, Somerville, Galway & Cavendish, Harvey townships
31G/3:	Finch township
40J/8:	Walpole Island Indian Reservation, very small DND property
40J/16:	Sarnia Indian Reservation
40P/4:	Canadian Forces Camp Ipperwash; Kettle Point Indian Reservation; West Williams, Lobo outside the Lake Erie Basin, east half of McGillvray townships
41A/9:	Wasaga Beach
41A/11:	Saugeen and Chiefs Point Indian Reservations

SOUTHERN ONTARIO LAND USE BESIDE WETLANDS

LAKE ERIE/ST. CLAIR BASIN: NTS SHEET NUMBER:

NTS MAP TITLE:

				NTS Fores	OMAF Fore	Idle	Row	Mixed	Hay/Pas	Special	Town	Rural Res	Other	Built	Extract	Sod	Rec.	Water	Wetland
County	Township	Wetland	Class	Dark Green	Light Green	Light Blue	Orange	Pink	Yellow	Brown	Dark Blue	Red	Purple	B(U)	E1 /E2	T	R	W	X
																,			

APPENDIX C:

Data

Table C-1: Perimeter (kilometers) of Lands Uses Abutting Evaluated Wetlands: by NTS Sample Area

NTS Map	NTS Study Area (Sq. Km)	Forest	Idle Land	Agricultural Systems				Dense Built-up	Rural Non-farm & Roads	Dispersed Built-up	Extraction	Sod	Recreation	Water	OMAF Wetland	Total
				Row Crop	Mixed/ Grain	Hay/ Pasture	Specialty									
30 L/14	588	142.4	63.5	36.9	38.0	27.5	0.3	8.5	40.3	14.7	10.7	0.0	7.3	1.1	10.0	401.2
30 M/11	254	0.2	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	2.8
30 M/13	1114	85.5	7.4	6.0	14.9	26.5	1.2	1.6	1.1	1.3	0.0	0.0	0.1	1.8	0.1	147.8
30 M/15	578	20.8	1.8	4.6	5.5	5.0	0.6	1.0	5.3	4.8	0.5	0.1	5.6	4.7	0.6	60.9
30 N/14	395	24.4	2.3	38.9	5.9	18.3	0.2	0.0	12.9	0.0	0.0	0.0	6.0	23.7	10.0	142.5
31 B/13	1090	276.2	75.7	22.4	7.0	81.4	1.5	0.1	2.1	0.1	1.0	0.0	0.3	25.8	209.9	703.4
31 C/2	463	27.9	0.9	8.3	3.9	27.4	0.7	1.0	5.6	4.8	0.0	0.0	0.0	24.2	12.6	117.3
31 C/8	964	178.6	8.3	*2.2*	0.3	69 1	0.0	1.9	4.1	0.8	0.0	0.0	0.7	76.4	14.6	357.4
31 C/10	300	21.8	0.0	0.0	0.0	0.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	3.0	0.0	25.6
31 D/1	1006	153.7	6.3	36.4	19.9	68.2	0.0	0.0	12.0	2.6	0.3	0.0	0.5	43.6	7.8	351.2
31 D/5	952	160.1	20.1	19.1	25.2	29.8	6.5	7.0	6.1	3.0	0.5	1.2	1.6	1.2	11.6	293.0
31 D/10	318	100.2	0.2	1.1	*2.7*	59.0	0.0	0.0	5.9	0.3	0.5	0.0	0.0	8.1	14.2	202.2
31 G/3	878	83.2	31.4	6.6	32.0	33.1	0.3	0.1	0.4	0.1	0.8	0.0	0.3	0.0	12.7	200.9
31 G/7	1083	147.1	15.9	8.8	7.7	80.5	0.0	0.7	6.3	0.1	0.5	0.0	0.3	0.3	2.6	270.7
40I/15	1137	66.4	4.1	86.9	10.8	7.1	12.2	0.0	0.7	0.9	1.7	0.0	6.3	1.7	0.0	204.8
40 J/2	1088	6.7	0.0	11.2	0.0	1.0	2.2	0.0	2.3	0.0	0.0	0.0	8.7	1.0	0.1	33.2
40 J/6	65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	1.0
40 J/8	1019	0.2	0.0	29.0	0.0	0,3	1.3	0.0	9.2	0.7	0.0	0.0	1.5	15.7	15.2	73.1
40 J/16	1012	10.1	0.8	5.0	2.8	0.4	0.0	0.0	0.9	3.2	0.2	0.0	0.2	0.0	0.0	23.5
40 P/4	793	34.7	0.9	13.3	4.6	2.6	0.0	2.0	5.1	0.5	0.0	0.0	2.4	4.0	0.0	70.1
40 P/6	1150	15.3	0.0	3.0	4.4	0.9	0.7	0.0	0.9	0.0	0.0	0.0	0.0	0.3	0.0	25.5
40 P/8	1124	254.6	83.3	202.9	129.8	201.0	9.5	1.4	56.0	24.5	9.7	1.8	35.7	12.1	1.2	1023.3
40 P/10	1112	16.2	0.6	21.3	32.1	9.6	0.0	0.0	0.9	0.3	0.0	0.0	0.0	0.0	0.0	80.9
40 P/14	1116	416.2	4.4	190.9	200.6	157.9	0.0	0.0	11.5	0.4	1.1	0.0	1.6	2.1	5.4	992.0
41 A/1	1114	130.5	43.6	3.8	68.1	210.8	1.2	0.0	16.8	0.2	0.3	0.0	0.1	0.0	0.0	475.4
41 A/9	129	14.7	0.1	0.0	0.0	0.0	0.0	0.0	3.5	0.9	0.0	0.0	1.3	4.8	0.0	25.3
41 A/11	603	224.2	18.7	6.0	8.9	91.5	0.0	0.5	9.1	1.9	0.6	0.0	0.0	40.2	0.5	400.1
Total Samples	21445	2611.7	388.3	764.8	631.5	1219.0	38.4	26.8	219.0	66.6	28.4	3.1	80.5	297.8	329.1	6704.6

Table C-2: Percentage of Wetland Perimeter for Each Land Use: by NTS Sample Area

NTS Map	NTS Study Area (Sq. Km)	Total Perimeter (km)	Forest	Idle-Land	Agricultural Systems				Rural							
					Row Crop	Mixed Grain	Hay/ Pasture	Specialty	Dense Built-up	Non-farm & Roads	Dispersed Built-up	Extraction	Sod	Recreation	Water	OMAF Wetland
30 U14	588	401.2	35.5	15.8	9.2	9.5	6.8	0.1	2.1	10.0	3.7	2.7	0.0	1.8	0.3	2.5
30 M/11	254	2.8	7.1	0.0	0.0	0.0	0.0	0.0	35.7	0.0	0.0	0.0	0.0	0.0	57.1	0.0
30 M/13	1114	147.8	57.8	5.0	4.4	10.1	17.9	0.0	1.1	0.7	0.9	0.0	0.0	0.1	1.2	0.1
30 M/15	578	60.9	34.2	3.0	7.6	9.0	8.2	1.0	1.6	8.6	7.9	0.8	0.2	9.2	7.7	1.0
30 N/14	395	142.5	17.1	1.6	27.3	4.1	12.8	0.1	0.0	9.1	0.0	0.0	0.0	4.2	16.6	7.0
31 B/13	1090	703.4	39.3	10.8	3.2	1.0	11.6	0.2	0.0	0.3	0.0	0.1	0.0	0.0	3.7	29.8
31 C/2	463	117.3	23.8	0.8	7.1	3.3	23.3	0.6	0.9	4.8	4.1	0.0	0.0	0.0	20.6	10.7
31 C/8	964	357.4	50.0	2.3	0.6	0.3	19.3	0.0	0.5	1.1	0.2	0.0	0.0	0.2	21.4	4.1
31 C/10	300	25.6	85.2	0.0	0.0	0.0	2.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	11.7	0.0
31 D/1	1006	351.2	43.8	1.8	10.4	5.7	19.4	0.0	0.0	3.4	0.7	0.1	0.0	0.1	12.4	2.2
31 D/5	952	293.0	54.7	6.9	6.5	8.6	10.2	2.2	2.4	2.1	1.0	0.2	0.4	0.5	0.4	4.0
31 D/10	318	202.2	49.6	0.1	0.5	1.3	34.1	0.0	0.0	2.9	0.1	0.2	0.0	0.0	4.0	7.0
31 G/3	878	200.9	41.4	15.6	3.3	15.9	15.5	0.1	0.0	0.2	0.0	0.4	0.0	0.1	0.0	6.3
31 G/7	1083	270.7	54.3	5.9	3.3	2.8	29.7	0.0	0.3	2.3	0.0	0.2	0.0	0.1	0.1	0.9
40I/15	1137	204.8	32.4	2.0	42.4	8.2	3.5	6.0	0.0	0.3	0.4	0.8	0.0	3.1	0.8	0.0
40 J/2	1088	33.2	20.2	0.0	33.7	0.0	3.0	6.5	0.0	6.9	0.0	0.0	0.0	26.2	3.0	0.3
40 J/8	65	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	50.0	0.0
40 J/8	1019	73.1	0.3	0.0	39.7	0.0	0.4	1.8	0.0	12.6	1.0	0.0	0.0	2.1	21.5	20.8
40 J/16	1012	23.5	43.0	3.4	21.3	11.3	1.7	0.0	0.0	3.8	13.8	0.6	0.0	0.9	0.0	0.0
40 P/4	793	70.1	49.5	1.3	19.0	6.6	3.6	0.0	2.9	7.3	0.7	0.0	0.0	3.4	5.7	0.0
40 P/6	1150	25.5	60.1	0.0	11.6	17.3	3.5	2.8	0.0	3.5	0.0	0.0	0.0	0.0	1.2	0.0
40 P/8	1124	1023.3	24.9	8.1	19.8	1 2.7	19.6	0.9	0.1	5.5	2.4	0.9	0.2	3.5	1.2	0.1
40 P/10	1112	80.9	20.0	0.7	26.3	39.6	11.9	0.0	0.0	1.1	0.4	0.0	0.0	0.0	0.0	0.0
40 P/14	1 116	992.0	42.0	0.4	19.2	20.2	15.9	0.0	0.0	1.2	0.0	0.1	0.0	0.2	0.2	0.5
41 A/1	1114	475.4	27.5	9.2	0.8	14.3	44.3	0.3	0.0	3.5	0.0	0.1	0.0	0.0	0.0	0.0
41 A/9	129	25.3	58.1	0.4	0.4	0.0	0.0	0.0	0.0	13.8	3.5	0.0	0.0	5.1	19.0	0.0
41 A/11	603	400.1	56.0	4.2	1.5	2.2	22.9	0.0	0.1	2.3	0.5	0.1	0.0	0.0	10.0	0.1
All Samples	21445	6704.6	39.0	5.8	1 1.4	9.4	18.2	0.6	0.4	3.3	1.0	0.4	0.0	1.2	4.4	4.9
Bardecki Sample	7229	2979	40.0	4.9	11.1	10 5	20.6	0.5	0.1	1.8	0.2	0.2	0.0	0.6	1.6	7.8

Table C-3: Relative Occurrence of Land Uses Abutting Evaluated Wetlands: by NTS Sample Area

(Expressed as abutting perimeter (meters) per NTS study area (square kilometers))

NTS Map	NTS Study Area (Sq. Km)	Forest	Idle Land	Agricultural Systems				Rural								Total
				Row Crop	Mixed/ Grain	Hay/ Pasture	Specialty	Dense Built-up	Non-farm & Roads	Dispersed Built-up	Extraction	Sod	Recreation	Water	OMAF Wetland	
30 L/14	588	242.2	108.0	62.8	64.6	46.7	0.5	14.5	68.5	25.0	18.2	0.0	12.4	1.9	17.0	682.2
30 M/11	254	0.8	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	6.3	0.0	11.0
30 M/13	1114	76.7	6.6	5.8	13.3	23.7	1.1	1.4	1.0	1.2	0.0	0.0	0.1	1.6	0.1	132.6
30 M/15	578	36.0	3.1	8.0	9.5	8.7	1.0	1.7	9.1	8.3	0.9	0.2	9.7	8.1	1.0	105.3
30 N/14	395	61.6	5.8	98.4	14.9	46.3	0.5	0.0	32.7	0.0	0.0	0.0	15.2	60.0	25.3	360.8
31 B/13	1090	253.4	69.4	20.6	6.4	74.6	1.4	0.1	1.9	0.1	0.9	0.0	0.3	23.7	192.6	645.3
31 C/2	463	60.3	1.9	17.9	8.4	59:1	1.5	2.2	12.1	10.4	0.0	0.0	0.0	52.3	27.2	253.2
31 C/8	964	185.3	8.6	2.3	0.9	71.6	0.0	1.9	4.2	0.8	0.0	0.0	0.7	79.2	15.1	370.7
31 C/10	300	72.7	0.0	0.0	0.0	1.7	0.0	0.0	1.0	0.0	0.0	0.0	0.0	10.0	0.0	85.3
31 D/1	1006	152.7	6.3	36.1	19.3	6.8	0.0	0.0	11.9	2.6	0.3	0.0	0.5	43.3	7.8	349.1
31 D/5	952	168.2	21.1	20 1	26.5	31.3	6.8	7.4	6.4	3.2	0.5	1.3	1.7	1.3	12.2	307.7
31 D/10	318	315.1	0.6	3.5	8.5	216.8	0.0	0.0	18.6	0.9	1.6	0.0	0.0	25.5	44.7	635.7
31 G/3	878	94.8	35.8	7.5	36.4	37.7	0.3	0.1	0.4	0.1	0.9	0.0	0.3	0.0	14.5	228.8
31 G/7	1083	135.8	14.7	8.1	7.1	74.3	0.0	0.6	5.8	0.1	0.5	0.0	0.3	0.3	2.4	250.0
40I/15	1137	58.4	3.6	76.4	14.8	6.2	10.7	0.0	0.6	0.8	1.5	0.0	5.5	1.5	0.0	180.1
40 *J/2*	1088	6.2	0.0	10.3	0.0	0.9	2.0	0.0	2.1	0.0	0.0	0.0	8.0	0.9	0.1	30.5
40 J/6	65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	7.7	0.0	15.4
40 J/8	1019	0.2	0.0	28.5	0.0	0.3	1.3	0.0	9.0	0.7	0.0	0.0	1.5	15.4	14.9	71.7
40 J/16	1012	10.0	0.8	4.9	*2.7*	0.4	0.0	0.0	0.9	3.2	0.1	0.0	0.2	0.0	0.0	23.2
40 P/4	793	43.8	1.1	16.8	5.8	3.2	0.0	2.5	6.4	0.6	0.0	0.0	3.0	5.0	0.0	88.3
40 P/6	1150	13.3	0.0	2.6	3.8	0.8	0.6	0.0	0.8	0.0	0.0	0.0	0.0	0.3	0.0	22.1
40 P/8	1124	226.5	74.1	180.5	115.5	178.8	8.5	1.2	49.8	21.8	8.6	1.6	31.8	10.8	1.1	910.4
40 P/10	1112	14.6	0.5	19:1	28.8	8.6	0.0	0.0	0.8	0.3	0.0	0.0	0.0	0.0	0.0	72.7
40 P/14	1116	372.9	3.9	171.1	179.7	141.5	0.0	0.0	10.3	0.4	1.0	0.0	1.4	1.9	4.8	888.9
41 A/1	1114	117.1	39.1	3.4	61.1	189.2	1.1	0.0	15.1	0.2	0.3	0.0	0.1	0.0	0.0	426.7
41 A/9	129	114.0	0.8	0.0	0.0	0.0	0.0	0.0	27.1	7.0	0.0	0.0	10.1	37.2	0.0	196.1
41 A/11	603	371.8	27.7	9 9	148	151.7	0.0	0.8	15.1	3.2	1.0	0.0	0.0	66.7	0.8	663.4
All Samples	21445	121.8	18 1	35.7	29.4	56.8	1.8	1.2	10.2	3.1	1.3	0.1	3.8	13.9	15.3	312.6
Bardecki Sample	7229	164.9	20.3	45.9	43.3	84.9	2.1	0.5	7.4	1.0	0.8	0.0	2.3	6.5	32.2	412.1

Table C-4: General Land Uses Abutting Evaluated Wetlands: Perimeter, Percentage, and Relative Occurrence - by NTS Sample Area

NTS Map	NTS Study Area (sq. km)	Natural Land			Agriculture			Built-up			Water			Other (Recreation, Extraction, and Sod)		
		Perimeter (km)	% of Perimeter	Occurrence (m/sq km)	Perimeter (km)	% of Perimeter	Occurrence (m/sq km)	Perimeter (km)	% of Perimeter	Occurrence (m/sq km)	Perimeter (km)	% of Perimeter	Occurrence (m/sq km)	Perimeter (km)	% of Perimeter	Occurrence (m/sq km)
30 L/14	588	216	54	367	103	26	175	84	18	108	1	0	2	18	4	31
30 M/11	254	0	7	1	0	0	0	1	38	4	2	57	8	0	0	0
30 M/13	1114	93	83	83	49	33	44	4	3	4	2	1	2	0	0	0
30 M/15	578	23	38	40	16	28	27	11	18	19	5	8	8	6	10	11
30 N/14	395	37	28	93	63	44	180	13	9	33	24	17	80	6	4	15
31 B/13	1090	562	80	515	112	16	103	2	0	2	26	4	24	1	0	1
31 C/2	463	41	35	89	40	34	87	11	10	25	24	21	52	0	0	0
31 C/8	984	202	56	209	72	20	75	7	2	7	76	21	79	1	0	1
31 C/10	300	22	85	73	1	2	2	0	1	1	3	12	10	0	0	0
31 D/1	1006	168	48	187	124	35	124	15	4	15	44	12	43	1	0	1
31 D/5	952	192	65	201	81	27	85	18	5	17	1	0	1	3	1	3
31 D/10	318	115	57	360	73	38	229	6	3	19	8	4	25	1	0	2
31 G/3	878	127	63	145	72	36	82	1	0	1	0	0	0	1	1	1
31 G/7	1083	166	61	153	97	38	90	7	3	7	0	0	0	1	0	1
40I/15	1137	70	34	62	123	80	108	2	1	1	2	1	1	8	4	7
40 J/2	1088	7	20	8	14	43	13	2	7	2	1	3	1	9	26	8
40 J/6	65	0	0	0	0	0	0	1	50	8	1	50	8	0	0	0
40 J/8	1019	15	21	15	31	42	30	10	14	10	16	21	15	2	2	1
40 J/16	1012	11	46	11	8	35	8	4	17	4	0	0	0	0	1	0
40 P/4	793	36	51	45	20	29	26	8	11	10	4	6	5	2	3	3
40 P/8	1150	15	60	13	9	35	8	1	4	1	0	1	0	0	0	0
40 P/8	1124	339	33	302	543	53	483	82	8	73	12	1	11	47	5	42
40 P/10	1112	17	21	15	63	78	57	1	1	1	0	0	0	0	0	0
40 P/14	1116	426	43	382	549	55	492	12	1	11	2	0	2	3	0	2
41 A/1	1114	174	37	156	284	60	255	17	4	15	0	0	0	0	0	0
41 A/9	129	15	58	115	0	0	0	4	17	34	5	19	37	1	5	10
41 A/11	603	241	60	400	106	27	176	12	3	19	40	10	67	1	0	1
All Samples	21445	3325	50	155	2654	40	124	312	5	15	256	4	14	112	2	5
Bardecki Sample	7229	1571	53	217	1274	43	176	65	2	9	47	2	6	22	1	3

APPENDIX D

Percentage of Wetland Perimeter for Each Land Use: by Wetland Class

Wetland Class	Total Perimeter (km)	Forest	Idle Land	Agricultural Systems				Dense Built-up	Rural Non-farm & Roads	Dispersed Built-up	Extraction	Sod	Recreation	Water	OMAF Wetland
				Row Crop	Mixed/ Grain	Hay/ Pasture	Specialty								
1	2526.2	36.9	6.5	11.6	8.3	17.1	0.4	0.4	3.8	0.9	0.8	0.0	1 7	5.0	6.4
2	1250.1	36.1	6.9	11.3	7.9	16.3	1.0	0.3	3.9	1.9	0.2	0.0	1.7	5.7	6.8
3	673.9	42.7	4.9	8.2	8 5	20.9	0 4	0.5	3.2	1.2	0.4	0.0	1.5	3.7	3.8
4	383.8	48.8	0.8	12.3	11.9	16.1	0.0	0.0	1.9	0.3	0.1	0.0	0.3	5.3	2.3
5	834.1	42.4	4.2	15.8	13.1	16.9	0 4	0.0	1.7	0.6	0.1	0.2	0.2	2.5	1.8
6	586.0	34.7	6.0	8.8	13.3	*26.7*	0 7	1.4	3.8	0.5	0.2	0.0	0.7	2.1	1.2
7	319.6	39.6	8.6	12.7	9.1	19.6	1.6	0.0	2.1	0.8	0.3	0.0	0.1	1.3	4.3