

## **“Conserving soil, improving water quality and enhancing wildlife habitat on agricultural lands”**

Formerly Indicator # 7028

### **Overall Assessment**

Trend: Increasing

Rationale: The number of best management practices implemented on private agricultural lands aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased from 2005 to present.

### **Lake-by-Lake Assessment**

#### **Lake Superior**

Canadian Trend: Undetermined

Canadian Rationale: Small proportion of agricultural land in the Ontario portion of this lakeshed.

U.S. Trend: Increasing

U.S. Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

#### **Lake Michigan**

Canadian Trend: Not Applicable

Canadian Rationale: Lake Michigan entirely within U.S. boundary.

U.S. Trend: Increasing

U.S. Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

#### **Lake Huron**

Canadian Trend: Increasing (for part of lakeshed assessed)

Canadian Rationale: The number of best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

U.S. Trend: Increasing

U.S. Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

#### **Lake Erie**

Canadian Trend: Increasing

Canadian Rationale: The number of best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased

U.S. Trend: Increasing

U.S. Rationale: The area of land removed from previous agricultural production has increased. The area of

agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

## **Lake Ontario**

Canadian Trend: Increasing

Canadian Rationale: The number of best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased

U.S. Trend: Increasing

U.S. Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

## **Other Spatial Scales**

Lower Fox River Watershed (U.S.)

Trend: Increasing

Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

Saginaw River Watershed (U.S.)

Trend: Increasing

Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

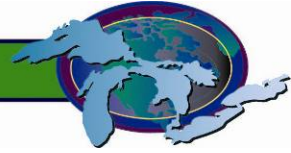
Maumee River Watershed (U.S.)

Trend: Increasing

Rationale: The area of land removed from previous agricultural production has increased. The area of agricultural land affected by best management practices aimed at conserving soil, improving water quality and enhancing wildlife habitat has increased.

## **Purpose**

- To quantify the number of field-scale best management practices (BMPs), both structural and practice/technology, implemented and assumed maintained on private agricultural land in Great Lakes basin portions of Canada and the United States
- To determine progress towards the general goals of reducing on- and off-site impacts of agricultural production on water quality and quantity, soil quality and wildlife habitat/populations.
- The Agricultural Lands indicator is used in the Great Lakes indicator suite as a response indicator in the Restoration and Protection top level reporting category.



### **Ecosystem Objective**

This indicator supports Annexes 2, 3, 12 and 13 of the GLWQA.

### **Ecological Condition**

#### Measure

The most readily accessible and reliable source of data for this type of indicator at this scale is the databases used to track the number of best management practices (BMPs) financially supported by U.S. and Canadian federal agri-environmental cost-share and incentive programs.

Adoption of practices in the U.S. is quantified by participation in Farm Bill programs including:

- the Conservation Reserve Program (CRP),
- Conservation Reserve Enhancement Program (CREP),
- Wildlife Habitat Incentives Program (WHIP),
- Conservation Stewardship Program (CSP), and,
- Environmental Quality Incentives Program (EQIP).

This participation is documented by the Farm Service Agency (FSA) database and the Natural Resources Conservation Service (NRCS) Protracts database.

Adoption of practices in Ontario, Canada is documented by participation in:

- Federal/Provincial Canada Ontario Farm Stewardship Program (COFSP: 2005-2011),
- Greencover Canada (GC: 2005-2009 only, Ontario only) and,
- Canada-Ontario Water Supply Expansion Program (COWSEP: 2005-2009 only).

Databases for these agri-environmental programs do not include practices that may have been solely supported by state/provincial or local programs or implemented by agricultural producers without federal government financial support. Thus, they are a conservative estimate of the agricultural sector's response to conserving soil, improving water quality/quantity and enhancing wildlife habitat.

The practices tabulated include both structural and practice/technology activities. Examples of structural activities include:

- establishment of permanent vegetative filter strips at field edges to reduce non-point source pollutant movement to surface water;
- construction of manure storages so that nutrients can be applied at the most appropriate times of the year and to prevent runoff from manure piles;
- construction of retention ponds to trap runoff from confined animal feeding operations;
- diversion of clean water around agricultural facilities;
- fencing livestock out of riparian areas;
- erosion control structures;
- nutrient recovery and water treatment technologies; and
- complete retirement of fields and marginal land from agricultural production by tree planting and natural vegetative succession.

Examples of practice/technology activities include:

- practicing integrated pest management(IPM) so that pesticides are used judiciously;

- practicing nutrient management (NM) to match nutrient application with crop needs using optimal timing, rates and methods of nutrient application to increase plant utilization and avoid field losses from runoff or leaching;
- using precision farming tools to maintain specified distances from streams and wells, and minimize overlap of applications of pesticides and nutrients;
- irrigation scheduling;
- field wind strips; and
- cover crops.

For the indicator, the number of selected practices funded are tabulated for fiscal years since April 1, 2005 in Ontario and October 1, 2004 in the United States. The number of practices is normalized by the number of hectares of agricultural land for each spatial unit as determined by the Canada 2006 Census of Agriculture or United States 2006 National Land Cover Data (NLCD).

### Overall Assessment - Canada

In Ontario, the number of BMPs funded and implemented per hectare of agricultural land has been cumulatively increasing since 2005. The Environmental Farm Plan Program directs farmers to priority actions on their farms through a process of education and risk assessment. Associated cost-share funding helps to accelerate their adoption of these practices or actions. Over the past 6 years, funding has accelerated the implementation of almost 19,000 best management practices by producers in Ontario (Figure 1). The rate of increase has slowed as agri-environmental program funding available for cost share has decreased since 2008. The distribution by county (Figure 2) shows the areas of the province which have had the most BMPs per 1000 ha of agricultural land cumulatively adopted. Southwestern Ontario, with the greatest proportion of cropland and livestock production in the province, has generally had the greatest intensity of funding and adoption of BMPs.

A spatial analysis of nutrient management related BMPs, a subset of 33 practices for both livestock and crop production, was also conducted. The crop spatial analysis compared the number of crop nutrient management BMPs adopted to the area receiving commercial fertilizer inputs on a county basis (Figure 3). This relationship is highly significant with 87% of the variation in adoption being explained. The livestock spatial analysis compared the number of livestock nutrient management BMPs adopted with the amount of nutrients produced in manure on a county basis. Figure 4 illustrates the BMP adoption relationship with phosphorus produced from manure; 92% of the variation in adoption is explained by total manure P generated in each county. Table 1 provides the breakpoints used for describing high, medium and low categories for both figures. Both analyses show there is a higher adoption of nutrient management BMPs in Ontario where there is an increased risk of excess nutrients.

### Overall Assessment - United States

The number of active contracts between the USDA Farm Service Agency and private landowners that remove land from agricultural production increased from 34,662 in 2005 to 44,965 in 2010. This increase in contracts translates into an increase in area from 189,153 hectares (468,202 acres) to 239,128 hectares (591,903 acres). This increase represents 2.1% of agricultural land use based on 2006 National Land Cover Data (NLCD) representing both cultivated cropland and hayland/pasture land.

The cumulative number of applied best management practices on privately owned agricultural land and cost shared by the USDA Natural Resources Conservation Service (NRCS) implemented under the Environmental Quality Incentive Program, Conservation Stewardship Program, or Wildlife Habitat Incentives Program increased from 4,131 to 14,173. It is important to note here that these numbers assume a BMP applied using NRCS cost-share

monies from 2005-2010 are assumed to be present and maintained for the expected lifespan of the respective BMP as well as in 2010 following termination of any NRCS contracts made during the period of interest (2005-2010). While some contracts may be active as of 2010, earlier contracts made between NRCS and a landowner (e.g., 2005-2007) may have expired.

This increase in best management practices translated into an increase in cumulative area of agricultural land treated from 7,496,810 hectares (18,556,459 acres) to 10,943,513 hectares (27,087,902 acres). It is important to note that differences in NRCS program goals, implementation, and tracking may affect these calculated areas of land affected. While programs like EQIP and WHIP are focused on particular BMPs implemented in specific areas of an agricultural operation, CSP provides annual payments for operation-level environmental benefits. Therefore, acreage accounted for by EQIP/WHIP may be characterized as practice-level where CSP acreage may be characterized as operation-level. When viewed relative to area of agricultural land (2006 NLCD) and USGS 8-digit HUCs, cumulative implementation of NRCS practices from 2005 to 2010 ranges from 0 to 58 practices/1000 hectares (Figure 5). The largest implementation relative to agricultural land (58) occurs along the north shore of Lake Superior. However, closer inspection of this area indicates the smallest total area of agricultural land (243 ha) and only 14 implemented practices.

A closer inspection of watersheds dominated by agricultural land use (cultivated crops and hayland/pastureland) indicated central and southern portions of the U.S. side of the basin have the greatest potential for implementation of agricultural best management practices (Figure 6). Some of these watersheds include the Lower Fox River (Wisconsin), Saginaw Bay watersheds (Michigan), and Western Lake Erie watersheds (Michigan, Ohio, and Indiana).

### Lakeshed Analysis - Ontario, Canada

In the Canada Ontario Farm Stewardship Program (COFSP) database, practices are located in a county and a Conservation Authority (CA). Figure 7 illustrates the watersheds selected that were comparable to CA designations in the COFSP database and used to calculate the indicator on a lakeshed basis in Canada. To estimate practices adopted on a watershed basis, the area of agricultural land in a fundamental drainage area (as defined by Atlas of Canada) is interpolated from the 2006 Census of Agriculture information using an area-weighted approach. Thus error is introduced into the indicator when calculated on a watershed basis. This representation is also limited because not all lake basins have full CA coverage in Ontario so only Lakes Ontario, Erie and part of Huron are analyzed. Practices that are outside these boundaries are excluded from the lakeshed analysis (2434 practices or 13% of total for 6 years).

The number of BMPs implemented are cumulatively increasing in all lakesheds (Table 2). In Ontario, the Lake Erie basin has the greatest number of BMPs cost-shared per ha of agricultural land. The portion of the Lake Huron basin included for this indicator is next, followed by Lake Ontario. The acceleration of BMP adoption per ha of agricultural land is slowing similarly in all lakesheds as program funding has been reduced.

A categorization of practices by major effect was performed to aid in interpretation of trends by lakeshed. Categorization attempts to identify a major agri-environmental effect of a practice, however multiple benefits from application of a practice could occur. There has been no double counting of practices between categories, so some categories may be under-represented. Figure 8 illustrates that the type of the BMPs adopted can vary in each lakeshed. BMPs having a nutrient management effect are the highest proportion adopted in all lakesheds.

## Lakeshed Analysis - United States

On the U.S. side of the basin, area of agricultural land removed from production due to the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) currently ranges from 1,063 to 353,052 acres for lake basins (Figure 9a). Trends in agricultural land retired from production indicates the percent of land retired has increased to greater than 3% in Lake Erie basin, whereas all other lake basins are relatively steady or have decreased from their 2005 levels (Figure 9b). An exception is Lake Huron where percent of agricultural land retired from production peaked in 2007, followed by a decrease to about 2.5% (Figure 9b).

One hundred and six (106) different NRCS practices were reported to be applied in the Great Lakes Basin from 2005 to 2010 and represent a range of environmental concerns addressed on individual farms. A categorization of selected NRCS practices, performed to aid interpretation of trends, indicated varying application of practices on cropland, hayland/pastureland, and both land uses combined (Figure 10). While this categorization attempts to identify a major environmental concern associated with agricultural operations, multiple benefits from application of these practices are expected. However, no double counting of practices between categories occurred.

Approximately 6% to 13% of cropland in lake basins now adopt practices that reduce tillage/soil erosion (Figure 10a). Lake Erie and Ontario employ practices to reduce the impact of land managed for hay production and grazing on greater than 7% of that land use type (Figure 10b). Nutrient (Figure 10c) and pest (Figure 10d) management practices that increase efficiencies of applied agrochemicals while decreasing off-site losses are the most applied practices in many lake basins. Less than one percent of agricultural land in all lake basins is accounted for by practices implemented to intercept/redirect surface runoff and improve water quality of neighboring water bodies (Figure 10e) or improve habitat for wildlife (Figure 10f).

## Other Spatial Scales

Closer examination of U.S. watersheds with a higher proportion of agricultural land use indicate variable distribution of cropland, pasture/hayland, and resulting implementation of NRCS practices. In Western Lake Erie watersheds, cropland is concentrated in the central portion of this watershed (Figure 11a), whereas pasture/hayland is concentrated in the northern portion (Figure 11b). Number of NRCS practices relative to agricultural land is distributed relatively evenly throughout these watersheds, both in central and northern areas (Figure 11c). Identification of NRCS practices which are likely to have the largest effect on reducing phosphorus losses from agricultural operations show largest implementation densities in northern portions of this watershed. Similar patterns in cropland and pasture/hayland distribution were present in the Saginaw Bay and Lower Fox River watersheds, showing concentrations of the land uses and associated operations differing in location (Figure 12a, 12b, 13a, and 13b). NRCS practices were also distributed throughout these watersheds and no apparent spatial pattern was evident based on land use data alone (Figure 12c, 12d, 13c, and 13d).

## **Linkages**

This indicator is linked to the following Great Lakes indicators: nutrients in tributaries, pesticides in tributaries, watershed stressor index, land cover, nutrients in lakes, Cladophora, inland water quality index, bacterial loadings from tributaries, groundwater quality, beach postings, baseflow due to groundwater, sediment coastal nourishment, forest cover.

## **Management Challenges/Opportunities**

The indicator quantifies adoption of BMPs by agricultural producers who participate in federally funded/tracked cost-shared incentive programs. The indicator is affected by government budget constraints, market forces, industry and consumer expectations and other socio-economic factors which affect the adoption of BMPs. The indicator is

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not expected to necessarily respond or reflect directly the state of environment due to: the temporal lag between BMP implementation and environmental effect; the influence of the spatial distribution of BMP uptake on environmental conditions; and, unmanageable factors such as aquatic invasive species and climate change. In addition, cumulative thresholds of BMP uptake might be needed before a causal effect between BMP uptake and change in environmental conditions can be measured. There is currently no standard way of measuring the condition or maintenance of these BMPs over their expected lifespan.

## Comments from the author(s)

Programs differ between Ontario, Canada and the U.S. and thus do not necessarily have common definitions of agricultural best management practices or levels of funding. As the programs and jurisdictional context change (legislation, budget, and policies) over time, different agricultural practices have been emphasized, added or removed to these programs which may influence the number of BMPs funded and implemented in any one year. Based on eligibility criteria and funding available the number and rate of BMPs adopted can vary greatly between the two countries and in time.

Some practices may contribute to more than one outcome, or may even be somewhat antagonistic to each other. No attempt has been made in this analysis to rank or calculate net benefits or tabulate outcomes (i.e. soil quality vs. water quality vs. habitat) separately of different practices. Funding of management plans for such things as grazing, pesticide, irrigation, erosion and nutrient use are included as practices as they are assumed to be implemented.

## Assessing Data Quality

| Data Characteristics  | Strongly Agree | Agree | Neutral or Unknown | Disagree | Strongly Disagree | Not Applicable |
|---|----------------|-------|--------------------|----------|-------------------|----------------|
| 1. Data are documented, validated, or quality-assured by a recognized agency or organization  | X              |       |                    |          |                   |                |
| 2. Data are traceable to original sources   | X              |       |                    |          |                   |                |
| 3. The source of the data is a known, reliable and respected generator of data  | X              |       |                    |          |                   |                |
| 4. Geographic coverage and scale of data are appropriate to the Great Lakes basin   |                | X     |                    |          |                   |                |
| 5. Data obtained from sources within the U.S. are comparable to those from Canada   |                |       |                    | X        |                   |                |
| 6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report  |                |       | X                  |          |                   |                |
| Clarifying Notes: The data source for each country is similar but the number/variety of BMPs funded and the information collected when a BMP is implemented (e.g. hectares treated) is not similar for the separate programs in each country. Because all selected practices funded are included in the tabulation there is no statistical sampling from which to calculate uncertainty or variability. |                |       |                    |          |                   |                |

## Acknowledgments

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## Information Sources

Agriculture and Agri-Food Canada and Statistics Canada,

Customized tabulations, Census of Agriculture CGC Base 1996, 2001, 2006, Census of Agriculture Regular Base 1971, 1976, 1981, 1986, 1991

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North American Atlas – Waterbody

Atlas of Canada 1:1,000,000 National Frameworks Data, Hydrology – Fundamental Drainage Area

Atlas of Canada – Provincial Boundaries – 1:2,000,000

Canada-Ontario Farm Stewardship Program Database provided by the Ontario Soil and Crop Improvement Association

USGS 2006 National Land Cover Dataset

USDS NRCS Protract Database

USDA FSA CRP/CREP Database

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**Figure 11.** Western Lake Erie 12-digit HUC watersheds represent percent cropland (a), percent pasture/hayland (b), number of NRCS practices per area of agricultural land (c) and number of NRCS practices identified has high impact on phosphorus.

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**Figure 13.** Lower Fox River 12-digit HUC watersheds represent percent cropland (a), percent pasture/hayland (b), number of NRCS practices per area of agricultural land (c) and number of NRCS practices identified has high impact on phosphorus.

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## Last Updated

State of the Lakes Ecosystem Conference (SOLEC) 2011

|        | Figure 3  |  | Figure 4  |   |
|--------|---|--|---|---|
|        | Number of Crop Nutrient Management Related BMPs | Amount of Land receiving fertilizer (ha) | Number of Live-stock Nutrient Management Related BMPs | Amount of Phosphorus Produced from Manure (kg/ha) |
| High   | >95   | >65,000                                  | >200  | >11   |
| Medium | 31-95   | 30,000-65,000                            | 46-200  | 6-11  |
| Low    | 0-30  | 0-30,000                                 | 0-45  | 0-5   |

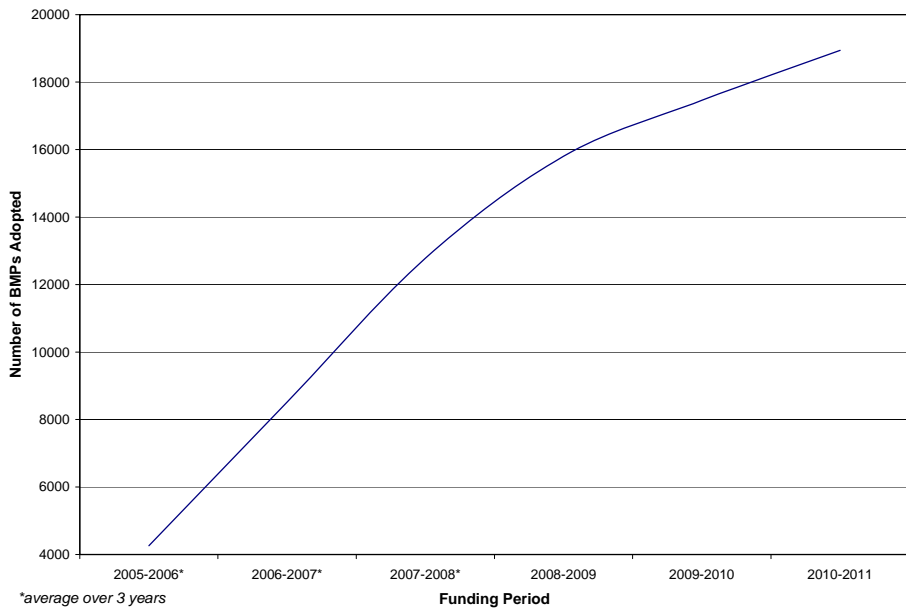
**Table 1.** Definition of High, Medium and Low Categories for Figure 3 and 4 Legends.

| Total BMPs adopted by Lakeshed per 1000 hectare of farmland by Funding Period |            |           |           |           |                             |
|---|------------|-----------|-----------|-----------|-----------------------------|
| Lakeshed  | 2005-2008* | 2008-2009 | 2009-2010 | 2010-2011 | All Funding Years 2005-2011 |
| <i>Lake Erie</i>  | 3.15       | 0.69      | 0.36      | 0.33      | 4.52                        |
| <i>Lake Huron</i>   | 2.64       | 0.67      | 0.40      | 0.33      | 4.04                        |
| <i>Lake Ontario</i>   | 2.24       | 0.55      | 0.34      | 0.30      | 3.42                        |

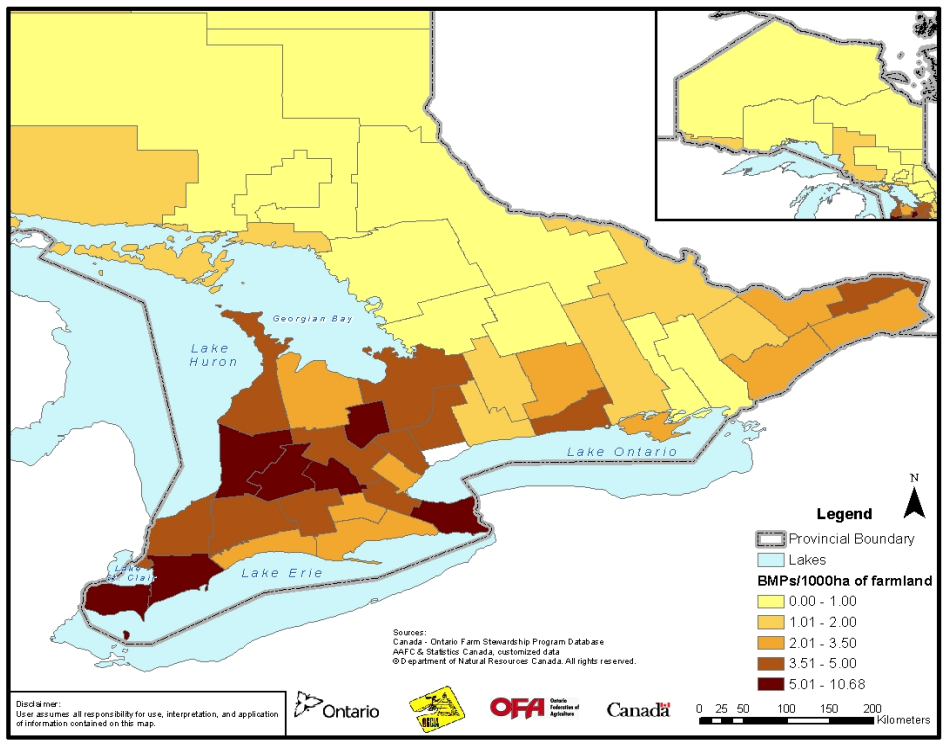
**Table 2.** Total BMPs adopted by Lakeshed per 1000 hectares of farmland by Funding Period

\*The first column for 2005-2008 represents 3 years cumulative adoption of practices as the COFSP database has combined these program years.

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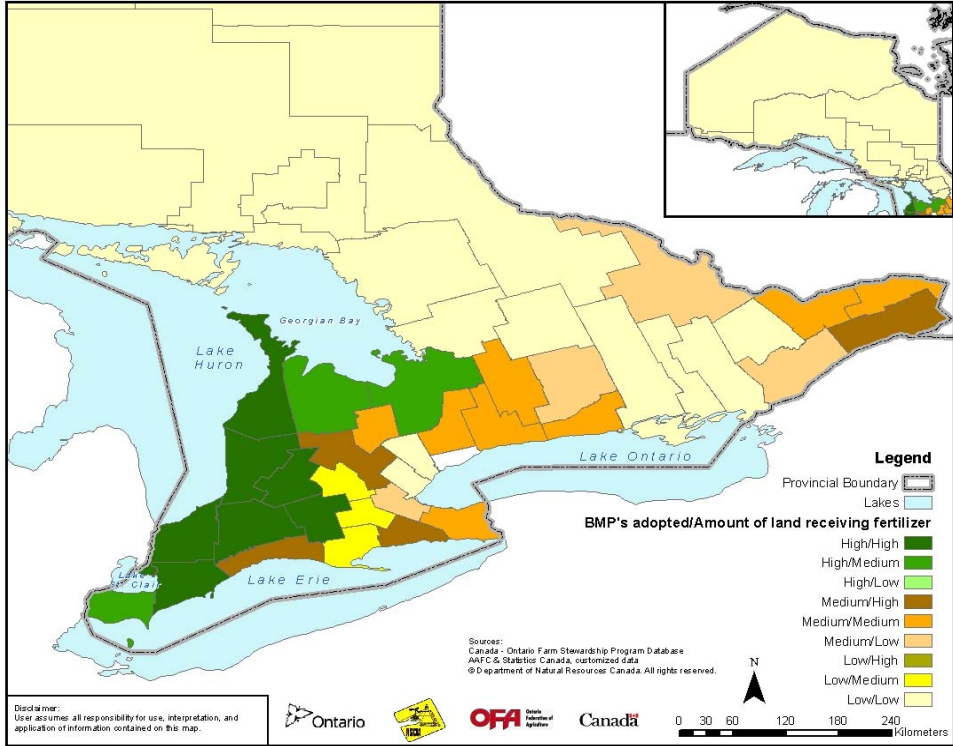


**Figure 1.** Cumulative adoption of BMPs in Ontario (from 2005 to 2011)

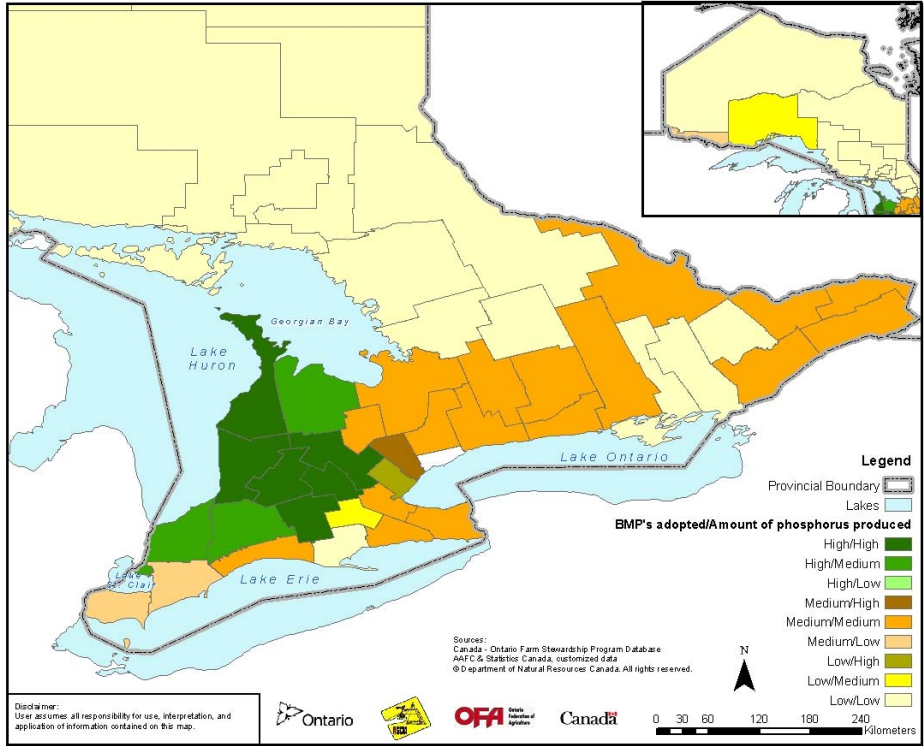


**Figure 2.** Distribution of BMPs per 1000 hectares of agricultural land cumulatively adopted by county (2005-2011)

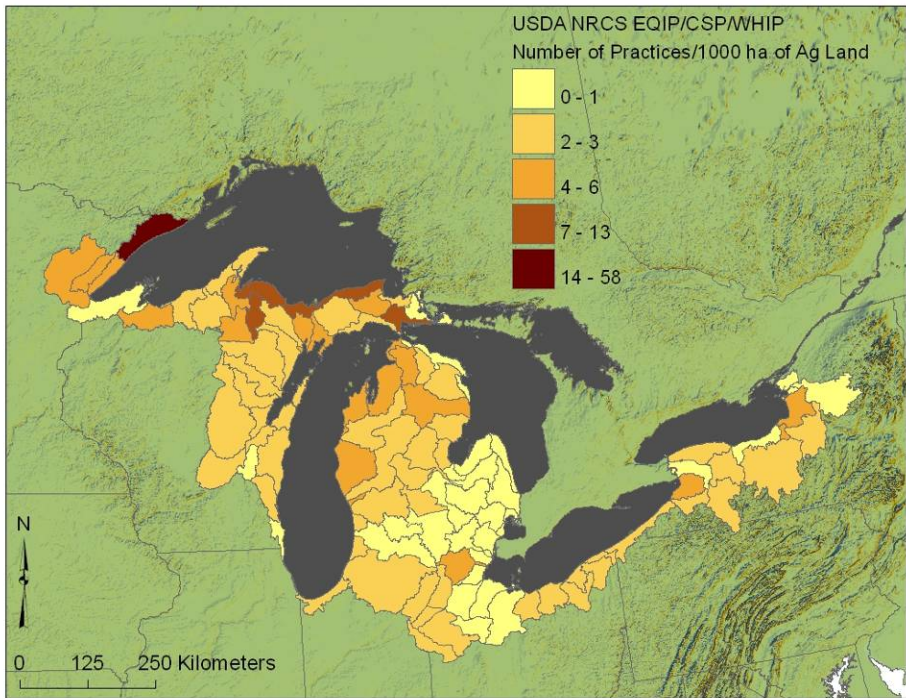
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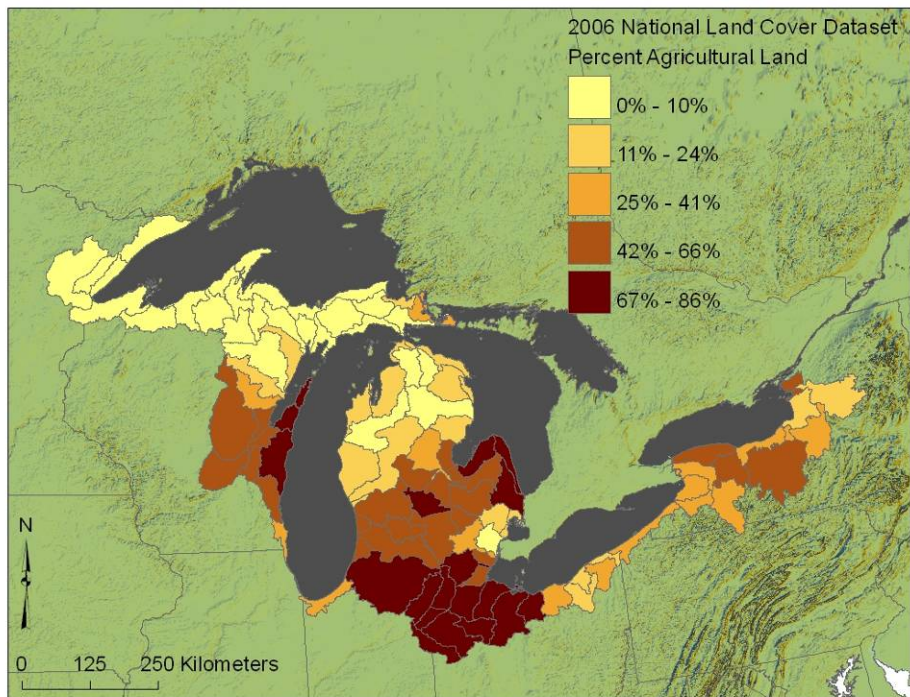
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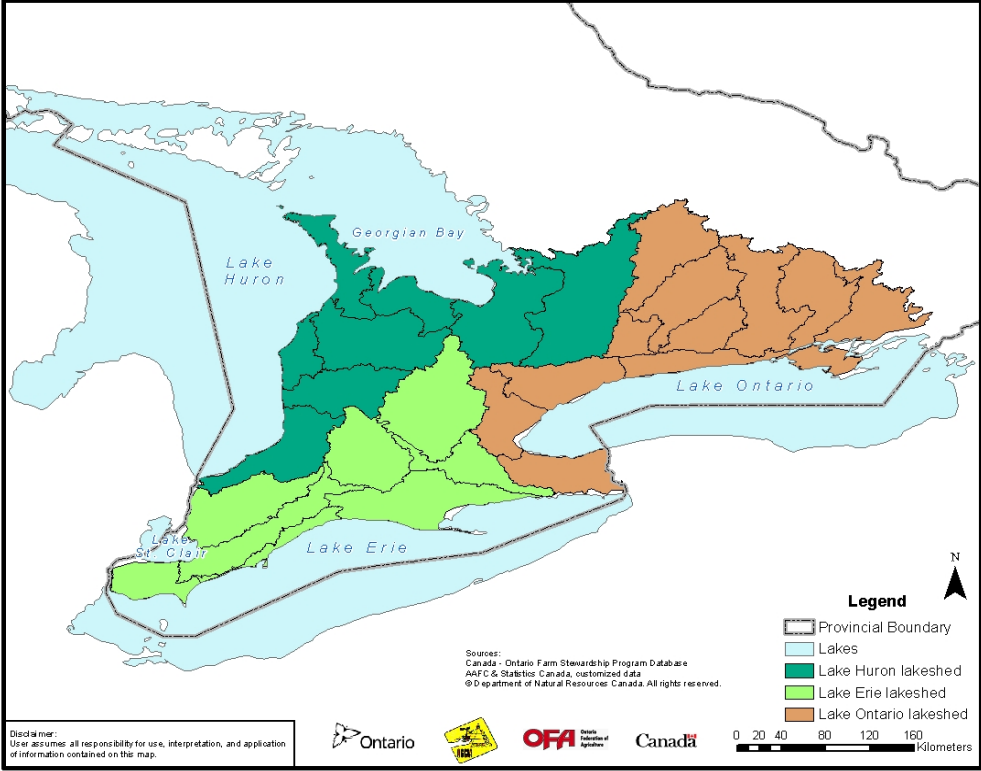


**Figure 5.** Number of USDA NRCS practices implemented in USGS 8-digit HUC watersheds per 1000 hectares of agricultural land.

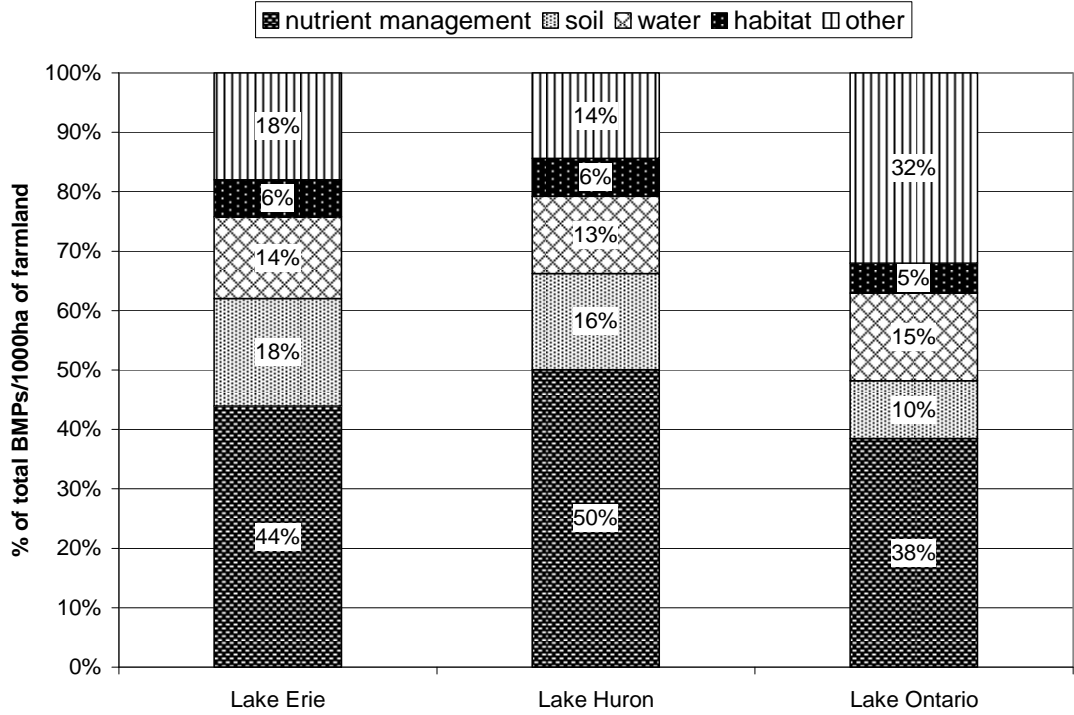


**Figure 6.** Percent area of USGS 8-digit HUC watersheds in agricultural land use including cultivated cropland and pasture/hayland.

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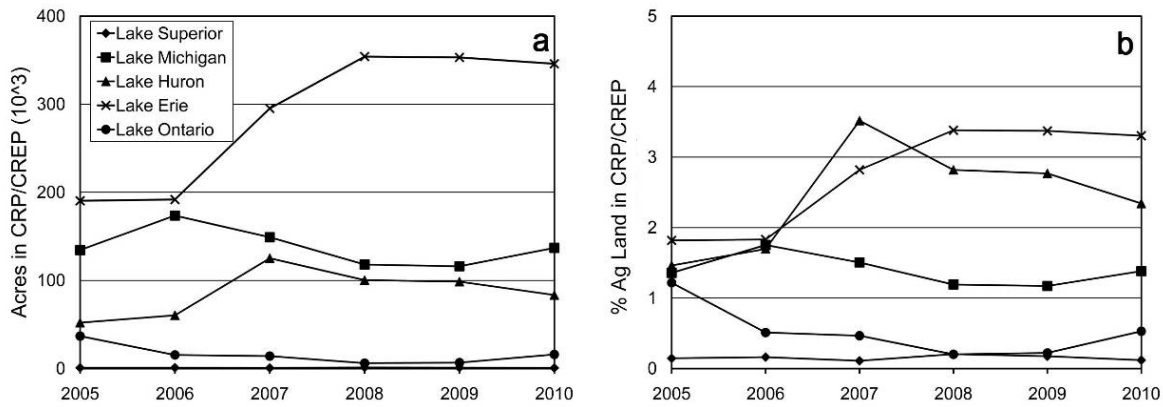


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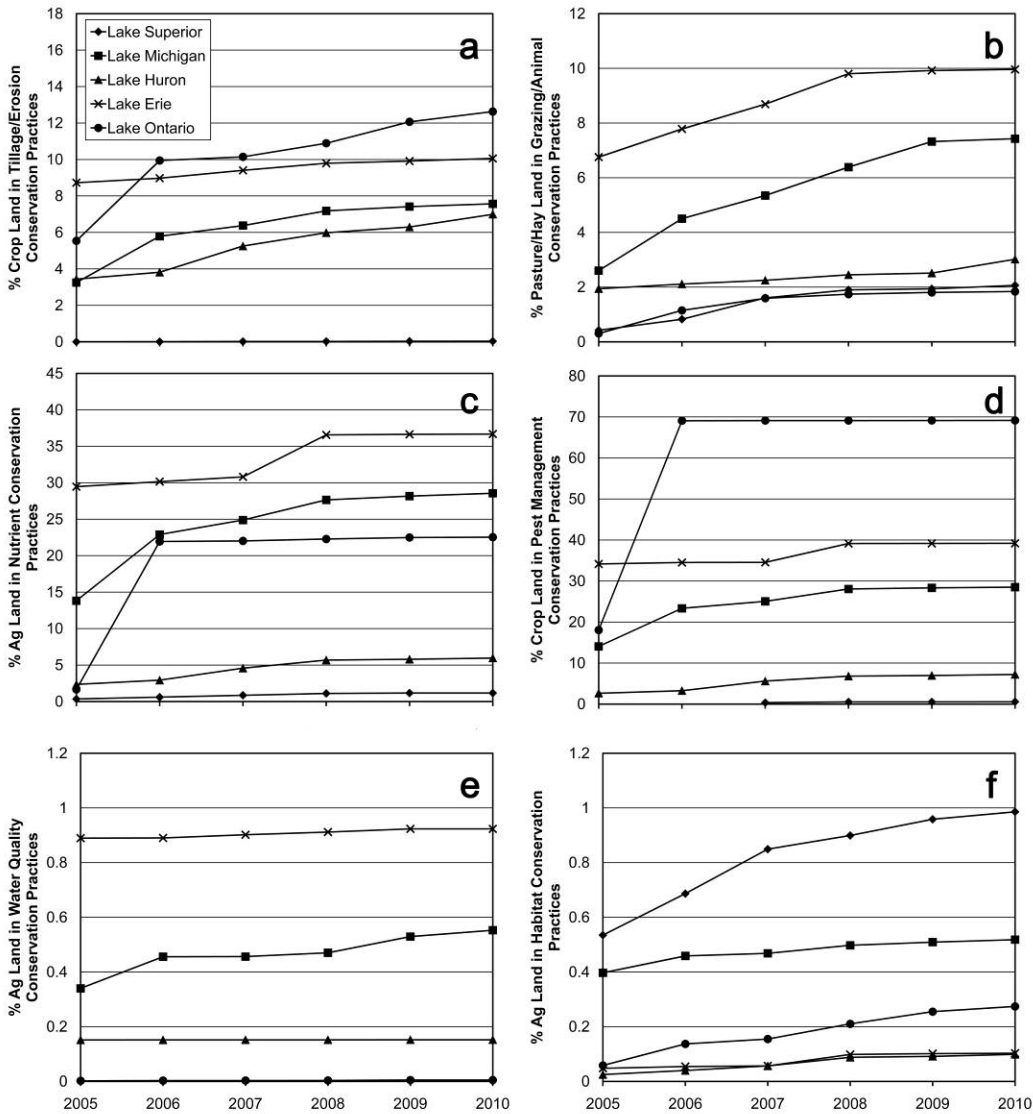


**Figure 8.** Proportion of cumulative adoption of BMPs by major effect by lakeshed

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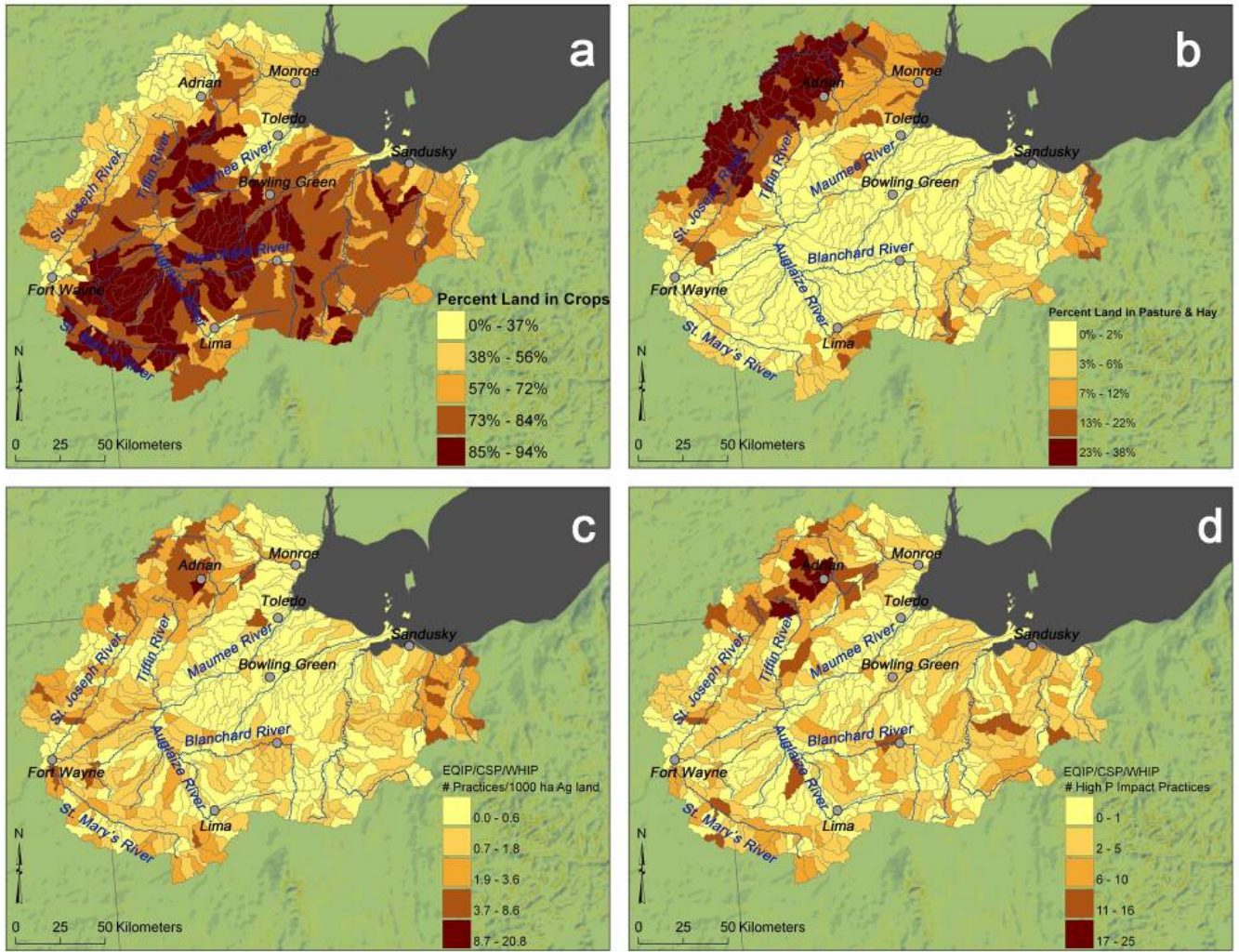


**Figure 9.** Trends in USDA Conservation CRP and CREP contracts and percent of agricultural land in retirement.



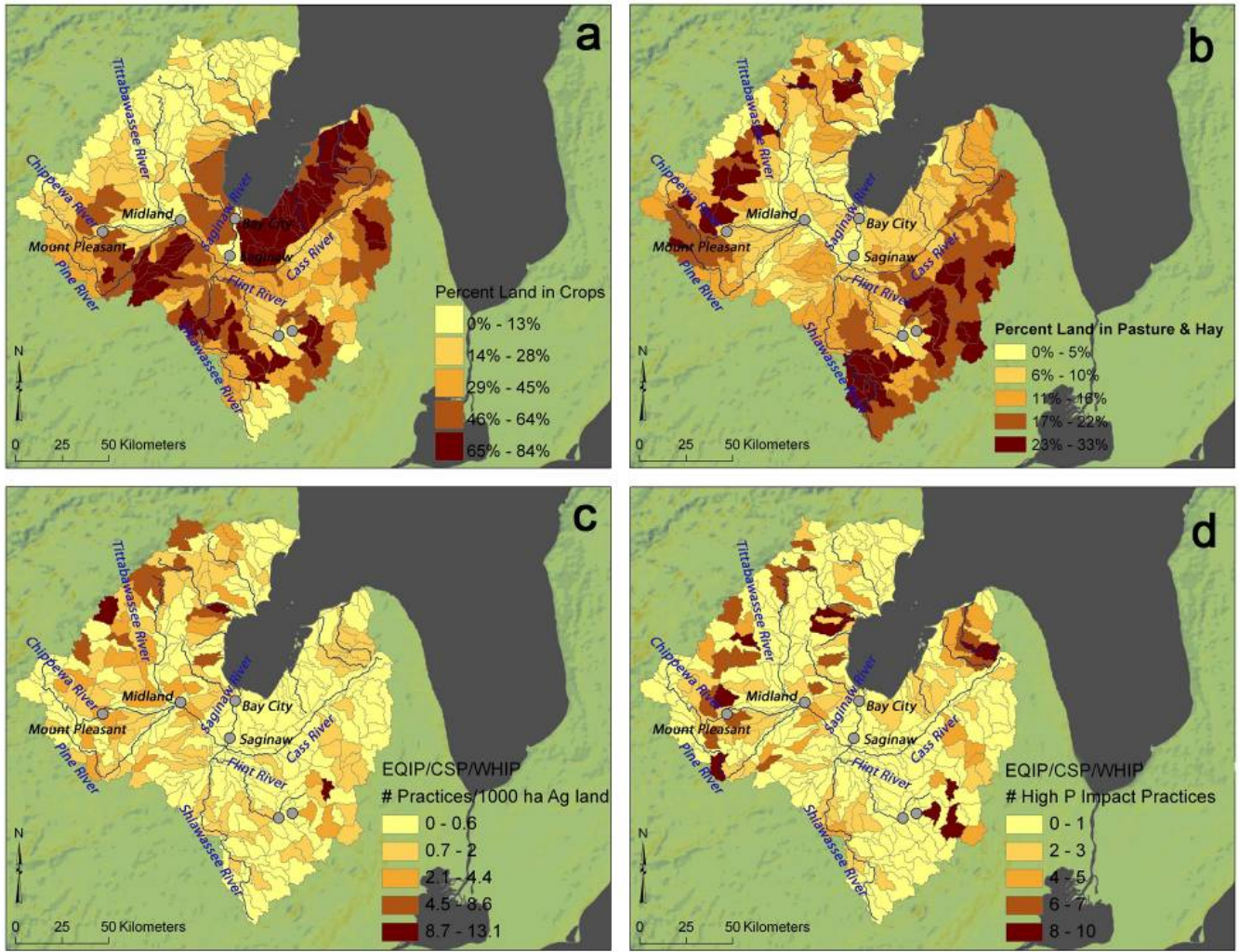
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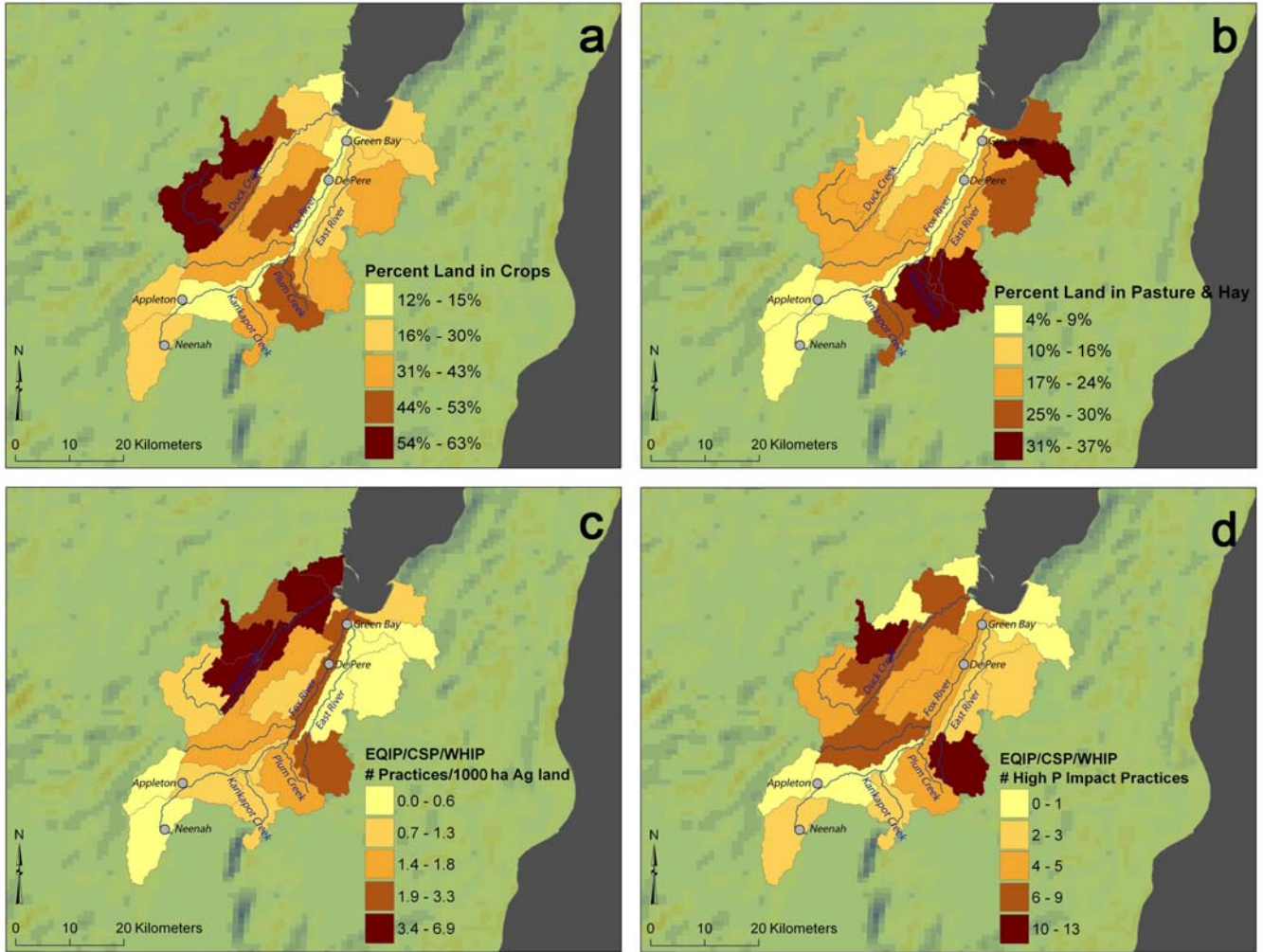
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**Figure 12.** Saginaw Bay 12-digit HUC watersheds represent percent cropland (a), percent pasture/hayland (b), number of NRCS practices per area of agricultural land (c) and number of NRCS practices identified has high impact on phosphorus.

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**Figure 13.** Lower Fox River 12-digit HUC watersheds represent percent cropland (a), percent pasture/hayland (b), number of NRCS practices per area of agricultural land (c) and number of NRCS practices identified has high impact on phosphorus.