Forest Cover
Formerly Indicator # 8500, 8503

This indicator includes two components:

- Percent of forested lands within watershed by lake basin, over time.
- Percent of forested lands within riparian zones by watershed, over time.

Overall Assessment
Component 1: Percent of forested lands within a watershed
Status: Fair
Trend: Improving
Rationale: Forested lands are a large percentage of land area within the Lake Superior basin (85%), a moderate amount in the Lake Michigan, Huron and Ontario basins (49% - 61%) and low in the Lake Erie basin (20%) based on satellite imagery. Trends in forest cover, based on forest inventory data, suggest that forest cover is increasing in all basins.

Component 2: Percent of forested lands within riparian zones
Status: Fair
Trend: Undetermined
Rationale: Similar to total forest cover, forested cover types in the riparian zone of water bodies is high in the Lake Superior basin, moderate in the Lake Michigan, Hurin and Ontario basins and low in the Lake Erie basins. Adequate, consistent long-term data is not available to assess trends.

Lake-by-Lake Assessment
Lake Superior
Component 1: Percent of forested lands within a watershed
Status: Good
Trend: TBD (trend analysis still in progress)
Rationale: The Lake Superior basin has a high forest cover (85%) and low rates of agriculture and development (3.2%). These data suggest that there is unlikely to be long-term impairment of water quality.

Component 2: Percent of forested lands within riparian zones
Status: Good
Trend: TDB
Rationale: With 96% of the riparian zones of water bodies in the Lake Superior basin having forest cover, these waters are likely to be well protected. Insufficient data is available to assess trends.

Lake Michigan
Component 1: Percent of forested lands within a watershed
Status: Fair
Trend: Improving
Rationale: There is considerable variation in the watersheds draining into Lake Michigan, Generally there is high forest cover in the northern watersheds, while southern watersheds have low forest cover.

Component 2: Percent of forested lands within riparian zones

Status: Fair
Trend: Undetermined
Rationale: Northerly watersheds have high forest cover in riparian zones, while southern watersheds have significant agricultural activity in riparian zones that may decrease water quality and ecosystem integrity. Insufficient data is available to assess trends.

Lake Huron
Component 1: Percent of forested lands within a watershed
Status: Good
Trend: TDB
Rationale: Most northerly watersheds have a high level of forest cover with the watersheds, while more southerly ones have low forest cover. There is some potential in southerly watersheds to have impairments in water quality and ecosystem integrity.

Component 2: Percent of forested lands within riparian zones
Status: Fair
Trend: TBD
Rationale: Watersheds in the southern portion of the basin have moderate levels of agriculture and forests in the riparian zones which could lead to impairments in water quality and ecosystem integrity.

Lake Erie
Component 1: Percent of forested lands within a watershed
Status: Poor
Trend: TDB
Rationale: Lake Erie has the lowest coverage by forests in the lake basin and the highest percentage of agricultural and developed lands. There is a large potential for water quality problems and risks to ecological integrity.

Component 2: Percent of forested lands within riparian zones
Status: Poor
Trend: TDB
Rationale: A high level of agricultural activities and a low proportion of forest cover in riparian zones suggests heightened threat to water quality and ecosystem integrity

Lake Ontario
Component 1: Percent of forested lands within a watershed
Status: Fair
Trend: TDB
Rationale: Most watersheds in the Lake Ontario basin have low forest covers and significant proportions of the land area in agricultural activities with the associated risks to water quality.

Component 2: Percent of forested lands within riparian zones
Status: Fair
Trend: TDB
Rationale: Moderate levels of forest and agricultural covers in riparian zones in the Lake Ontario basin suggests there is moderate risk to water quality and ecosystem integrity.

Purpose

- This indicator describes the forest cover that is required to perform the hydrologic functions and host the organisms and essential processes that are necessary for supplying high quality water and protecting the physical integrity of the watershed.
- The Forest Cover indicator is used in the Great Lakes indicator suite as a State indicator in the Landscape and Natural Processes category.

Ecosystem Objective

To have a forest composition and structure that most efficiently conserves the natural ecological diversity of the region.

Ecological Condition

Component 1 summarizes the percent of forested lands by watershed within each lake basin. Decades of research and monitoring have shown that water draining forested watersheds is of high quality, as measured by sediment yields, nutrient loadings, contaminant concentrations and temperatures. Forest cover also contributes to many other ecosystem services, including controlling soil erosion, increasing groundwater infiltration, stabilizing shorelines and mitigating storm run-off. Leaf litter and woody debris provide critical food and habitat for fish and other aquatic wildlife.

In general, an increase in forest cover improves water quality. Ernst (2004) in a small survey of municipal water systems, showed that water treatment costs can be directly related to the degree of forest cover in the source watershed. The function she developed suggests that treatment costs are lowest at levels of forest cover above ~60%. Other studies have been less successful in discovering empirical relationships between forest cover and the economics of municipal water supplies. For the purposes of this report, and subject to further discussion, we have used the following end-points in assessing the status and trends of Great Lakes watersheds: Good = >60% forest cover by lake basin; Fair = 30 – 60% forest cover by lake basin: and Poor = <30% forest cover by lake basin.

Figure 1 shows the tertiary watersheds draining into the Great Lakes and their level of forest cover. There is a strong N-S gradient evident in the degree of forest cover as would be expected given a similar gradient in population and agricultural activity. In the Lake Superior basin, 85% of the land area is forested (Table 1), with only minor amounts of development and agriculture. In all the other basins, forests have been replaced by development and agriculture, comprising 29% in the Lake Huron basin, ~45% in the Lake Michigan and Ontario basin and 78% in the Lake Erie basin (Table 1). However, it must be noted that within any given basin, there are watersheds with adequate to good forest cover.

Assessing trends in the forest cover indicator has proven difficult. Whereas the status of forest cover can be readily assessed through analysis of carefully checked and referenced satellite data, these data are only available for single points in time. For this report, we have employed data for forest inventory programs that can provide a time series up to 30 years. Figure 2 shows that in all lake basin, other than Lake Erie, there is a trend towards increasing forest cover.

Component 2 summarizes the area of riparian zones (30 metre buffer around all surface waters) that is forested within each lake basin. Where watersheds have experience large land-use changes due to agricultural activities or urban and suburban development, increased forest coverage within a riparian zone can mitigate many of the potentially harmful impacts on water bodies. Forested riparian zones can decrease the amount of surface runoff to water bodies (reducing erosion), mitigate nutrient loadings from fertilizer application and other non-point source pollutants and increases the capacity of the ecosystem to store water. Riparian zones can also important sources of energy and material to aquatic systems and help regulate water temperatures.

The end-points for this component have been defined as: Good = >80% forest cover in riparian zones; Fair = 50 – 80% forest cover in riparian zones; and Poor = <50% forest cover in riparian zones.

This component was assessed by creating a 30 m buffer around all waterbodies in the National Hydrology Dataset (US) and using it as a mask on the NLDC or Landcover 2008 data layers. On a lake basin level, the proportion of forest cover in riparian zones parallels that of the forest cover in the watersheds (Table 2). The Lake Superior basin

has 96% of its riparian zones identified as forested, while only 31% of riparian zones in the Lake Erie basin are forested, with Lakes Michigan, Huron and Ontario being intermediate. Also similar to the forest cover component, agriculture and development are the competing land uses. There is also substantial variation at the tertiary watershed level with each of the lake basins (Figure 3). The northern watersheds have much higher rates of forested riparian zones than watersheds in the south, where there is much greater development and agriculture.

Trend analysis is not presently possible for this component. What is required is a time series of properly classified satellite imagery over a long enough time period (>20 years) in order to identify trends with any degree of reliability.

Assessing Data Quality

Insert "x" under the statement that best corresponds with each data characteristic

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						
2. Data are traceable to original sources						
3. The source of the data is a known, reliable and respected generator of data						
4. Geographic coverage and scale of data are appropriate to the Great Lakes basin						
5. Data obtained from sources within the U.S. are comparable to those from Canada						
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report						
Clarifying Notes:						

Acknowledgments

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List of Tables

List of Figures

cover was estimated from satellite imagery and includes a variety of forest types (i.e. deciduous, conifer, mixed) and treed wetlands.
Sources: US NLCD 2006 and Ontario Landcover 2008)

Figure 2. Trends in forest cover estimated from forest inventory data. Preliminary figure, analysis for Ontario in progress.
Sources: USFS FIADB

Figure 3. Percentage of riparian zones with tertiary watersheds identified as forested.

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	Superior	Michigan	Huron	Erie	Ontario
Forest	85.0	49.1	61.0	19.6	49.1
Agriculture	1.7	35.1	24.6	61.0	35.5
Developed	1.5	10.3	4.4	17.3	8.3
Water	10.4	3.0	7.4	1.0	4.6
Wetland	1.0	2.3	0.9	0.8	1.9

Table 1. Percentage of land cover types by lake basin. Cover types were identified from Landsat satellite imagery for 2006 (US) and 2008 (Ontario), forest includes areas classisfied forest and treed wetlands.
Sources: National Land Classification Database (US) and Landcover 2008 (MNR, Forest Evaluations and Standards Sections)

	Superior	Michigan	Huron	Erie	Ontario
Forest	96.0	63.4	72.7	30.9	63.0
Agriculture	0.8	23.4	19.9	54.5	25.6
Urban	0.9	7.7	3.0	11.7	5.7
Wetland	1.6	5.0	2.0	2.7	5.1

Table 2. Percent of forest cover in riparian zones. Data based of summing cover types in a 30 m buffer around all water bodies.
Sources: National Land Classification Database (US) and Landcover 2008 (MNR, Forest Evaluations and Standards Sections)

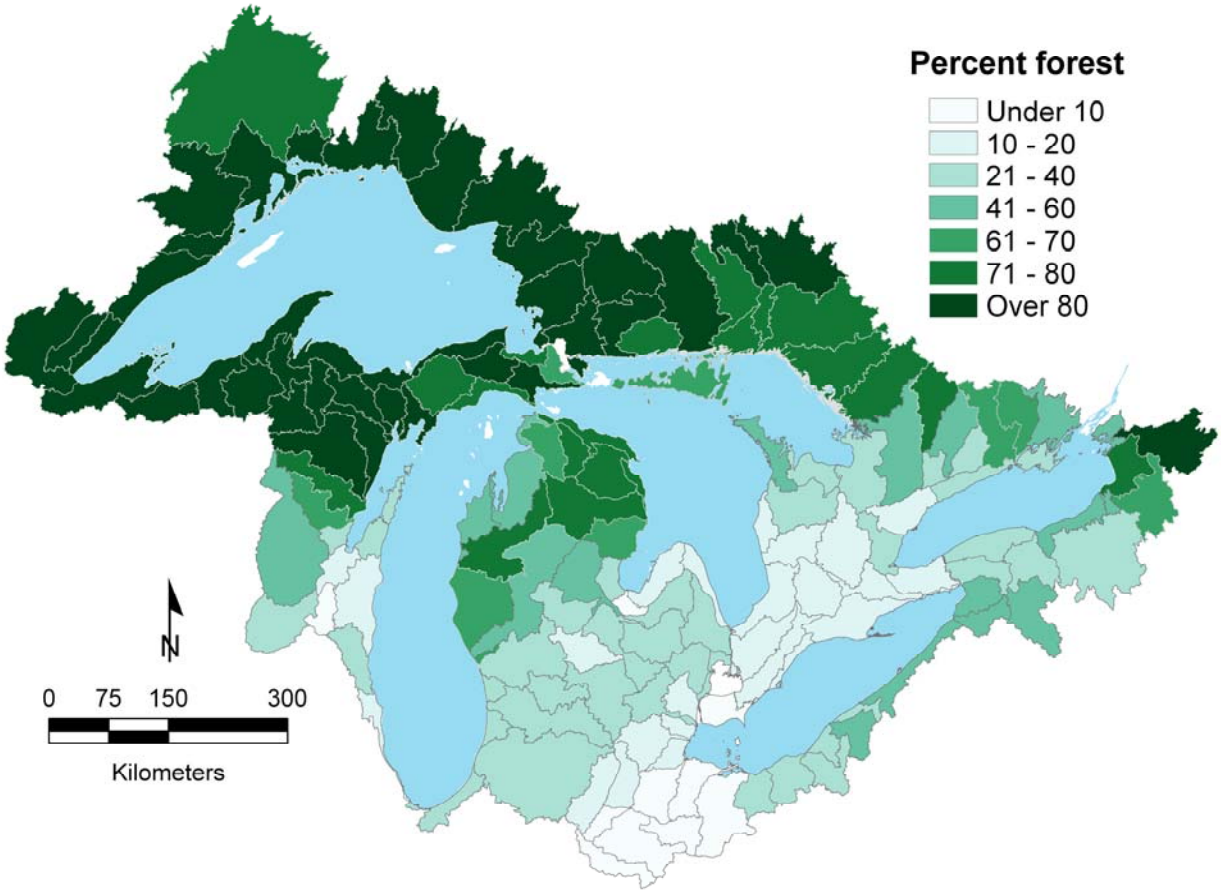

Figure 1. Percent forest cover in tertiary watersheds (HUC8 in US and 4 digit in Ontario) of the Great Lakes. Forest cover was estimated from satellite imagery and includes a variety of forest types (i.e. deciduous, conifer, mixed) and treed wetlands.
Sources: US NLCD 2006 and Ontario Landcover 2008)

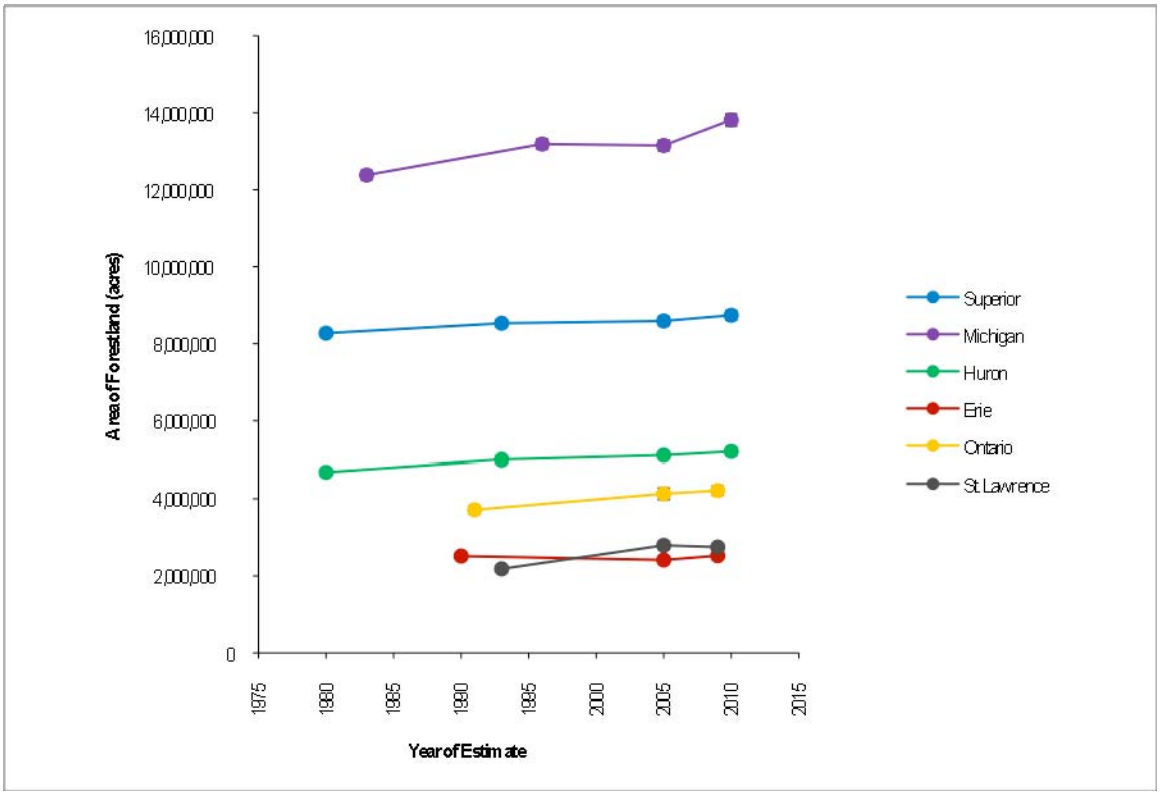

Figure 2. Trends in forest cover estimated from forest inventory data. Preliminary figure, analysis for Ontario in progress.
Sources: USFS FIADB

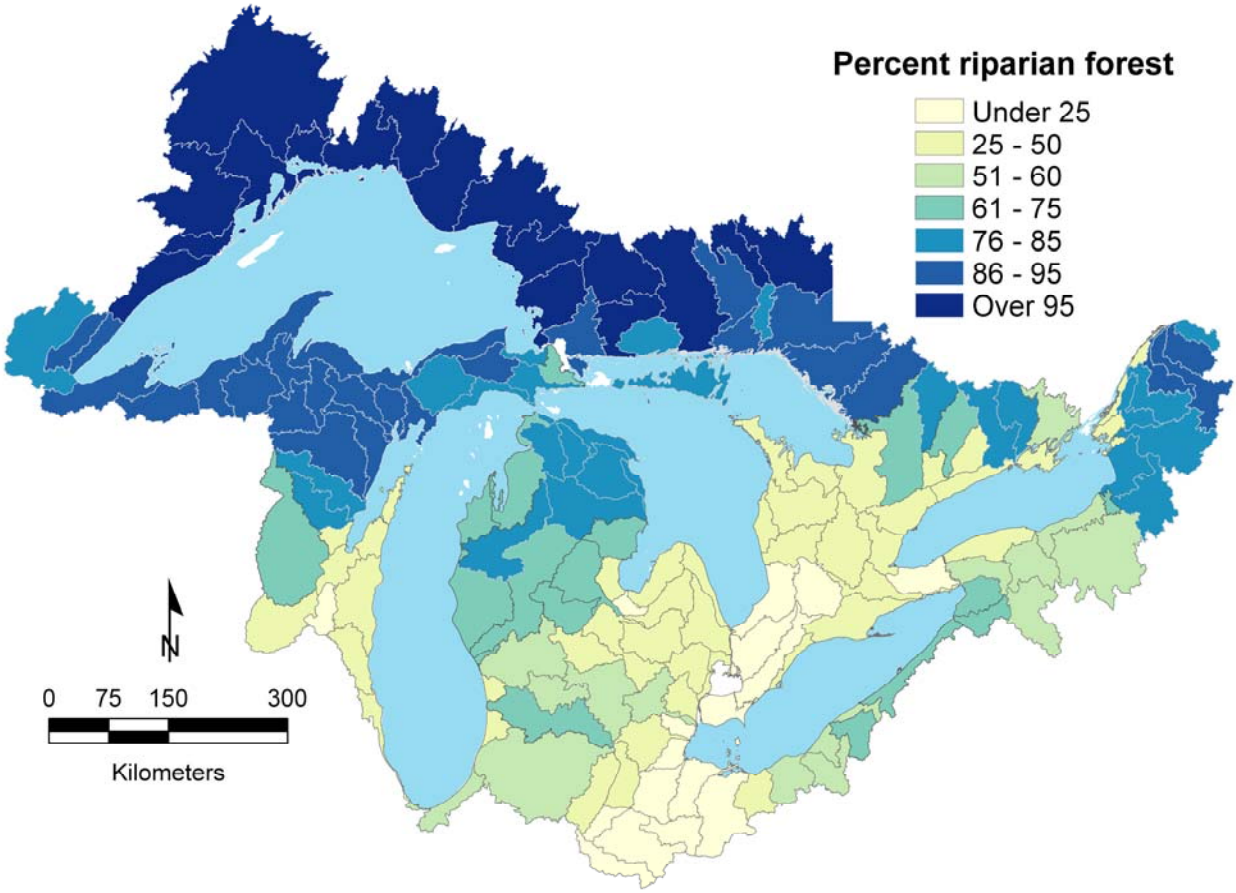

Figure 3. Percentage of riparian zones with tertiary watersheds identified as forested.
Source: