

# Great Lakes Regional Land Cover Change Report 1996–2010



## About This Report

The *Great Lakes Regional Land Cover Change Report, 1996–2010*, is one in a series of regional reports that summarize the land cover status of the coastal United States in 2010 and land cover changes over the previous decade and a half. This report provides an overview of key findings using reader-friendly maps and graphics.

## About the Coastal Change Analysis Program

Satellite imagery is a great way to get a big-picture view of the cumulative impacts of changes along our nation's coasts. The Coastal Change Analysis Program (C-CAP) within the National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management produces nationally standardized land cover and land cover change information for coastal regions of the United States, including the Great Lakes, using multiple dates of satellite imagery. C-CAP's data products provide inventories of coastal intertidal areas, wetlands, and adjacent uplands at approximately five-year intervals. This information helps to support decision-making about coastal resources and communities. The raster-based maps generated by C-CAP serve as a baseline for studies of coastal changes and evaluations of past or future management actions.

To learn more about the C-CAP data products used in this report and to access the data sets, please visit [www.coast.noaa.gov/digitalcoast/data/ccapregional](http://www.coast.noaa.gov/digitalcoast/data/ccapregional).

## About the NOAA Office for Coastal Management

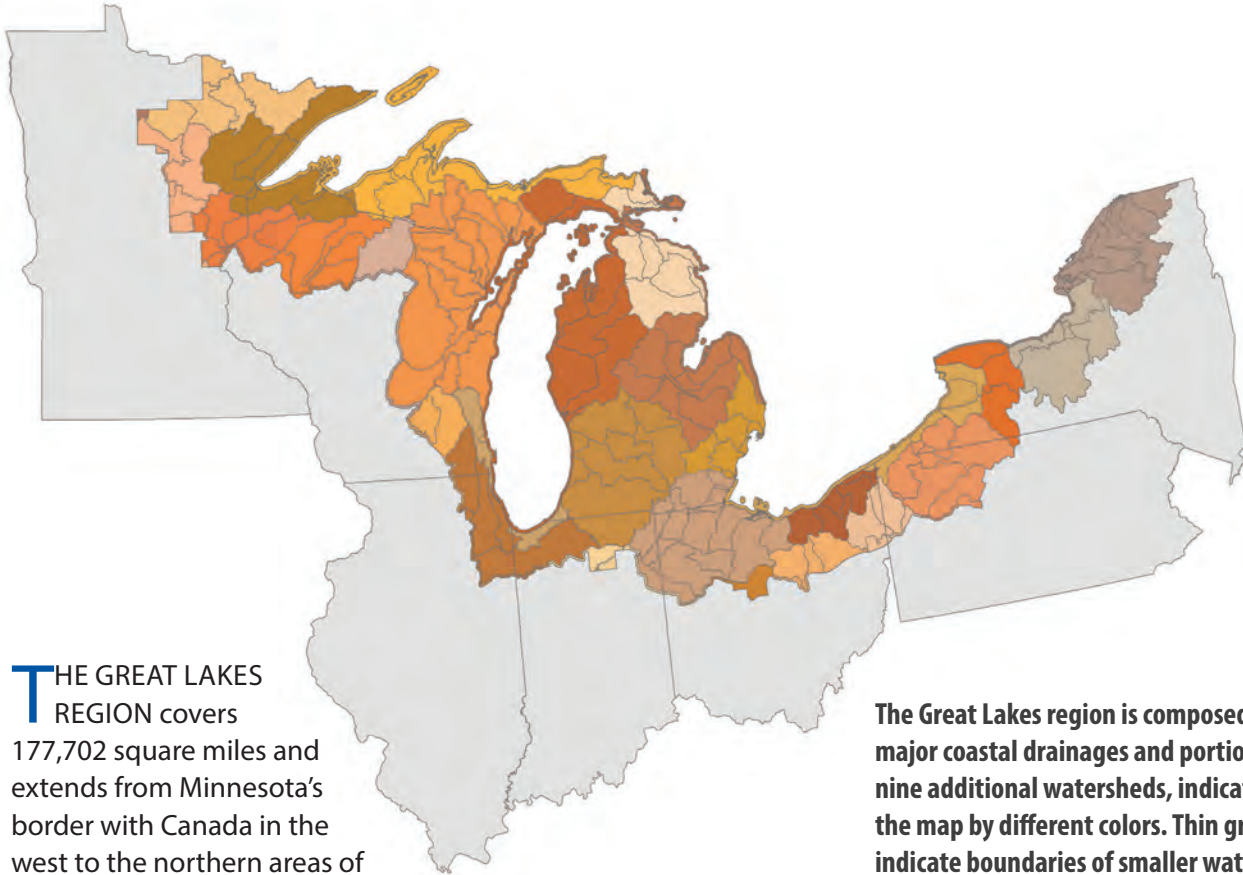
NOAA's Office for Coastal Management works at the center of the nation's coastal management efforts. From implementing the National Coastal Zone Management Program to providing technical assistance to coastal communities through the Digital Coast, the organization strives to help the nation's coastal communities prosper in the face of numerous natural and man-made challenges. To learn more, visit the website at [www.coast.noaa.gov](http://www.coast.noaa.gov).



# INTRODUCTION



Location of the Great Lakes region (red) within the Coastal Change Analysis Program's mapping coverage area (dark gray) in the contiguous United States.



## THE GREAT LAKES REGION

covers 177,702 square miles and extends from Minnesota's border with Canada in the west to the northern areas of New York state that drain to

the north in the east. The region includes all the coastal portions of Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. The five lakes of the Great Lakes Basin make up 95% of the freshwater supply in the U.S. With approximately 9,000 miles of shoreline, the Great Lakes are nicknamed the "Third Coast." The region is home to approximately 27 million people.

The Great Lakes region is composed of 16 major coastal drainages and portions of nine additional watersheds, indicated on the map by different colors. Thin gray lines indicate boundaries of smaller watersheds.

Flora and fauna of the Great Lakes are part of a large and diverse freshwater ecosystem. The region's city centers and coastal assets have supported its manufacturing, recreation, and tourism industries. However, some significant stressors have degraded the ecosystem integrity that the region relies on, including toxic substances, invasive species such as the Asian carp, nonpoint source pollution, and habitat change (resulting in areas known as "Areas of Concern").

Many types of land cover, such as forest, grassland, and shrub/scrub, occur in the Great Lakes, and the amount of each land cover type changes over time. Using images and data collected by satellites, NOAA's Coastal Change Analysis Program (C-CAP) measured the area of each land cover type gained or lost from 1996 to 2010. In this report, 18 land cover classes are grouped into eight general categories: developed, agriculture, grass, shrub, upland forest, wetland, barren, and water.

# LAND COVER

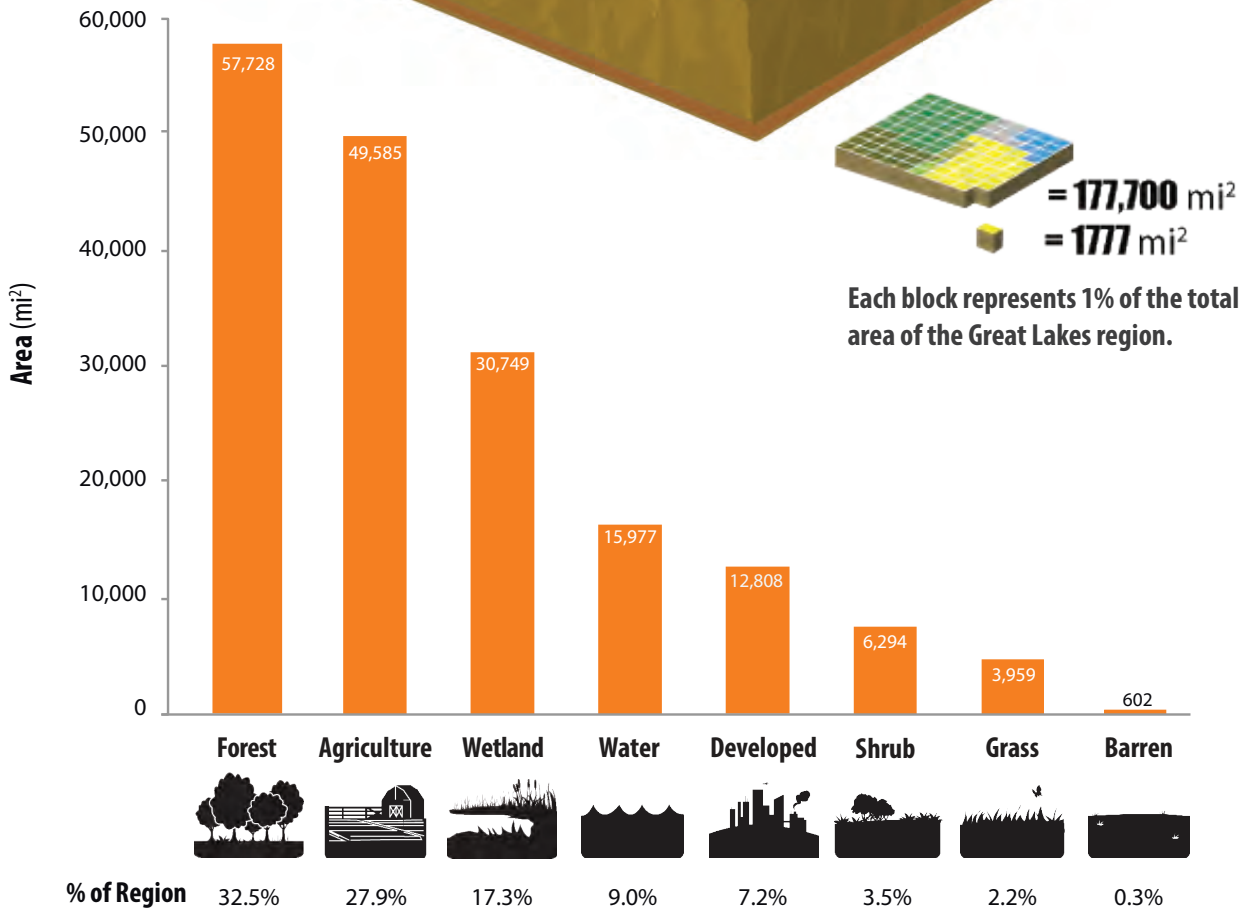
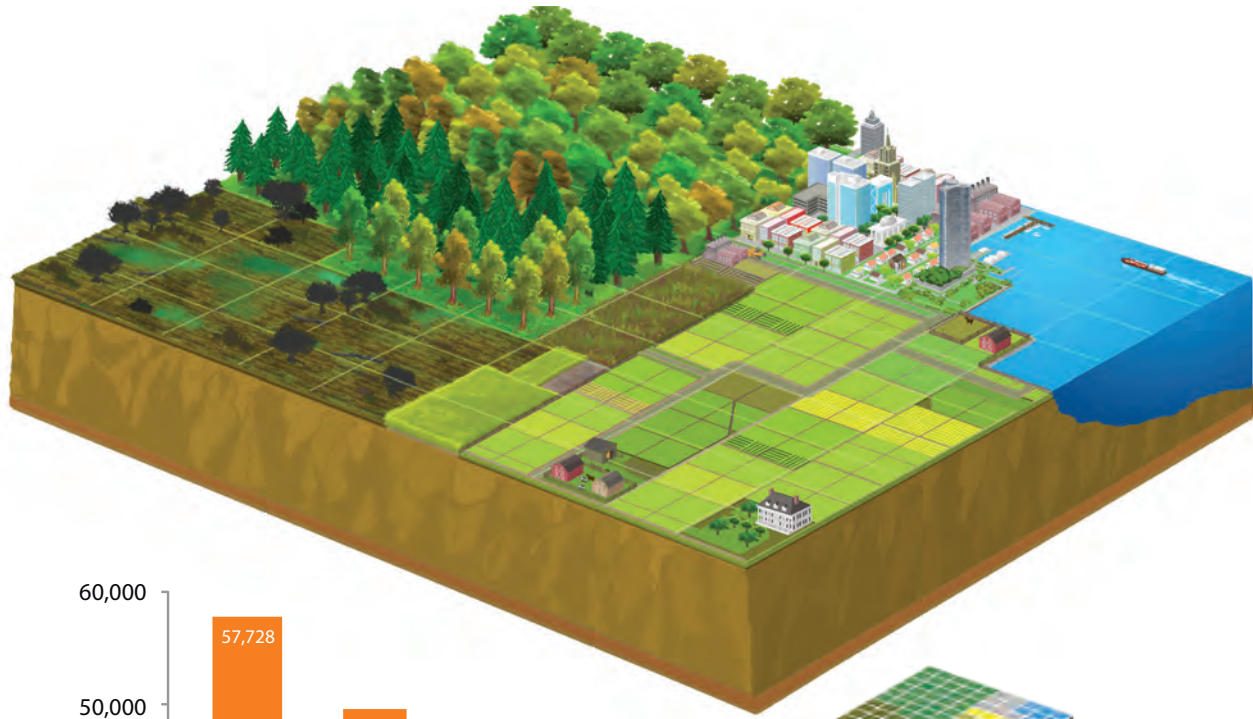
- Developed, High Intensity
- Developed, Medium Intensity
- Developed, Low Intensity
- Developed, Open Space
- Cultivated Crops
- Pasture/Hay
- Grassland/Herbaceous
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Palustrine Forested Wetland
- Palustrine Shrub/Scrub Wetland
- Palustrine Emergent Wetland
- Unconsolidated Shore
- Bare Land
- Open Water
- Palustrine Aquatic Bed
- Estuarine Aquatic Bed



This map shows the distribution of land cover types in the Great Lakes in 2010.

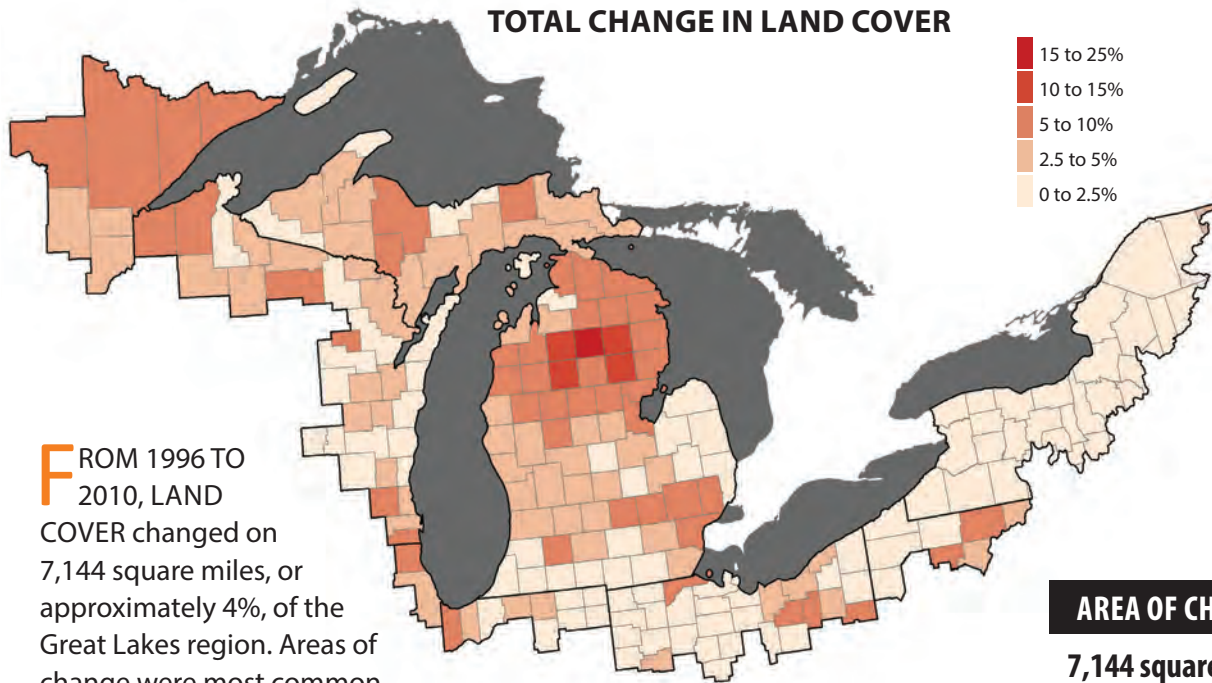


IN 2010, UPLAND FOREST (33%), AGRICULTURE (28%), AND WETLANDS (17%) were the most common categories of land cover in the region, accounting for approximately 78% of the area. The next most common cover types were water (9%), development (7%), and shrub (4%). Grass and barren land made up less than 3% of the total area.



The 18 land cover classes in the Great Lakes region have been grouped into eight major categories that are displayed in the map graphic to highlight their relative distribution in 2010. More detailed information about these eight categories is displayed in the bar chart.

### TOTAL CHANGE IN LAND COVER

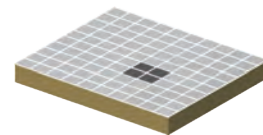


**F**ROM 1996 TO 2010, LAND COVER changed on 7,144 square miles, or approximately 4%, of the Great Lakes region. Areas of change were most common in the northern areas of Minnesota and Wisconsin, as well as the northern portion of Michigan's Lower Peninsula. Much of this change is associated with timber management activities, but a significant amount of development also occurred in the region. This developed related change can be seen in the counties surrounding Cleveland, Toledo, Detroit, Chicago, Milwaukee, as well as the area between Green Bay and Appleton.

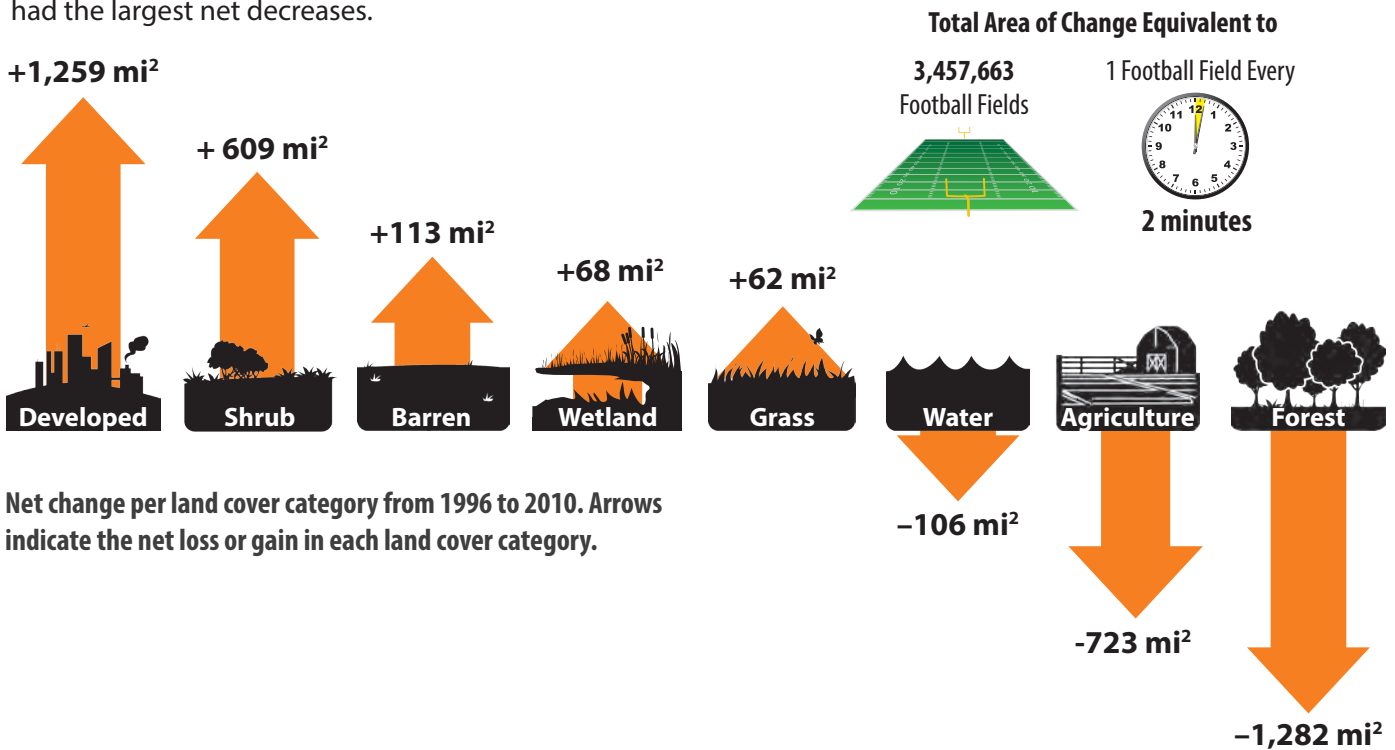
**AREA OF CHANGE**

**7,144 square miles**

**4% OF REGION**



With gains of 1,259 and 609 square miles, respectively, developed and shrub/scrub were the two land covers with the greatest net increases in area. Upland forest (1,282 square miles) and agriculture (723 square miles) had the largest net decreases.



Net change per land cover category from 1996 to 2010. Arrows indicate the net loss or gain in each land cover category.

# DEVELOPED



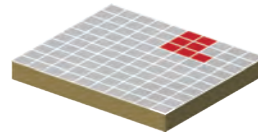
**I**N 2010, DEVELOPMENT accounted for 7% of the Great Lakes. This development is concentrated in the southern portions of the region, in areas surrounding (and between) the large metropolitan areas that include Milwaukee, Wisconsin; Chicago, Illinois; Detroit, Michigan; Cleveland, Ohio; and Buffalo, New York.

- Developed, High Intensity
- Developed, Medium Intensity
- Developed, Low Intensity
- Developed, Open Space

**DEVELOPED AREA**

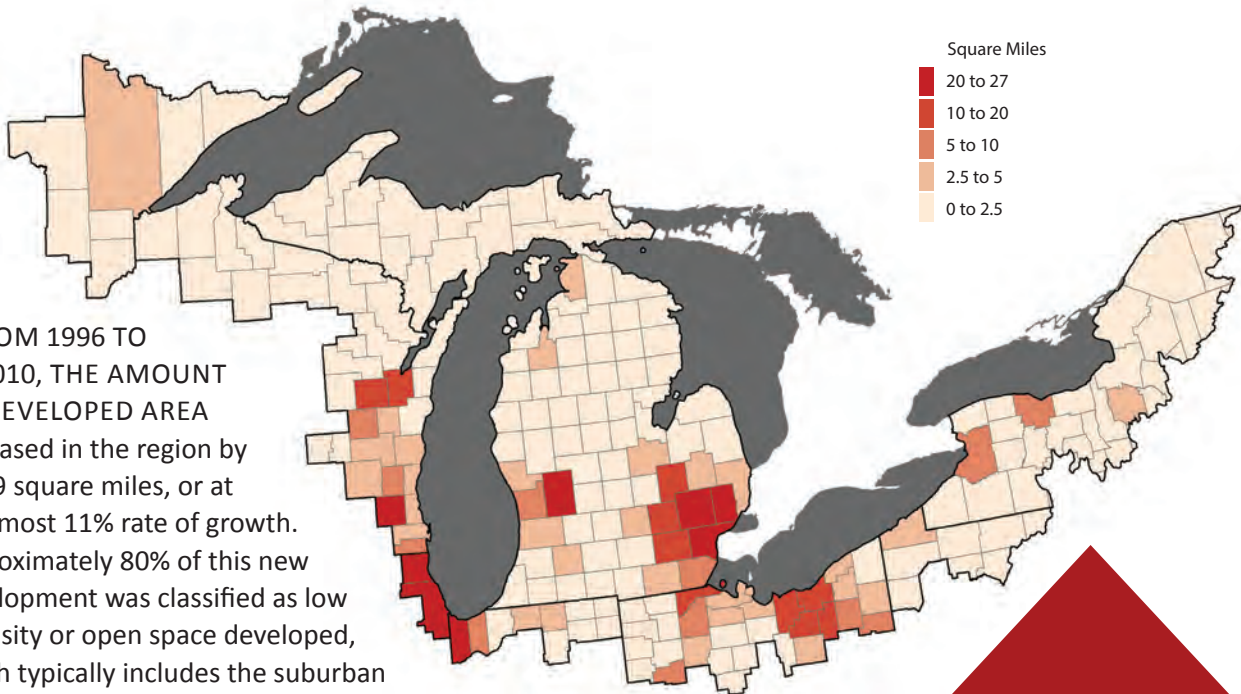
**12,808 square miles**

**7% OF REGION**



2010 development map for the Great Lakes region of the United States. This map depicts intensity of development.

## INCREASE IN DEVELOPED AREA

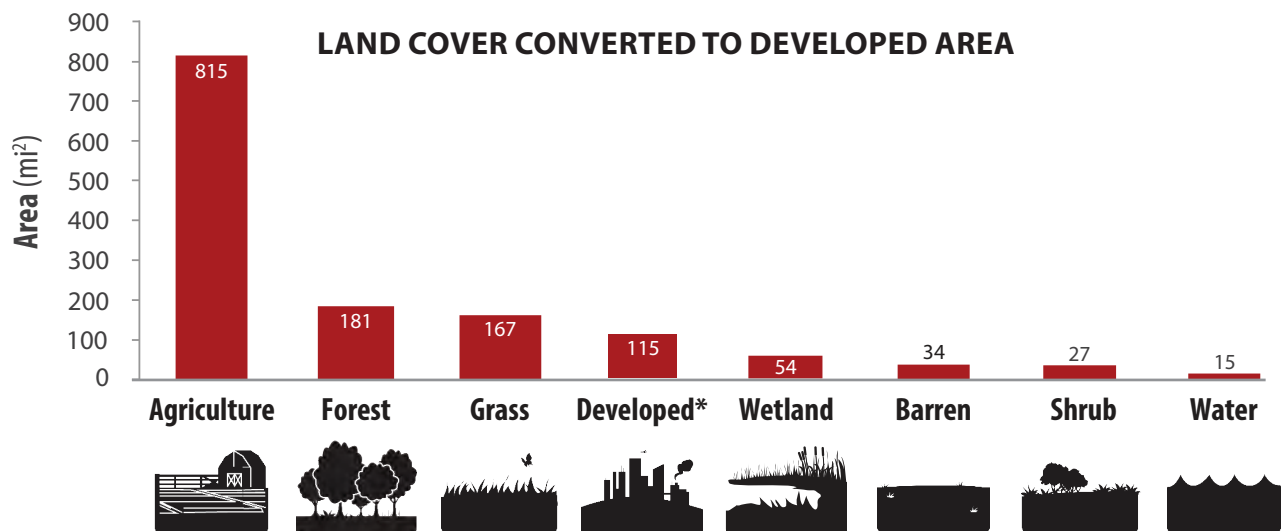
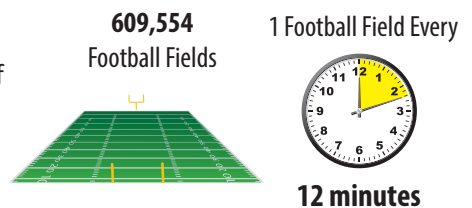


**F**ROM 1996 TO 2010, THE AMOUNT OF DEVELOPED AREA increased in the region by 1,259 square miles, or at an almost 11% rate of growth. Approximately 80% of this new development was classified as low intensity or open space developed, which typically includes the suburban and rural neighborhoods surrounding metropolitan areas and the associated parks, golf courses, and housing with large lawns. The counties surrounding Milwaukee, Chicago, Grand Rapids, and Detroit are areas of high increasing growth. The counties surrounding Green Bay and Appleton, Wisconsin, and Cleveland, Ohio, both have significant amounts of development as well.



New development across the Great Lakes during the 14-year time period came from lands previously categorized as agriculture (63%), upland forest (14%), and grass (13%). Barren and wetland features contributed an additional 4%. Development intensity increased on 115 square miles of already developed land; this type of change is commonly associated with increasing density of housing or infill development within city limits.

### Increase in Developed Area Equivalent to

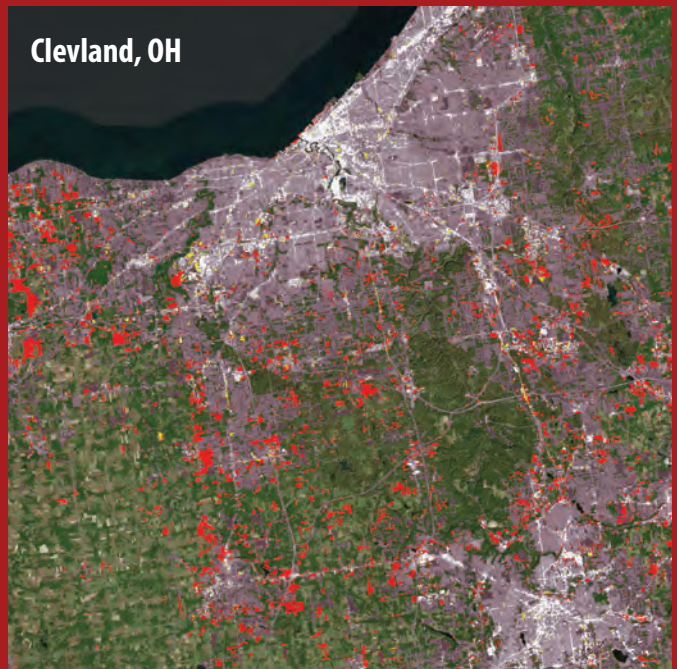
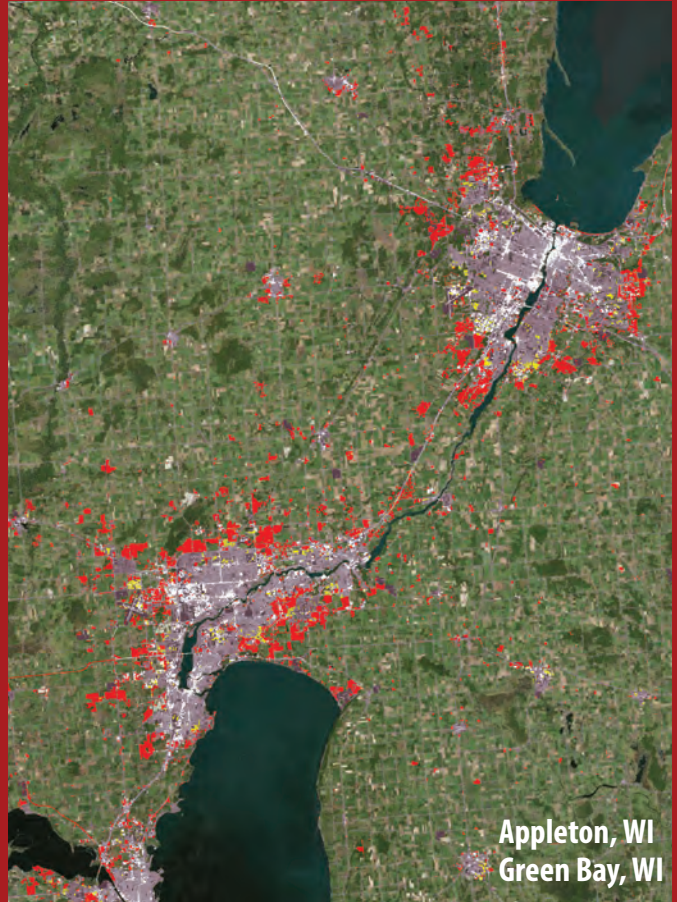


This bar graph shows the area of each land cover that was converted to development between 1996 and 2010.

\* Increases in development intensity



## HIGHLIGHT: METROPOLITAN DEVELOPMENT TRENDS



■ Pre-1996 High Intensity   ■ Pre-1996 Moderate Intensity   ■ Increased Intensity   ■ New Development

These images of large metropolitan areas within the Great Lakes region show patterns of new development (red) and increased density or infill development (yellow). This development often forms a halo pattern around a preexisting city core, reflecting the expansion of major roads and population growth away from the downtown. Background images: Esri

# FOREST

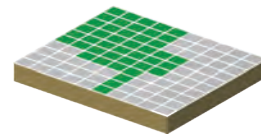
IN 2010, FOREST covered 43% of the Great Lakes region, including 32% upland forest and 11% wetland forest. While this report thus far has placed wetland forest types in the wetlands category, this section considers upland and wetland forests together for a more comprehensive view. Forest is clearly the dominant cover type for the region, with greater densities of forested areas in the northern regions, away from the large metropolitan areas and the dominant agricultural areas in the southern portion of the region. Deciduous and freshwater wetland forests are the dominant forest types, accounting for 53% and 24% of all forested areas, respectively.



**FORESTED AREA**

**76,670 square miles**

**43% OF REGION**



- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Palustrine Forested Wetland

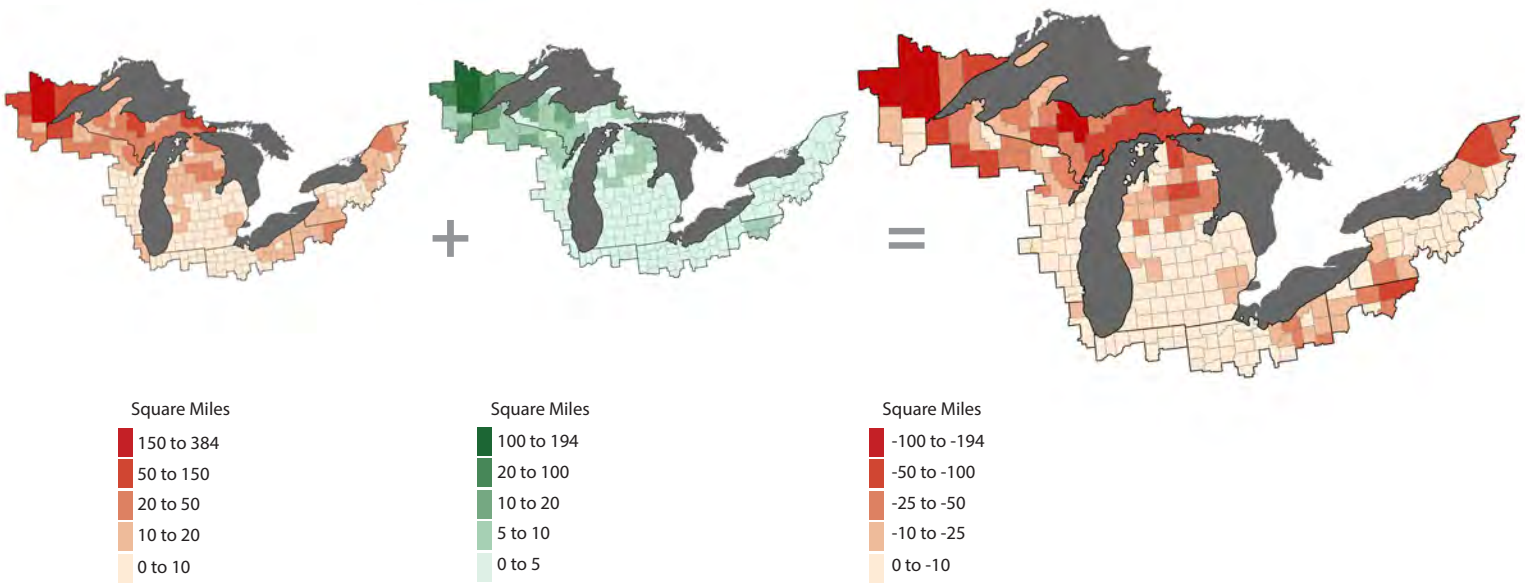
**2010 forest map for the Great Lakes. This map depicts three upland forest categories and one wetland forest category.**



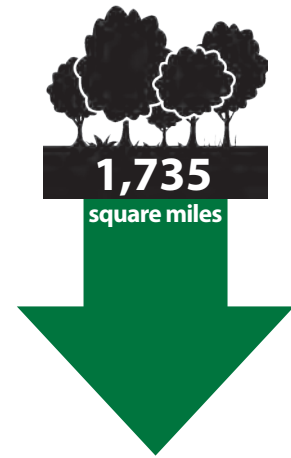
**FOREST AREA LOST**  
2,773 square miles

**FOREST AREA GAINED**  
1,038 square miles

**NET CHANGE  
IN FOREST AREA**



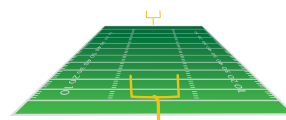
**F**ROM 1996 TO 2010, 2,773 SQUARE MILES OF FOREST changed to other types of land cover (above left), and 1,038 square miles of other land cover changed to forest (above center). The result was a net loss of 1,735 square miles of forest; most of these changes occurred in the northernmost areas away from development and agriculture.



**Decrease in Forest Area Equivalent to**

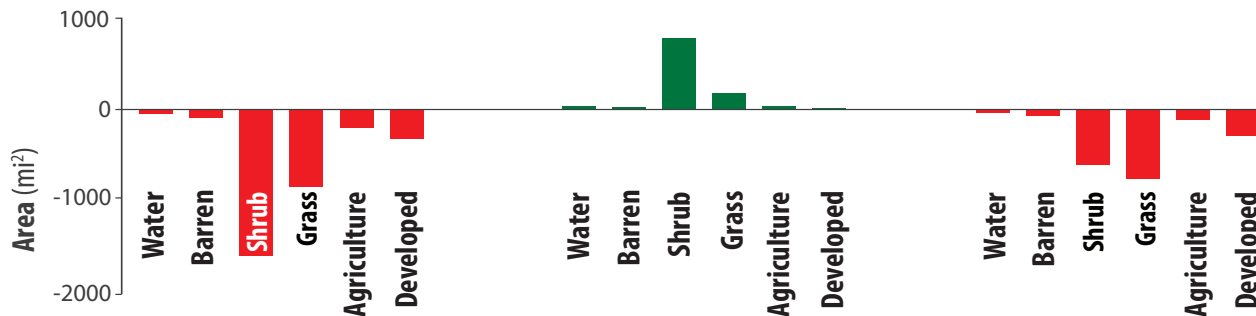
**839,609**  
Football Fields

**1 Football Field Every**



**9 minutes**

**FOREST LOST TO OTHER LAND COVER** + **FOREST GAINED FROM OTHER LAND COVER** = **NET CHANGE OF FOREST TO OTHER LAND COVER**



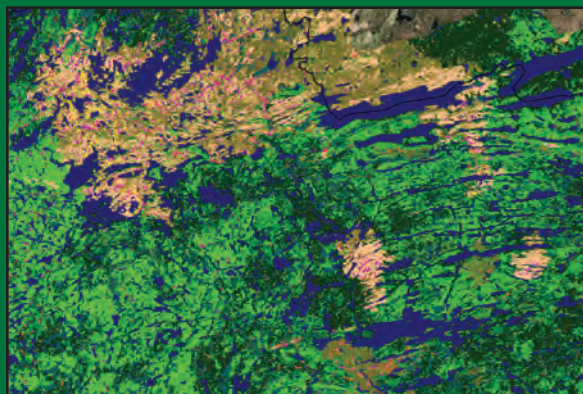
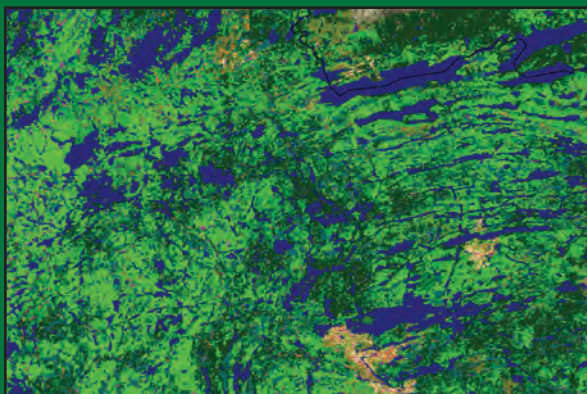
These graphs show the categories of land cover that forests were lost to or gained from, along with the resulting net change between each of these categories and forests between 1996 and 2010.

**M**OST OF THE LOSSES IN FOREST LAND COVER consisted of changes from forest to shrub and grass (85% of all forest losses, combined). At the same time, most forest gains came from these same two classes (89% of all gains). This pattern suggests that many of the region’s forested areas are undergoing transitions that do not result in permanent loss. However, losses of forest to development

are more likely to be permanent. Approximately 213 square miles of forest were lost to development during the study period, accounting for 8% of the net losses. Of these losses, 181 square miles were upland forest and 32 square miles were wetland forest.

### HIGHLIGHT: FOREST FIRE IMPACTS

Several forest fires in the Boundary Waters Canoe Area Wilderness of Minnesota (along the border with Canada) have had dramatic effects on the landscape. The Cavity Lake fire (2006) and the Ham Lake fire (2007) burned over 106,000 acres. The two images below show the forest extent before these fires (left) and the areas of grass and shrub that have regrown in the wake of the burn and forest loss (right). An area of regrowth (grass in 1996 to scrub in 2010) can also be seen and highlights recovery of the area after the 1996 Temperance fire (which burned more than 4,450 acres).

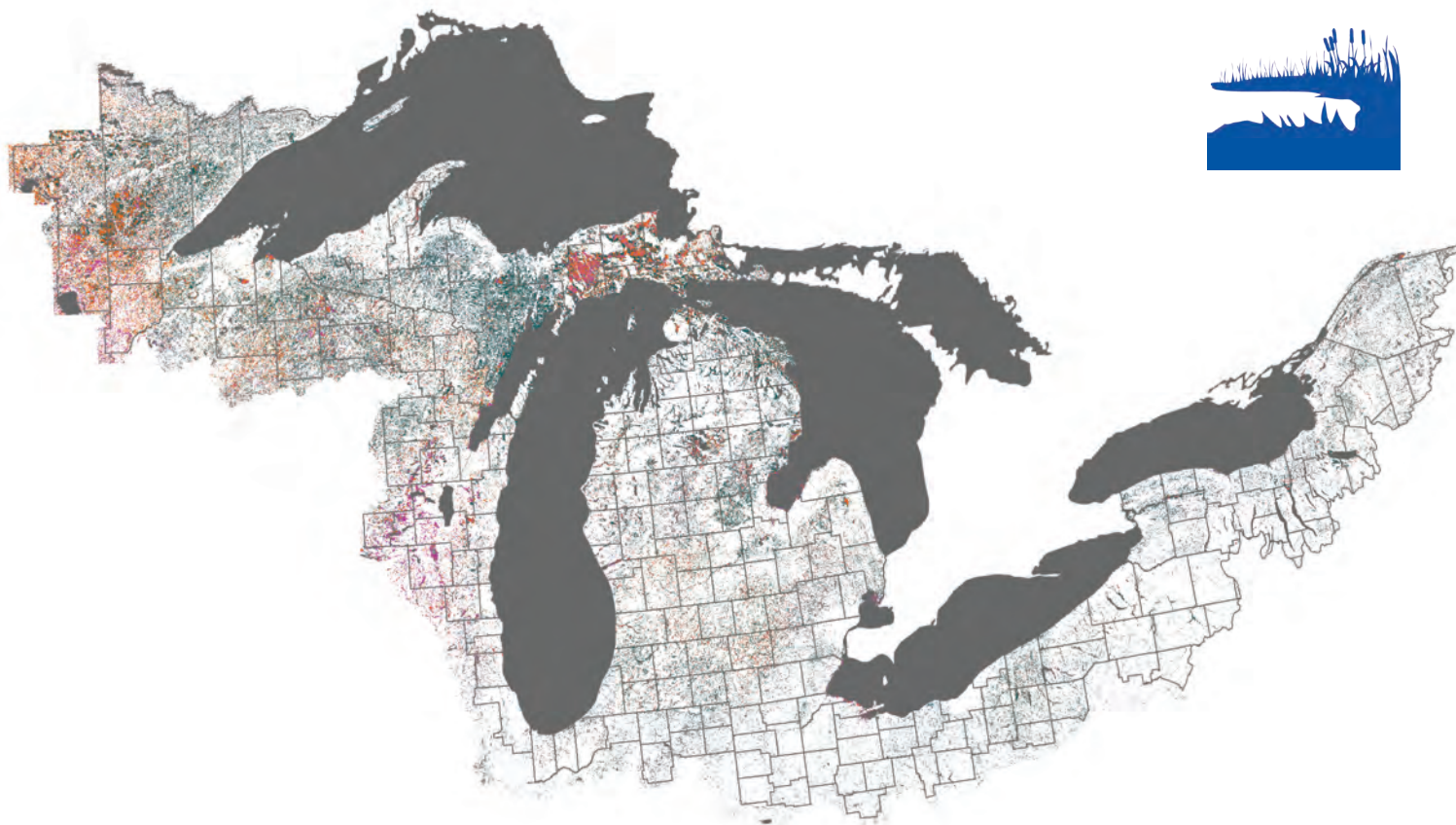
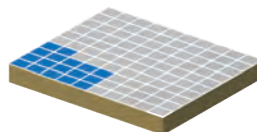


# WETLAND

**A**PPROXIMATELY 17% OF THE GREAT LAKES REGION was covered by wetlands in 2010. These wetlands are entirely freshwater wetlands (100%). Freshwater forested wetlands accounted for 62% of the total, while shrub and emergent wetlands accounted for 24% and 14%, respectively. Unconsolidated shore features along the coasts and rivers made up less than 1% of the area.

**WETLAND AREA**  
30,749 square miles

**17% OF REGION**



- Palustrine Forested
- Palustrine Emergent
- Palustrine Shrub/Scrub
- Unconsolidated Shore

2010 wetland map for the Great Lakes. This map depicts four wetland categories.

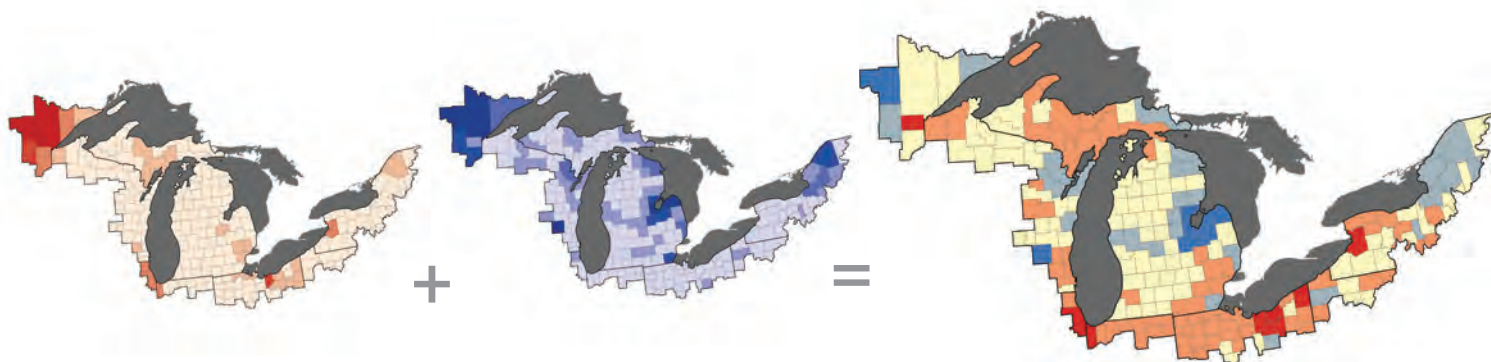
**WETLAND AREA LOST**

150 square miles

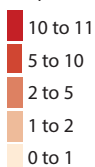
**WETLAND AREA GAINED**

218 square miles

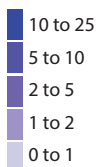
**NET CHANGE  
IN WETLAND AREA**



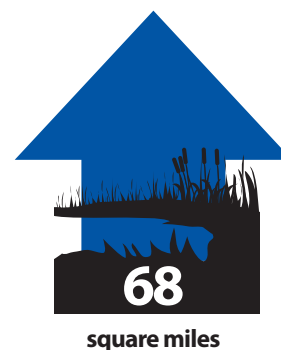
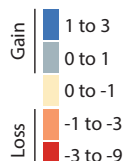
Square Miles



Square Miles



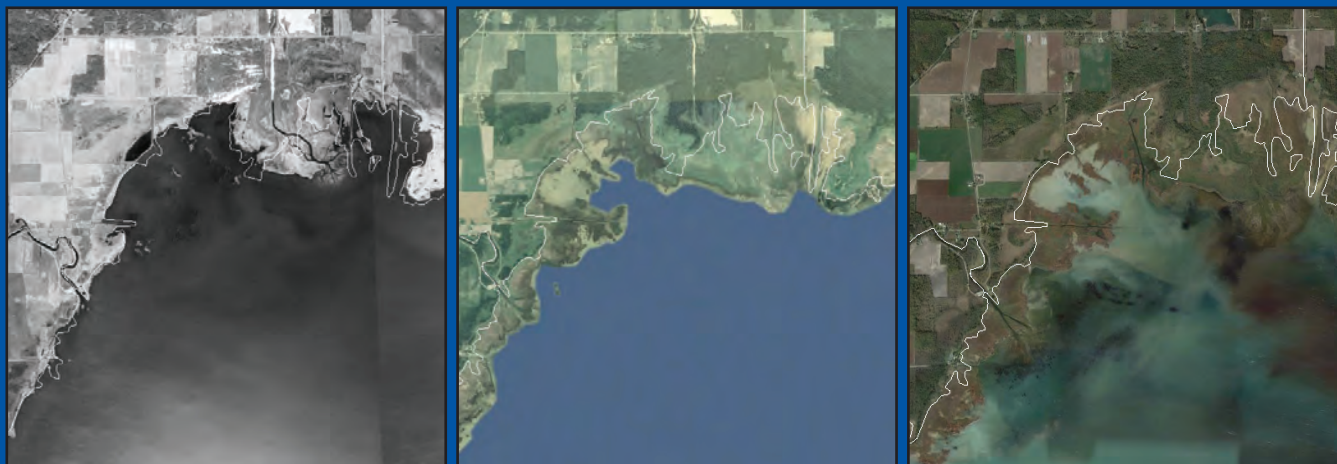
Square Miles



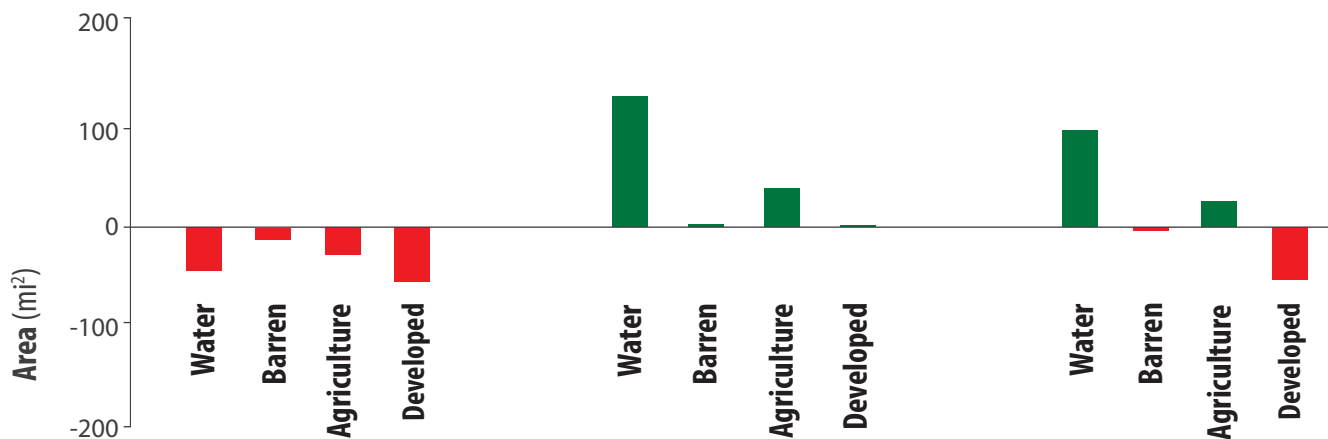
**W**ETLAND AREAS ACROSS THE REGION experienced a net increase of 68 square miles from 1996 to 2010, reflecting a loss of 150 square miles (above left) and a gain of 218 square miles (above center). While some areas had a net gain and others had a net loss, the overall net change was very small. Development around Chicago, Cleveland, and Buffalo dominate the areas of loss. Low water levels, such as those seen around Saginaw Bay, Michigan, and Horicon Marsh, Wisconsin (the largest freshwater cattail marsh in the United States), dominate the areas of wetland gains.

**HIGHLIGHT: DROUGHT AND LOW LAKE LEVEL IMPACTS**

This area along the shore of Saginaw Bay in Arenac County, Michigan, is just one example where C-CAP data have captured impacts of drought and lower-than-average lake levels, resulting in the addition of wetlands along the shore, as well as in ponds and other riparian features throughout the area. From 1996 to 2010 this county gained 973 acres of wetlands converted from formerly open water features. The following imagery shows the shoreline area of Arenac County in 1998, 2006, and 2013.



**WETLAND LOST TO OTHER LAND COVER** + **WETLAND GAINED FROM OTHER LAND COVER** = **NET CHANGE BETWEEN WETLAND AND OTHER LAND COVER**



These graphs show the categories of land cover that wetlands were lost to or gained from, along with the resulting net change between each of these categories and wetlands between 1996 and 2010.

**W**ETLANDS IN THE GREAT LAKES were primarily lost to development (43%) and water (33%). Most of the gains were from water features (72%), as well as formerly agricultural features (25%). These gains can be attributed to both the recent years of drought and the consequent low water levels in the lakes and ponds, as well as individual areas of restoration (in former agricultural areas).

**HIGHLIGHT: MARSH RESTORATION FROM FORMER AGRICULTURAL AREAS**

Dedicated on June 14, 2007, the Zeloski Marsh in Jefferson County, Wisconsin, is a 1,500-acre wetland restored from drained farmland. The marsh, forming the core of the Lake Mills Wildlife Area, owned and operated by the Wisconsin Department of Natural Resources (DNR), was restored in a collaborative effort of Wisconsin DNR, the U.S. Department of Agriculture’s Natural Resources Conservation Service, and the Madison Audubon Society. The image on the left shows the predominantly agricultural area in 1996. The image on the right highlights the area after restoration. The Glacial Drumlin bicycle trail can be seen crossing the marsh.

