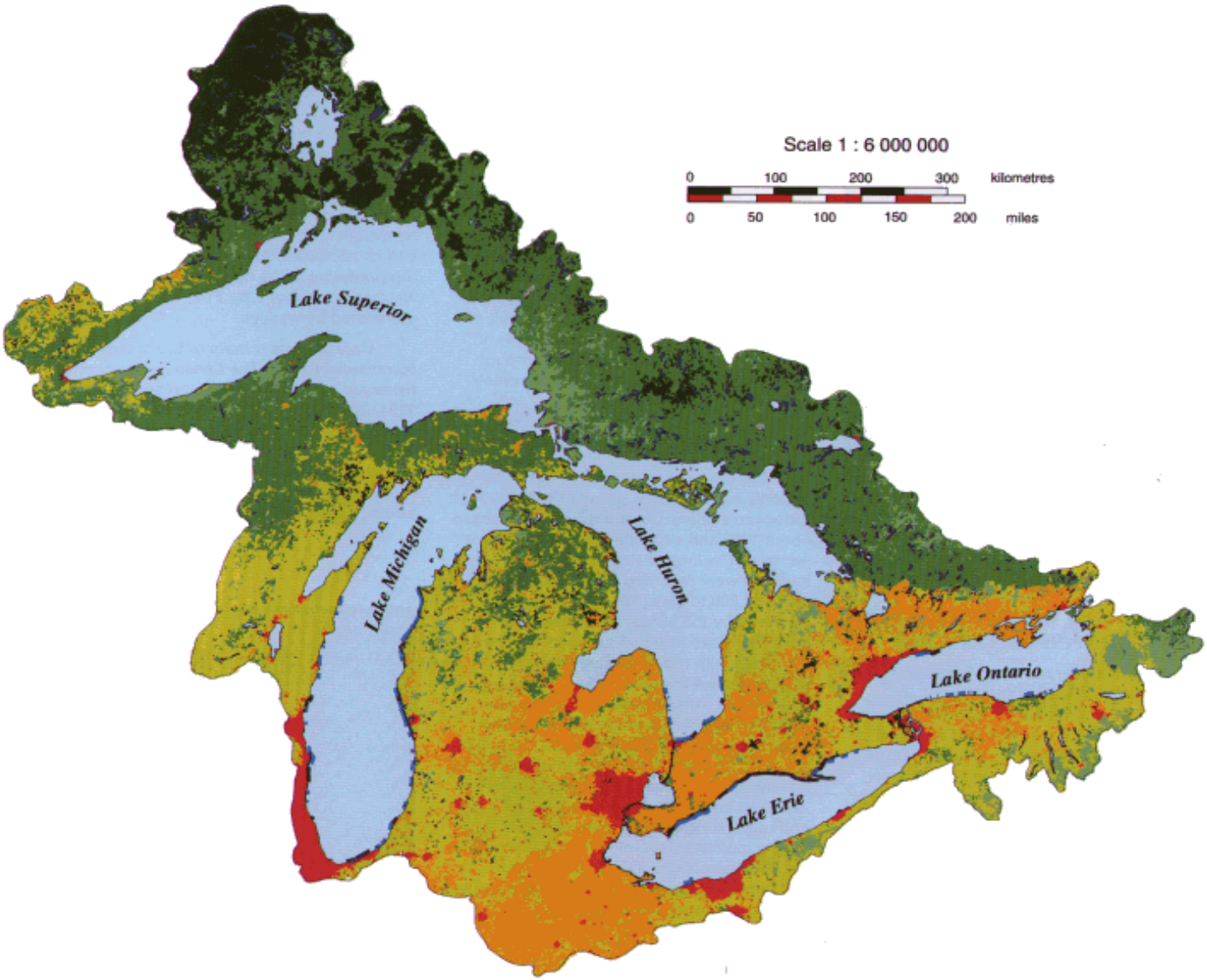
Groundwater, Agriculture and Forestry Indicators

Norman Grannemann
US Geological Survey

Groundwater



Land Use

Great Lakes Atlas
USEPA and Environment Canada

Groundwater Indicators

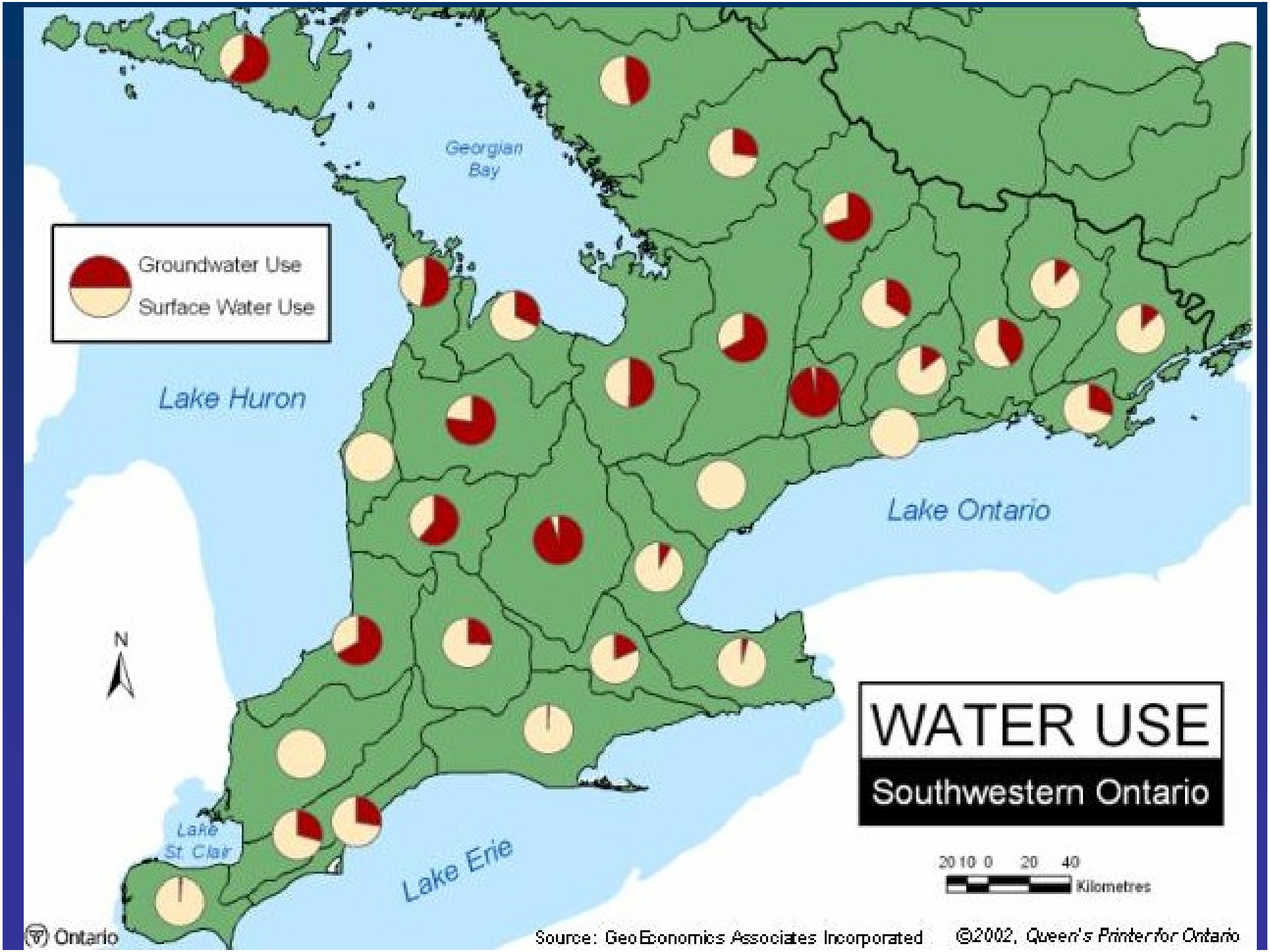
- To address *Great Lakes Water Quality Agreement*, Annex 16: Polluted Groundwater
- Based on available or easily collected data

Groundwater Indicators

1. Water Use
2. Natural and Human Induced Groundwater Quality
3. Base flow due to Groundwater Discharge
4. Groundwater and Amphibian Communities
5. Groundwater Dependant Plant and Animal Communities
6. Land Use and Intensity
7. Managing the Groundwater Resource

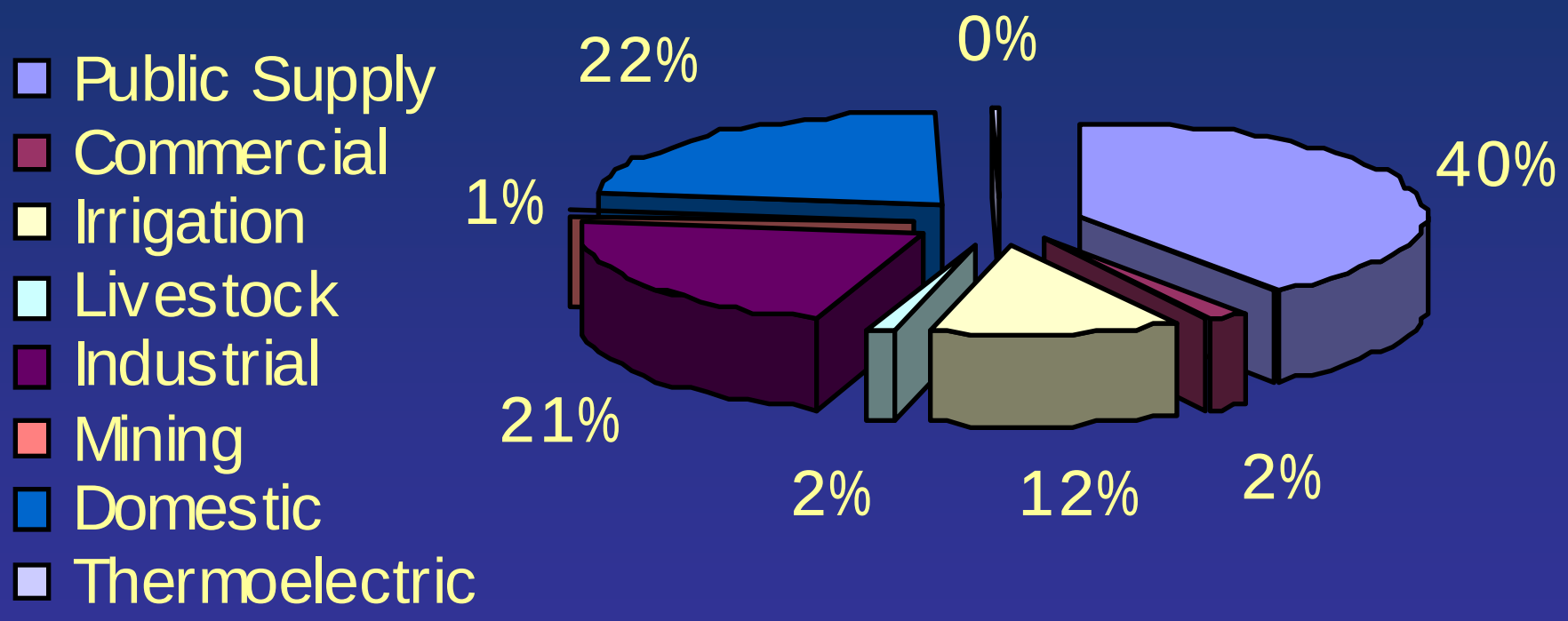
Water Use

- Measures water use within political sub-divisions;
- Infer the potential impacts of use and intensity on quantity and quality of groundwater.
- Also measures supply versus demand by assessing the construction of new wells or deepening of existing wells.

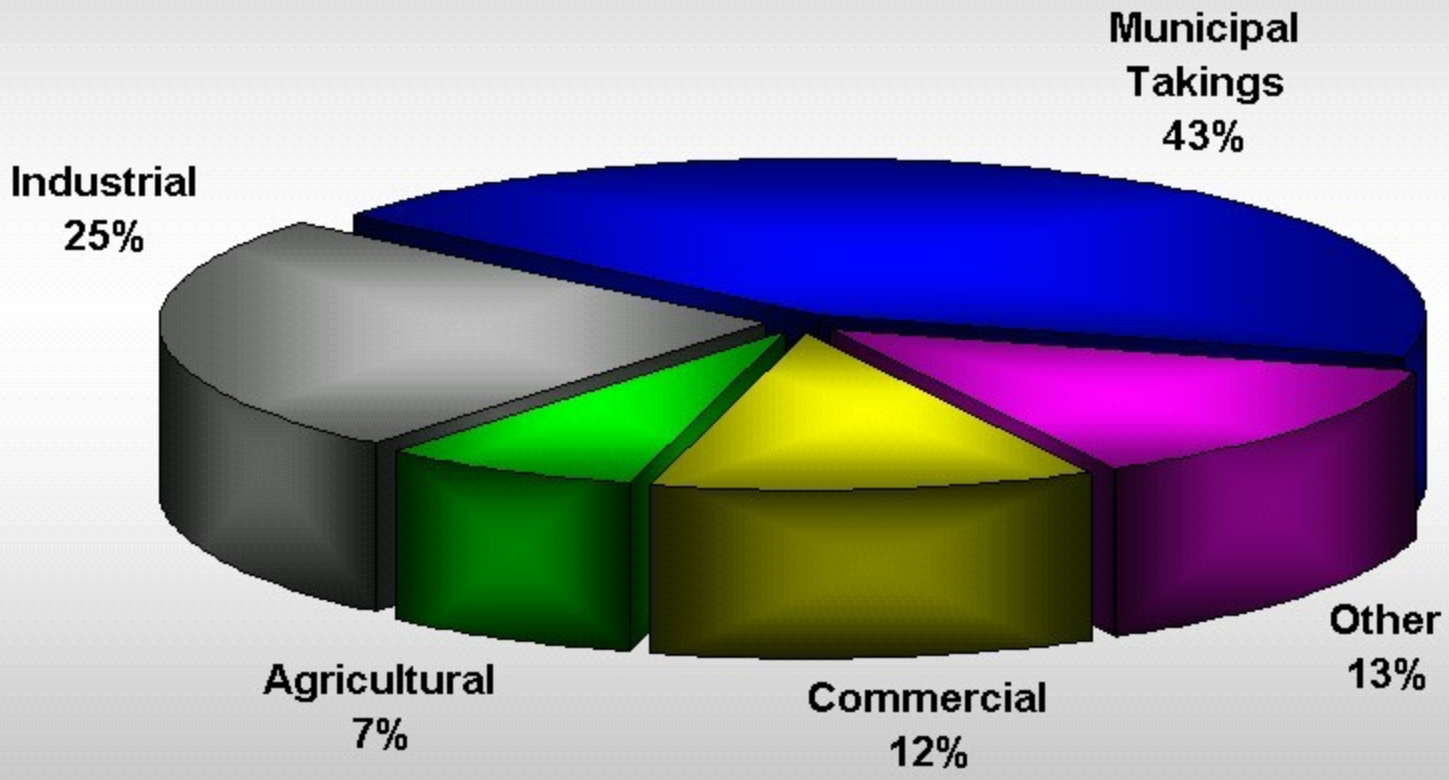

Groundwater Use
Surface Water Use
Georgian Bay
Lake Huron
Lake Ontario
Lake Erie
Lake St. Clair
N
WATER USE
Southwestern Ontario
20 10 0 20 40
Kilometres
Ontario
Source: GeoEconomics Associates Incorporated
©2002, Queen's Printer for Ontario

EXPLANATION
Great Lakes Drainage Basin
U.S.A./Canada border
Cities/towns
15 Ground-water withdrawal rate, in millions of gallons per day
0 50 100 MILES
0 50 100 KILOMETERS
CANADA
U.S.A.
Lake Superior
Lake Michigan
Lake Huron
Georgian Bay
Lake Ontario
Lake Erie
Marathon
Thunder Bay
Duluth
Marquette
Sault Ste. Marie
Sault Ste. Marie
Sudbury
Parry Sound
Petoskey
Traverse City
Owen Sound
Green Bay
27
Milwaukee
93
Chicago
200
Grand Rapids
33
Lansing
90
Kalamazoo
78
Battle Creek/ Jackson
82
Portage/Michigan City
30
Elkhart/Goshen
39
South Bend/Mishawaka
63
Fort Wayne
11
Bay City
Saginaw
Flint
Detroit
78
Windsor
Sarnia
London
Toledo
27
Cleveland/Akron
36
Erie
10
Buffalo
7
Niagara Falls
Hamilton
Toronto
Rochester
12
Syracuse
15
Oswego
Kingston
Trenton
Cornwall
Massena
Montreal
Trois Rivières
Source map: Environment Canada

Groundwater Use in Michigan, 1995



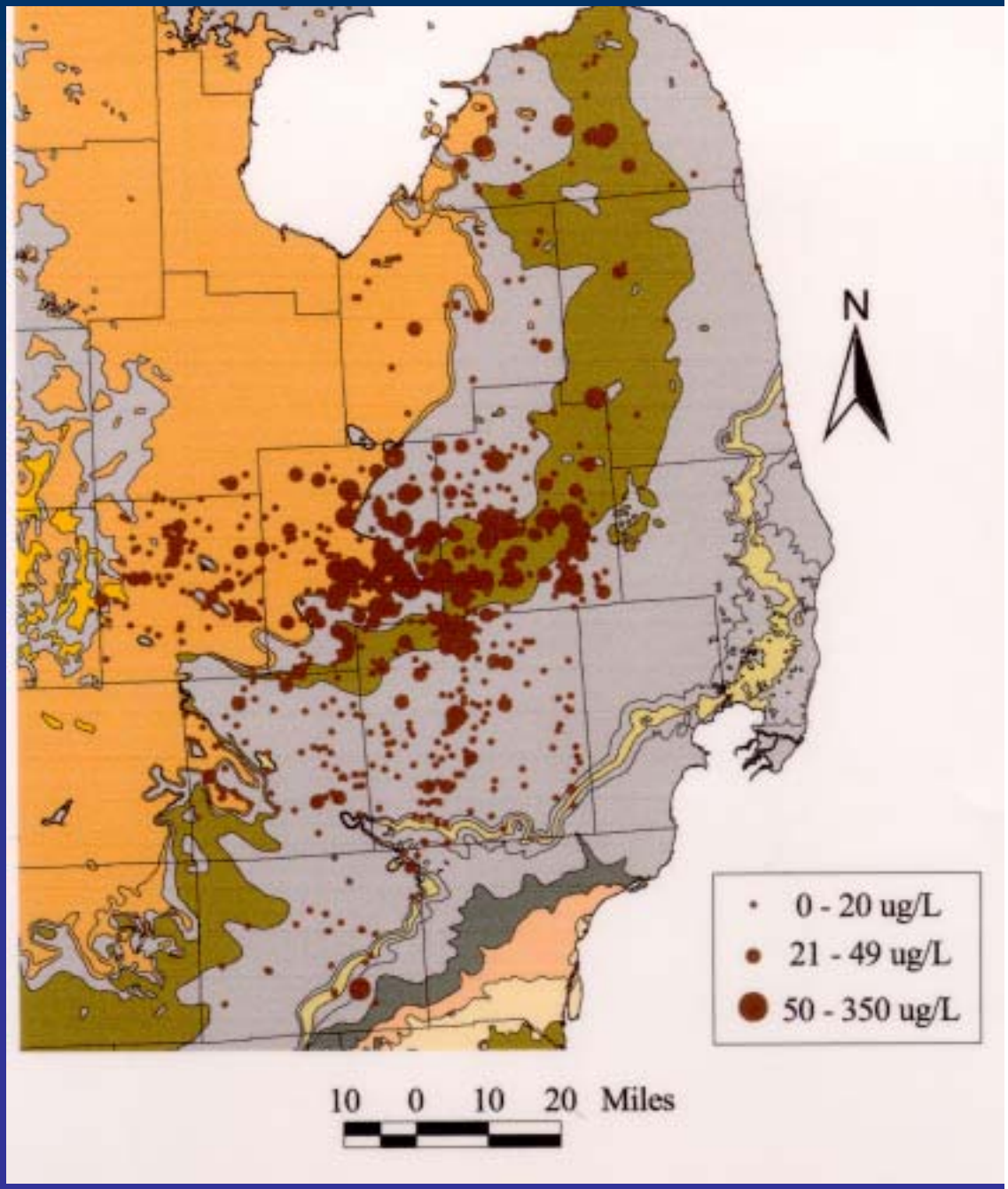
How Water is Being Used in the Grand River Watershed



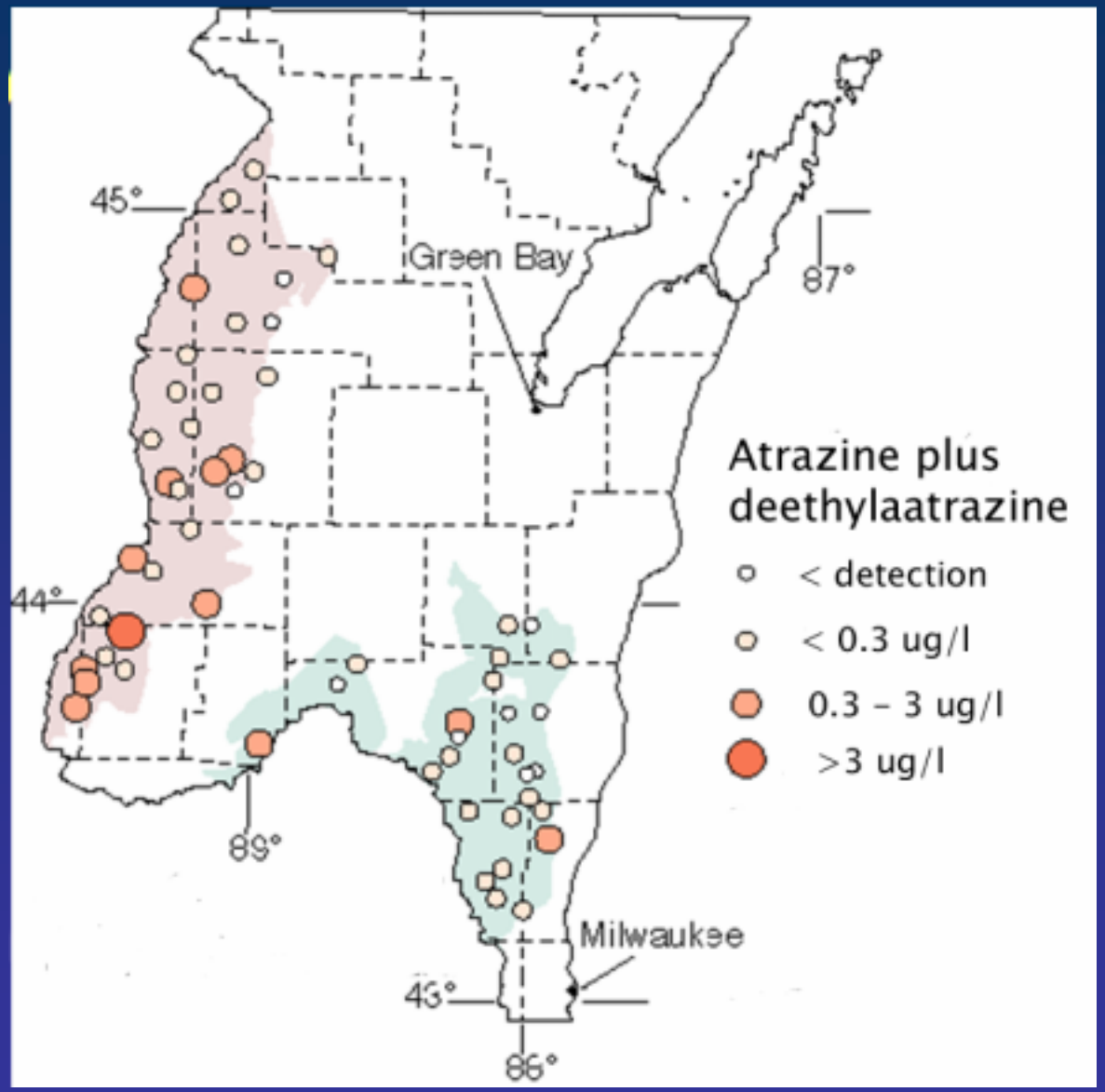
Natural and Human-Induced Groundwater Quality

- Quality of groundwater
  - Drinking water
  - Agricultural purposes
  - Ecosystem functions
- Areas of contamination
  - Remediation, prevention of non-point contamination

Arsenic in Groundwater from Southeastern Michigan



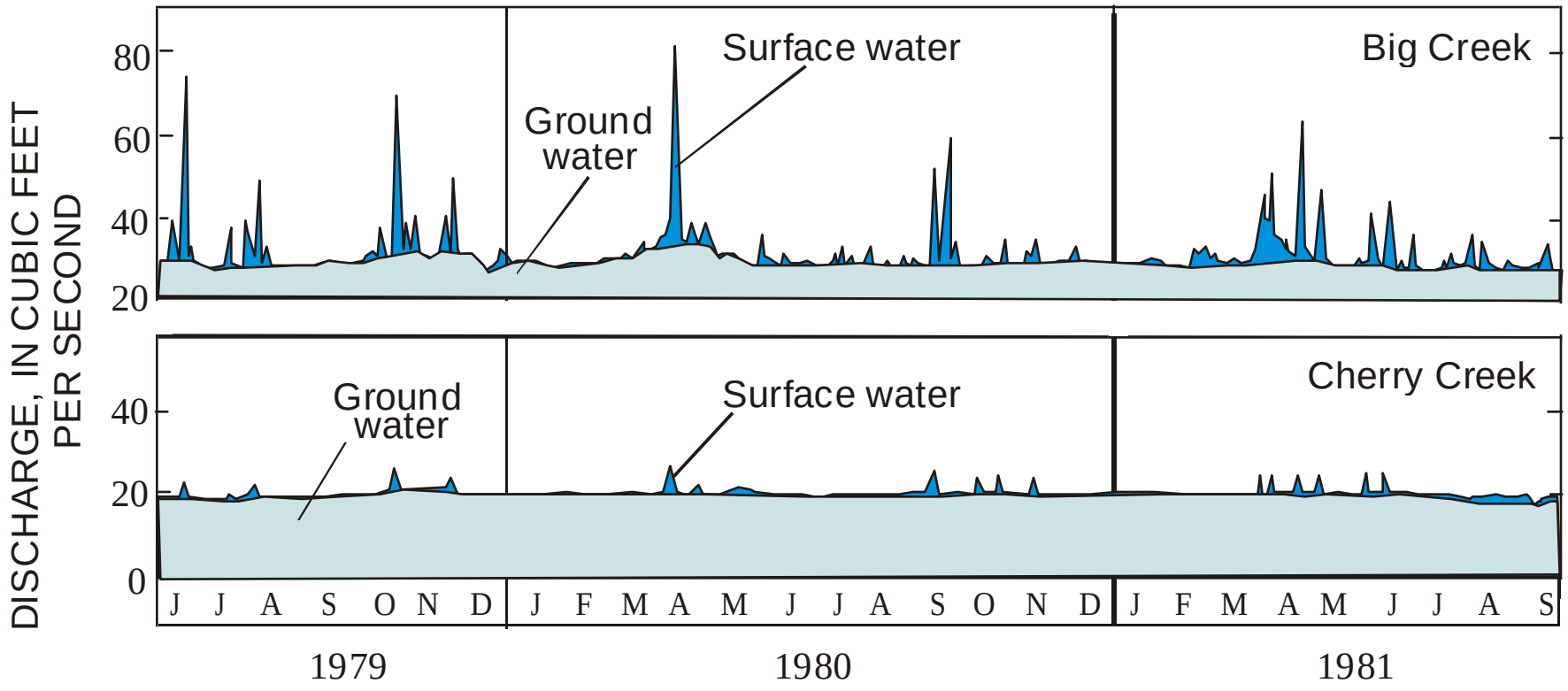
Atrazine in Groundwater from Eastern Wisconsin

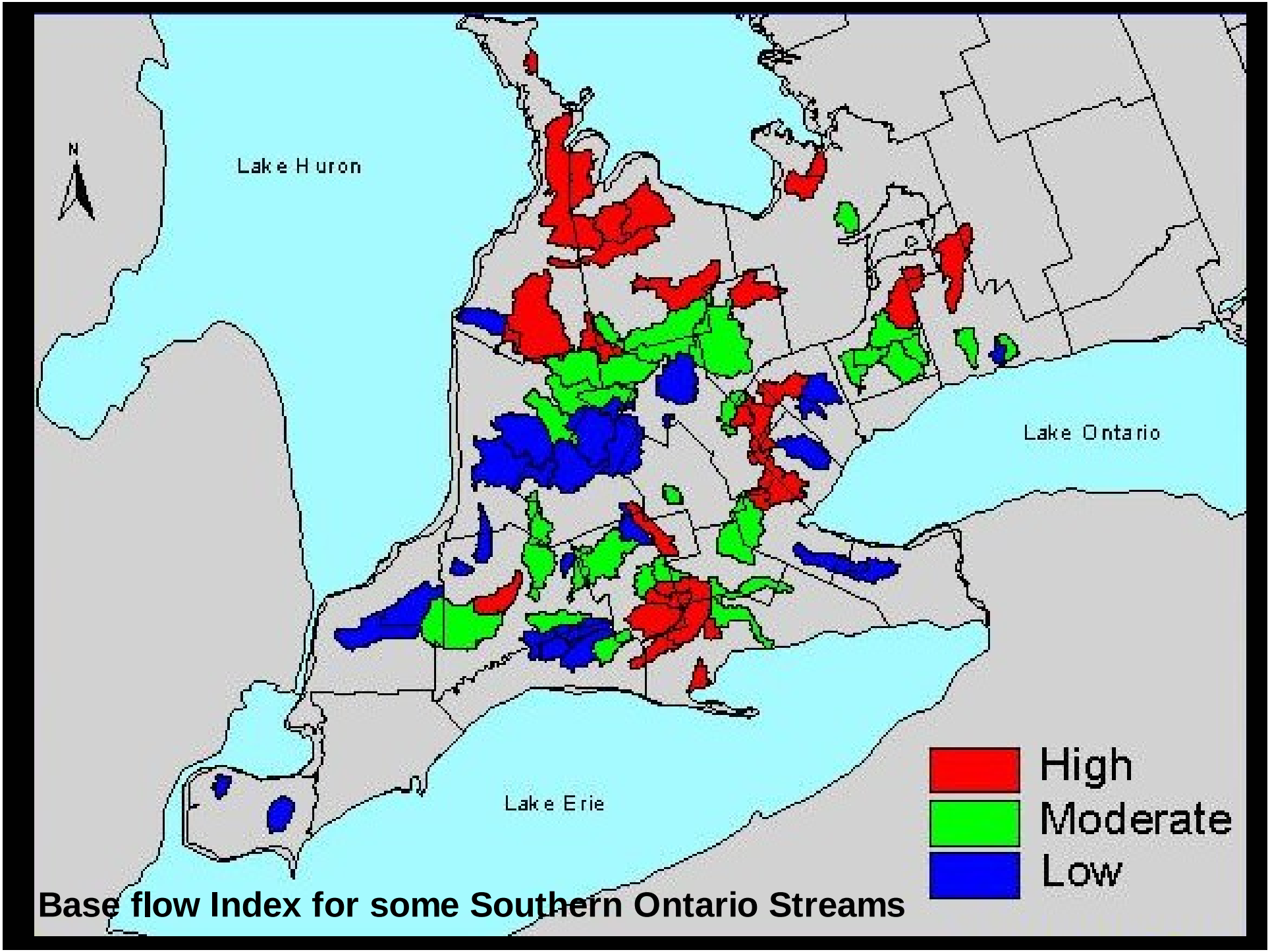


Base flow

- Contribution of groundwater to total stream flow
- Detects the impacts of humans

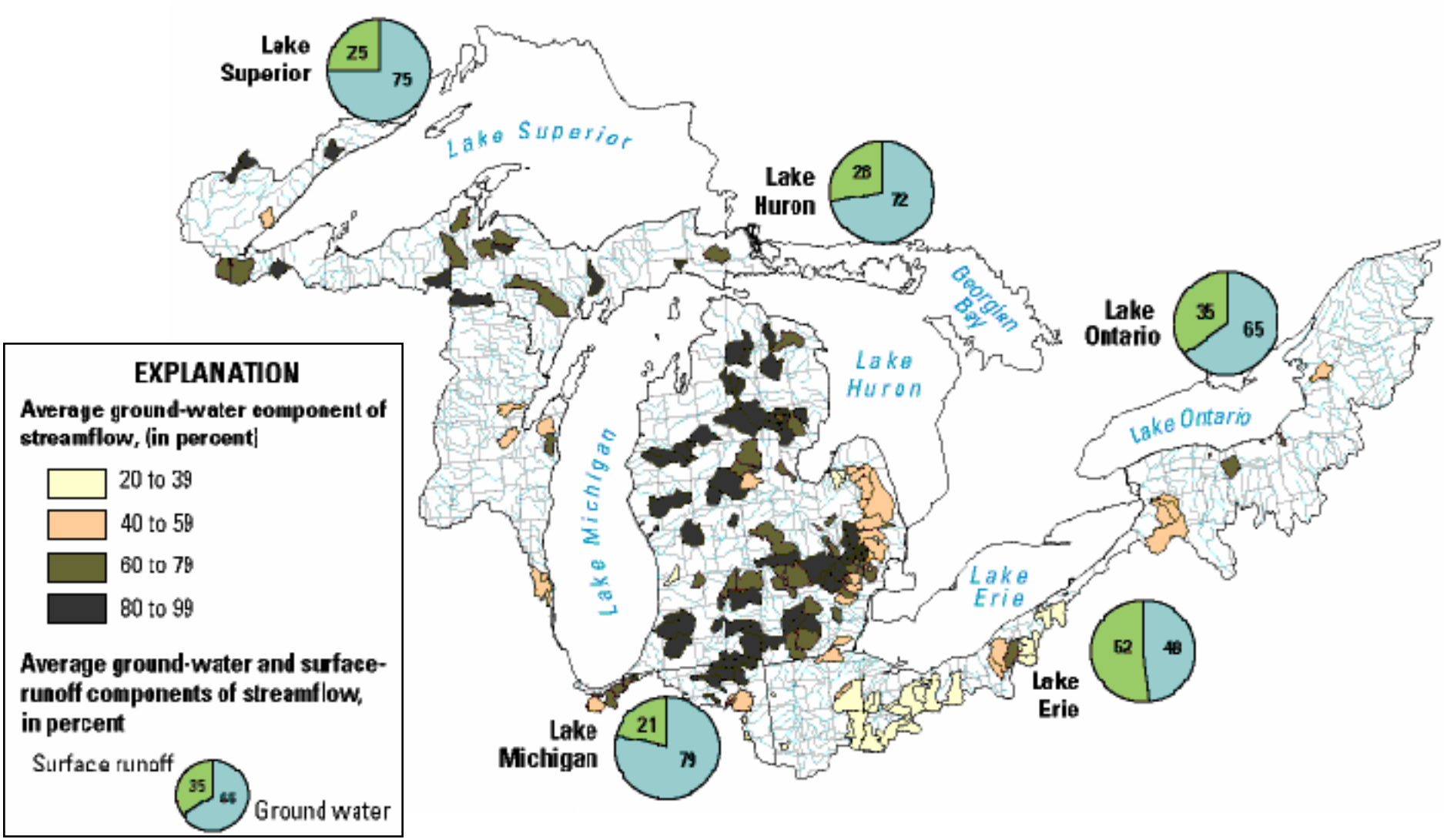
Examples of Base Flow





Base flow Index for some Southern Ontario Streams

Base flow component of stream flow



Groundwater and Amphibian Communities

Four-toed salamander

- Cool water adapted frogs and salamander species
- Groundwater discharge dominates stream flows

Groundwater Dependant Plant and Animal Communities

- Assesses locations of groundwater intrusions
- Measures contribution of groundwater to stream and near shore flows
- Evaluates trophic status, food web dynamics, location of fish, wildlife, plant communities at risk

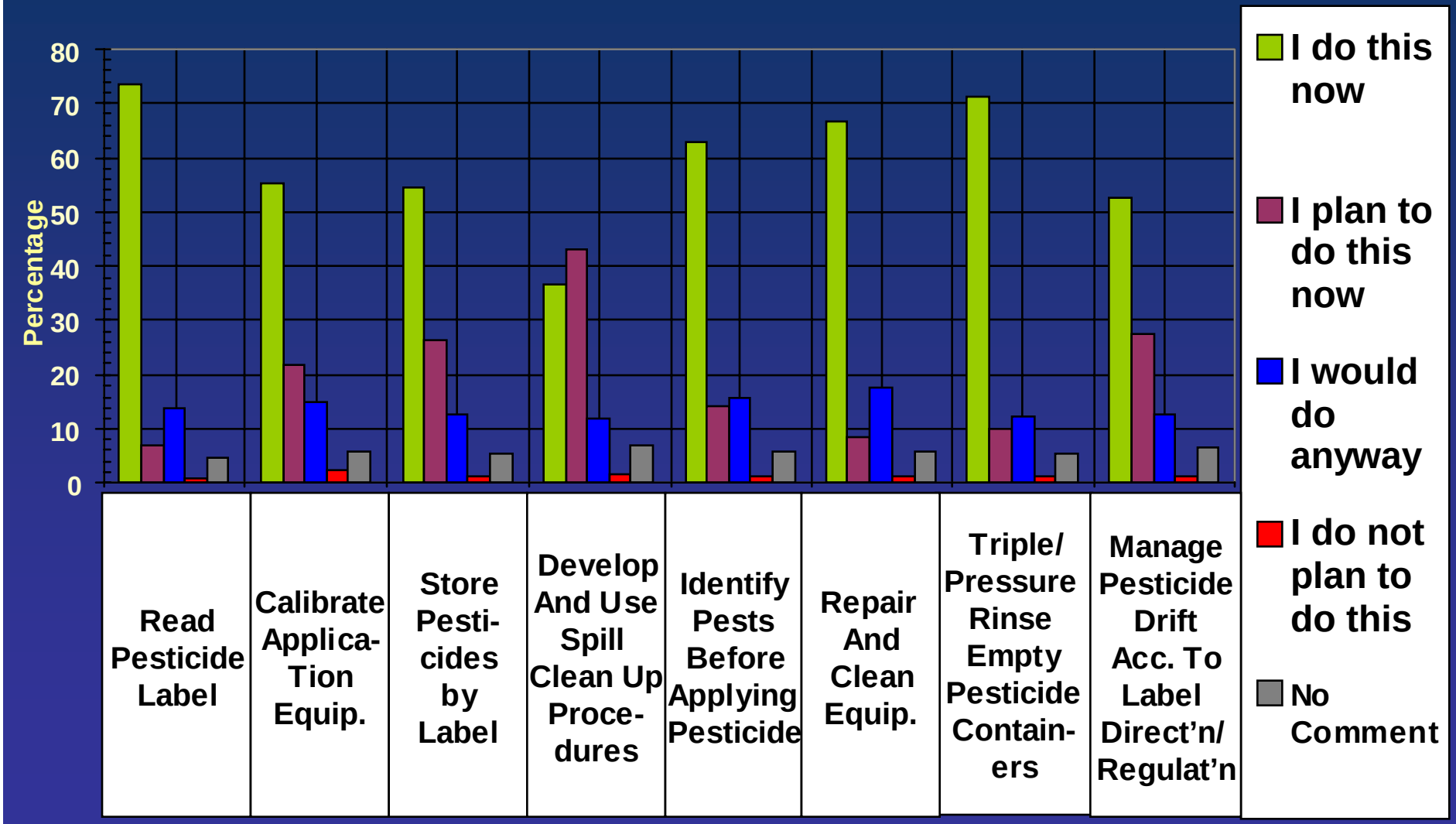
Brook Trout

Agricultural Indicators

Integrated Pest Management

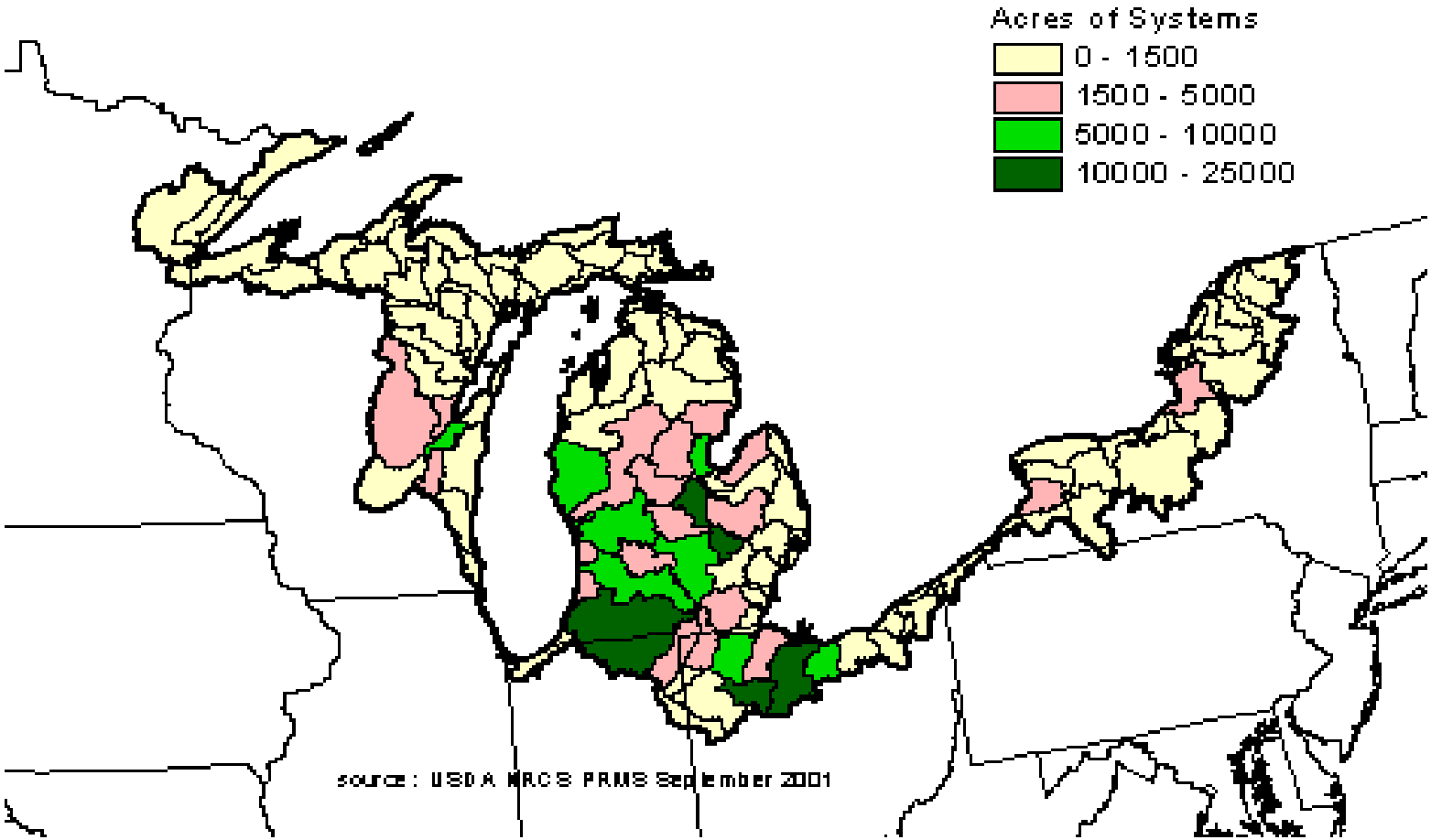
- This indicator reports the adoption of Integrated Pest Management (IPM) practices and the effects IPM has toward preventing surface and groundwater contamination in the Great Lakes Basin.

Grower Pesticide Safety Course Evaluation Results - 2000-2001



Pesticide Management Systems Planned
Total Acres - Cropland

Fiscal Year 2001

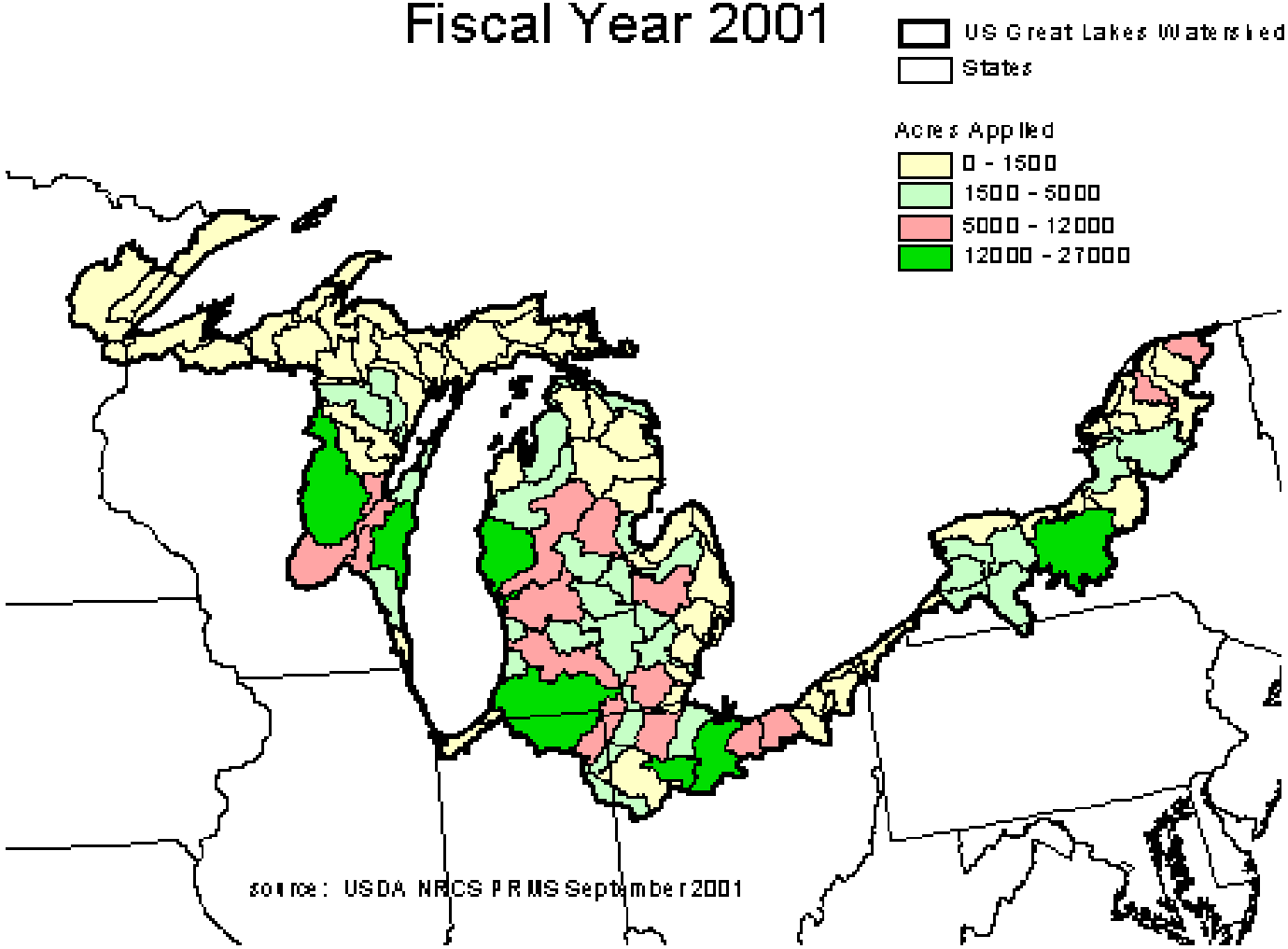


Nutrient Management Plans

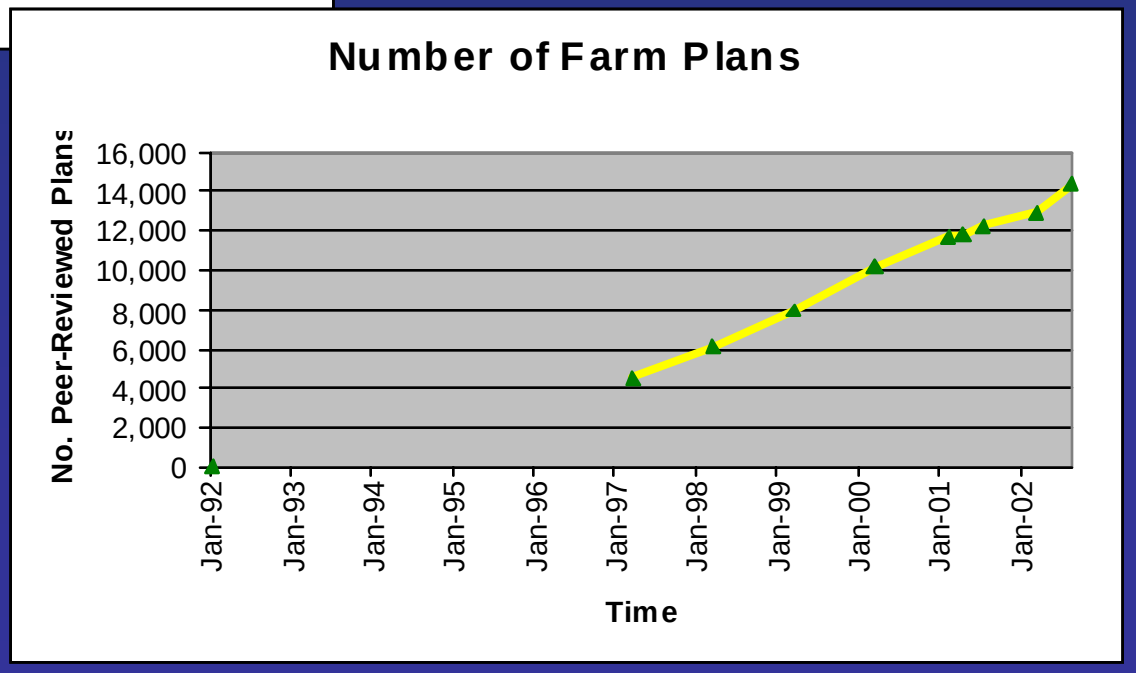
- Reports the number of Nutrient Management Plans in place, and infers environmentally friendly practices, to prevent ground and surface water contamination.

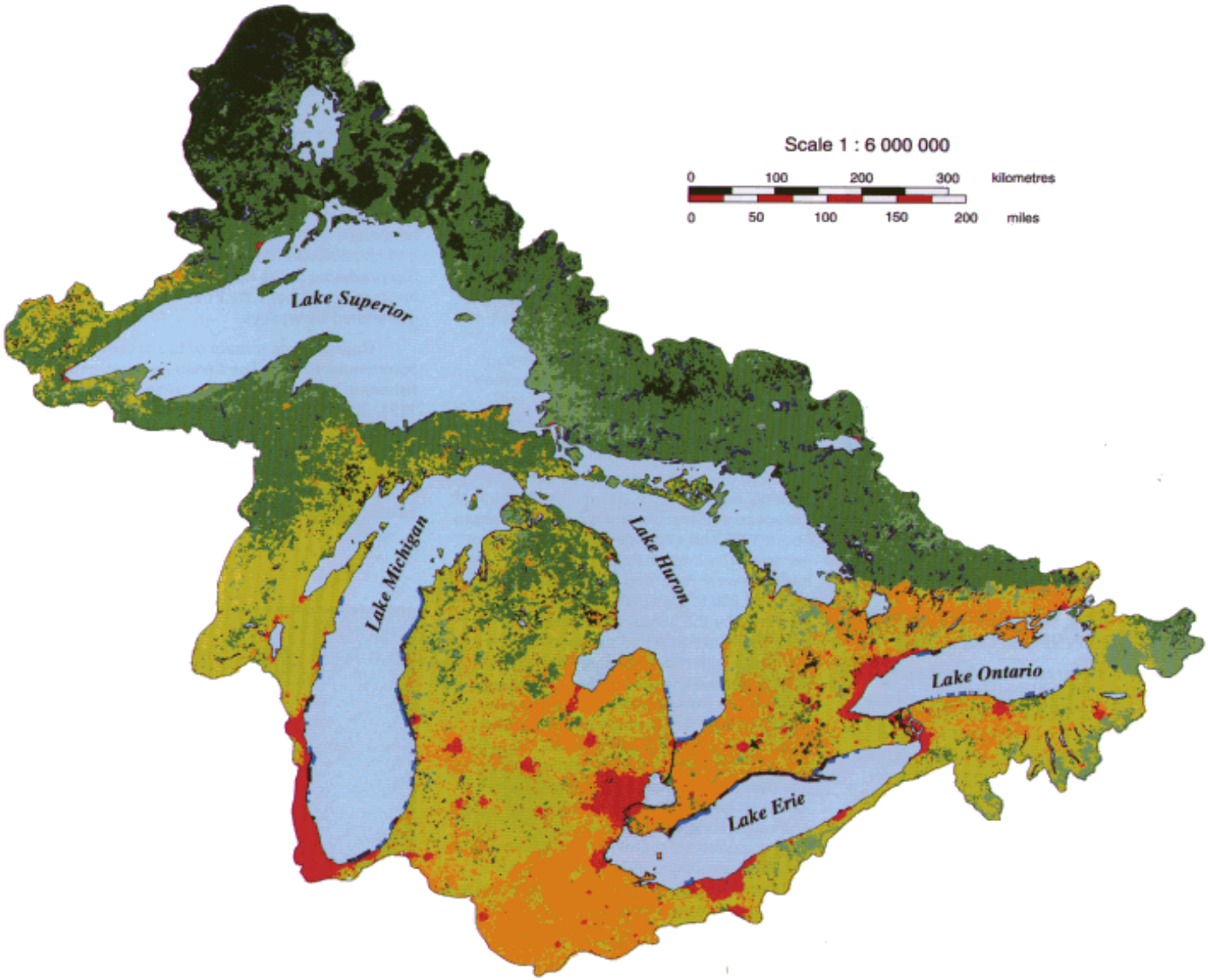
Nutrient Management Systems Planned
Total Acres - Cropland

Fiscal Year 2001



Area Under Management Plans
Number of Acres
70000
60000
50000
40000
30000
20000
10000
0
1998
1999
2000
Total
Year


Number of Farm Plans
No. Peer-Reviewed Plans
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Time

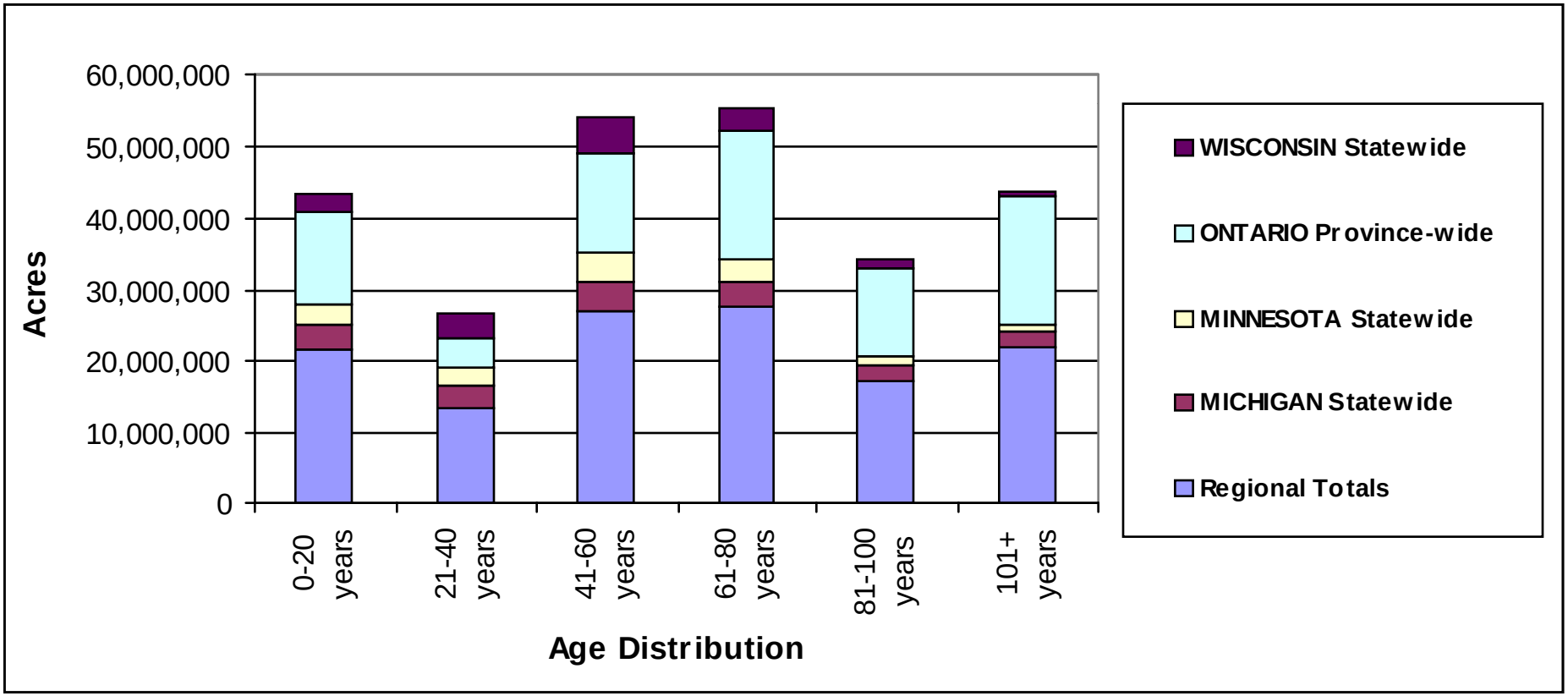

Scale 1 : 6 000 000
0
100
200
300
kilometres
0
50
100
150
200
miles
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie

Land Use

Forestry Indicators

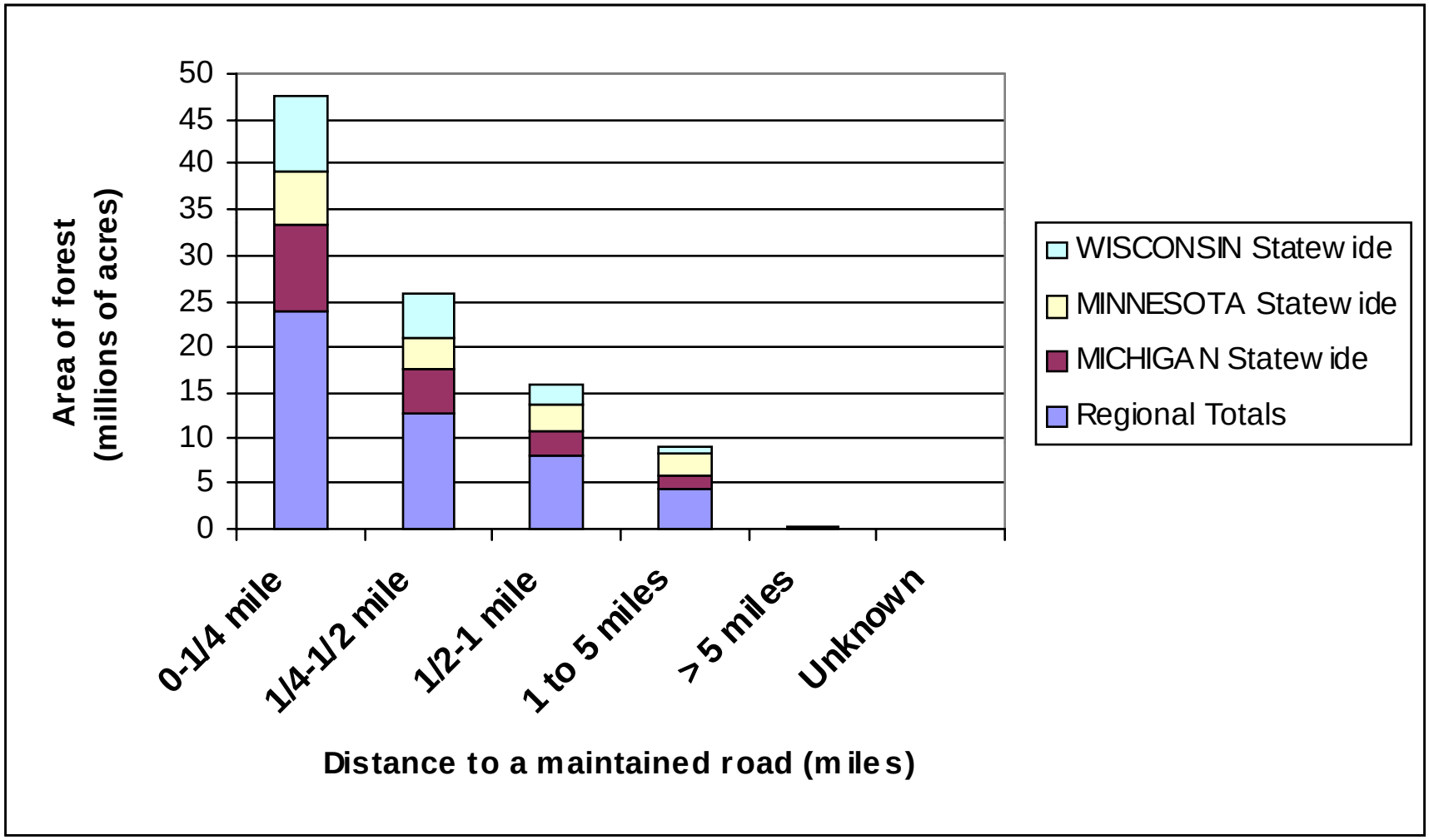
1. Proportion of forest area in each cover type and age-class (or successional stage).
2. Abundance of and trends in rare, threatened and endangered forest-based species.
3. Amount of habitat for selected forest species.

Forest Age Distribution (stand age in acres) with Regional Totals



4. Trends in the area of forest land due to land use change, including deforestation and afforestation.
5. Fragmentation of forest types
6. Compliance with and effectiveness of water quality Best Management Practices

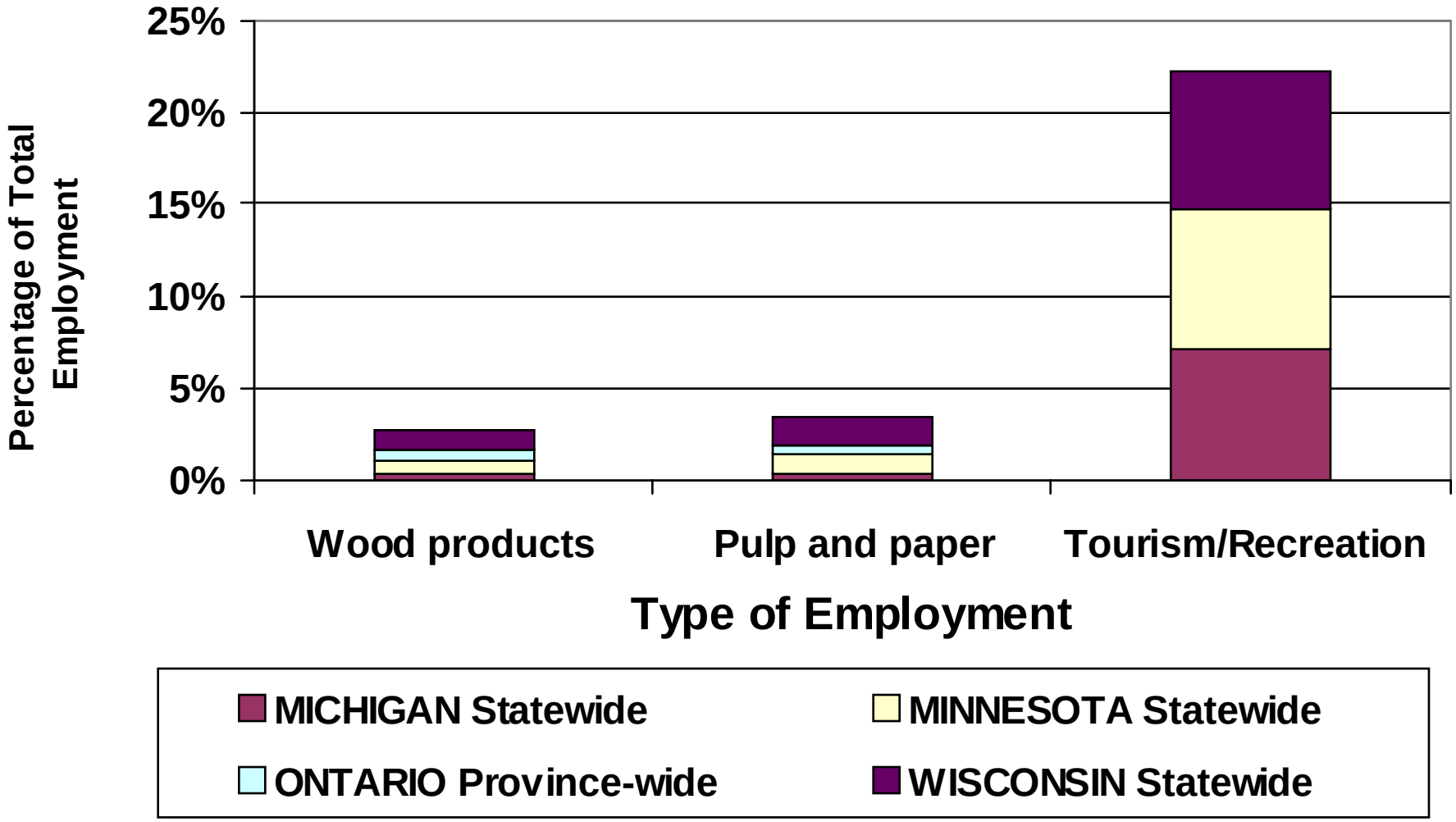
Fragmentation of Forests with Regional Totals



7. Area and severity of occurrence of non-native (invasive species) species detrimental to forest condition.
8. Forest land ownership and utilization. (to be defined)
9. Ranges of uses of the forest and meanings for those uses

10. Forest based employment by sector.
11. Representation of all publics in the public participation process.
12. Capacity to measure and monitor changes in the conservation and sustainable management of forests.

Percentage of the total employment in forest based occupations



Acknowledgments

Groundwater:

Doug Alley, Bob Davic, Doug Dodge, Fred Fleischer, Norm Grannemann, Wendy Leger, Cheryl Martin, Donna Myers, Andrew Piggott, Harvey Shear, Sam Singer

Agriculture: Roger Nanney; Peter Roberts

Forestry: Bill Meades; Great Lakes Forest Alliance