How are the Great Lakes Doing?

Jackie Adams, U.S. Environmental Protection Agency

Nancy Stadler-Salt, Environment and Climate Change Canada

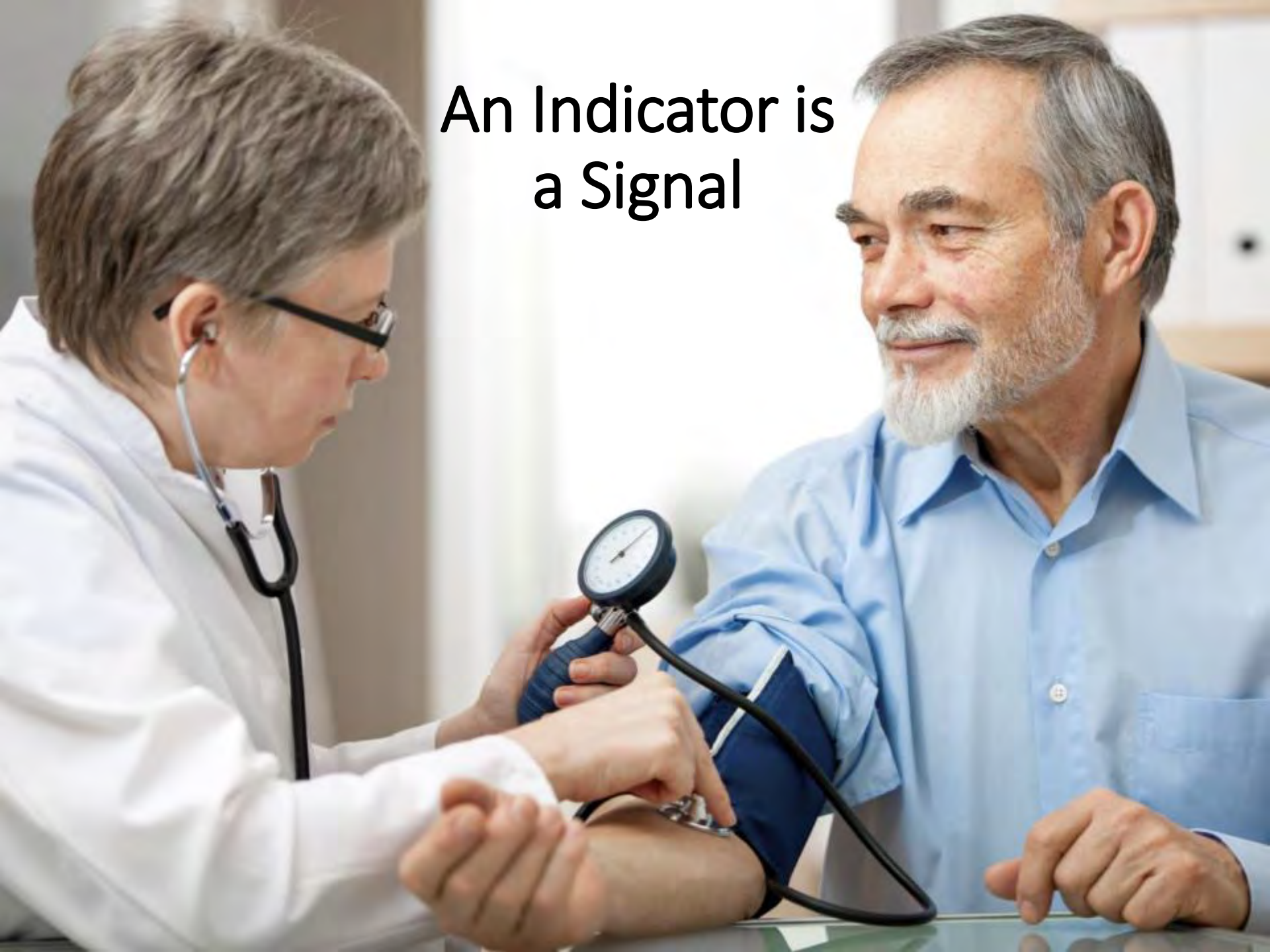
Photo credit: Don Breneman

Great Lakes Water Quality Agreement

Indicator Commitment

"…..comprehensive, science-based ecosystem indicators to assess the state of the Great Lakes to anticipate emerging threats and to measure progress"

Photo credit: NASA


An Indicator is
a Signal

Indicators Assess Status and Trends

STATUS:
Good
Fair
Poor
Undetermined

TREND:
Improving
Unchanging
Deteriorating
Undetermined

Photo credit: Stacey Cherwaty-Pergentile

A Robust Assessment Process

Parties Confirm Indicator Suite (Jan 2015)

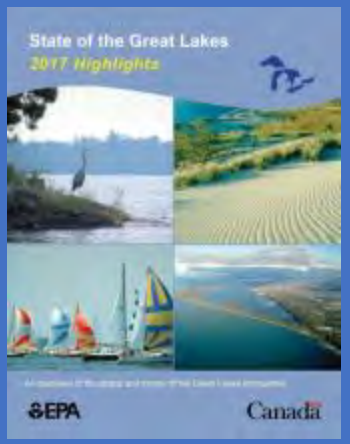
Identify Indicator Experts & Prepare Draft Reports (Jan-Dec 2015)

Technical Review Webinars (Feb/Mar 2016)

Develop Overall Assessments (mid-2016)

Public Forum (Oct 2016)

State of the Great Lakes 2017 Reports




LAKE SUPERIOR STATE UNIVERSITY
THE UNIVERSITY OF TOLEDO 1872
Environment Canada
Environnement Canada
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Fisheries and Oceans Canada
Pêches et Océans Canada
NOAA
DEPARTMENT OF ENVIRONMENTAL CONSERVATION NEW YORK STATE
Ontario
Ministère de l'Environnement et du Changement
Ontario
Ministry of Natural Resources and Forestry
USGS
science for a changing world
WISCONSIN DEPT. OF NATURAL RESOURCES
Natural Resources Canada
Ressources naturelles Canada
DNR
Indiana Department of Natural Resources
Conservation ONTARIO
US Army Corps of Engineers
UNIVERSITY OF MINNESOTA
Great Lakes Fishery Commission
UMD Natural Resources Research Institute
University of Windsor
Sea Grant ILLINOIS - INDIANA
INTERNATIONAL JOINT COMMISSION
CORNELL UNIVERSITY FOUNDED A.D. 1865
UWM UNIVERSITY of WISCONSIN MILWAUKEE
UMD
GRAND VALLEY STATE UNIVERSITY
OSU Oregon State
DEPARTMENT OF NATURAL RESOURCES OHIO
Ontario
Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover
The College at BROCKPORT STATE UNIVERSITY OF NEW YORK
UNIVERSITY of WISCONSIN Superior
DEPARTMENT OF NATURAL RESOURCES DNR MICHIGAN
MICHIGAN STATE UNIVERSITY
LimnoTech
CMU CENTRAL MICHIGAN UNIVERSITY
HEIDELBERG UNIVERSITY
CGLI Council of Great Lakes Industries
CILER Cooperative Institute for Limnology and Ecosystems Research
BUFFALO STATE The State University of New York
UNIVERSITY of WISCONSIN GREEN BAY 360° OF LEARNING
Great Lakes Indian Fish & Wildlife Commission
INDIANA UNIVERSITY
UNIVERSITY OF WISCONSIN River Falls
USDA U.S. Department of Agriculture
BIRD STUDIES ÉTUDES D'OISEAUX CANADA
NATURE CONSERVANCY CANADA
CSC
UNIVERSITY OF TORONTO MISSISSAUGA

What Indicators Are We Using?

Watershed Impacts and Climate Trends

Habitat and Species

Invasive Species

What Indicators Are We Using?

Nutrients and Algae

Groundwater

Toxic Chemicals

What Indicators Are We Using?

Contaminants in Edible Fish

Drinking Water

Beaches

General Objectives and Indicators

GLWQA General Objectives	Great Lakes Indicators
Be free from other substances, materials or conditions that may negatively impact the chemical, physical or biological integrity …	**Watershed Impacts and Climate Trends**
Support healthy and productive wetlands and other habitats to sustain resilient populations of native species.	**Habitats and Species**
Be free from the introduction and spread of aquatic … and terrestrial invasive species …	**Invasive Species**
Be free from nutrients … in amounts that promote growth of algae …	**Nutrients and Algae**
Be free from the harmful impact of contaminated groundwater.	**Groundwater**
Be free from pollutants … that could be harmful to human health …	**Toxic Chemicals**
Allow for human consumption of fish and wildlife.	**Fish Consumption**
Be a source of safe, high-quality drinking water.	**Drinking Water**
Allow for swimming and other recreational use.	**Beaches**

Watershed Impacts and Climate Trends

The Waters of the Great Lakes should be free from other substances, materials or conditions that may negatively impact the chemical, physical and biological integrity of the Waters of the Great Lakes

Photo credit: Stacey Cherwaty-Pergentile

Indicator: Watershed Impacts and **Climate Trends**

Climate Trends Sub-Indicators:

Precipitation Events

Surface Water Temperature

Ice Cover

Water Levels

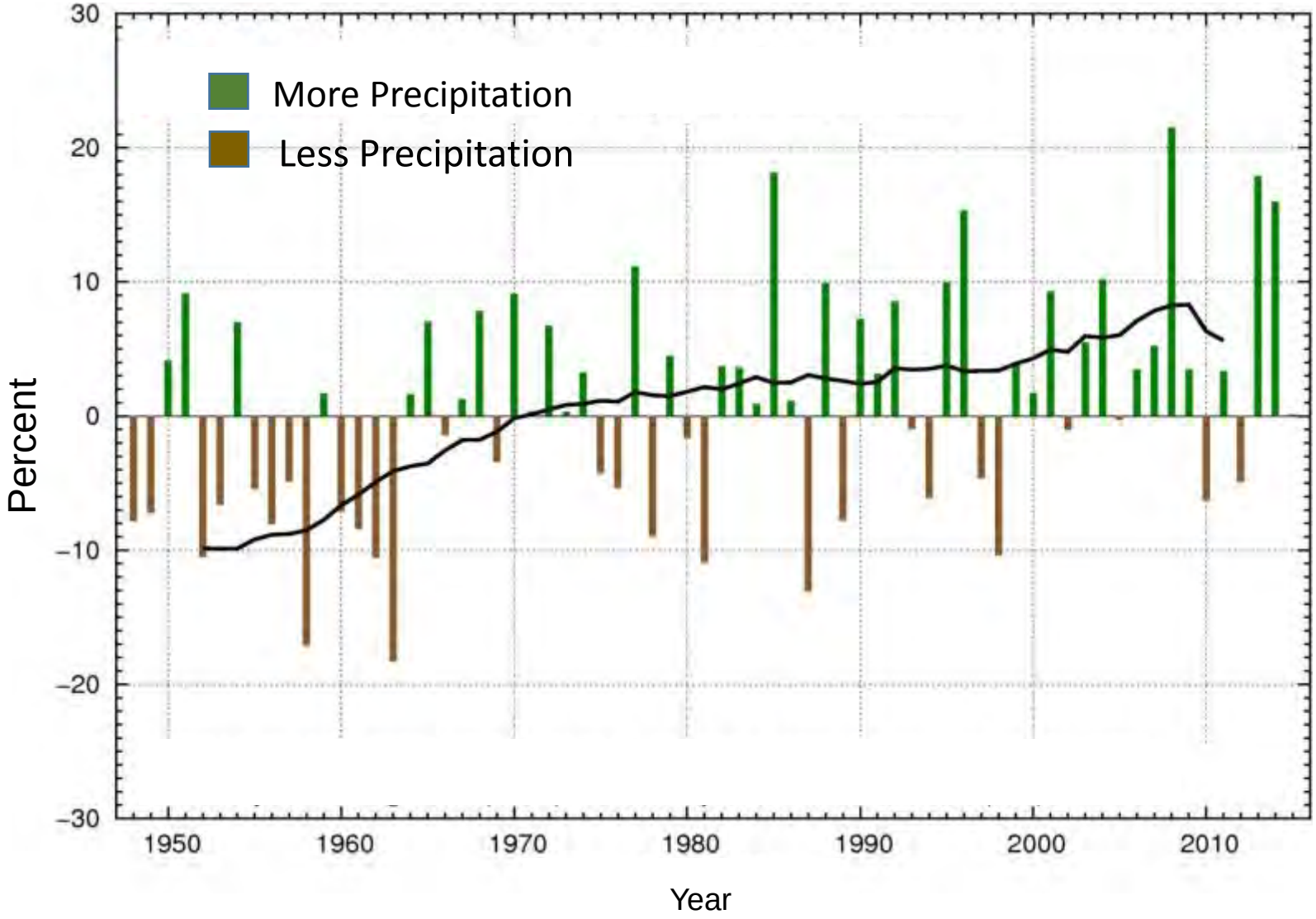
Baseflow Due to Groundwater

Watershed Impacts and Climate Trends

The Great Lakes are responding to a changing climate

Photo credit: Public Works and Government Services Canada ,Richard Vroom, 1976

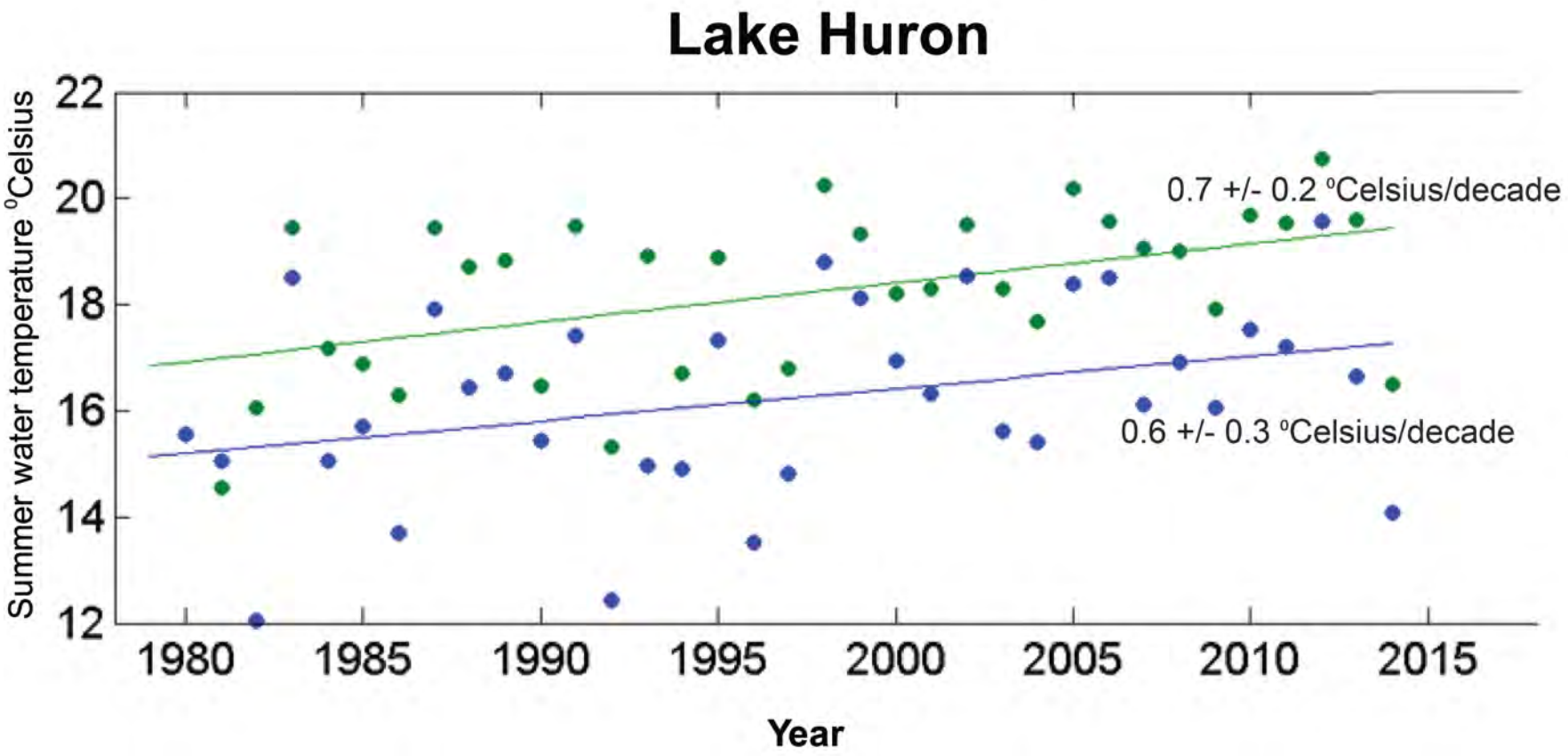
Precipitation Amounts Are Increasing



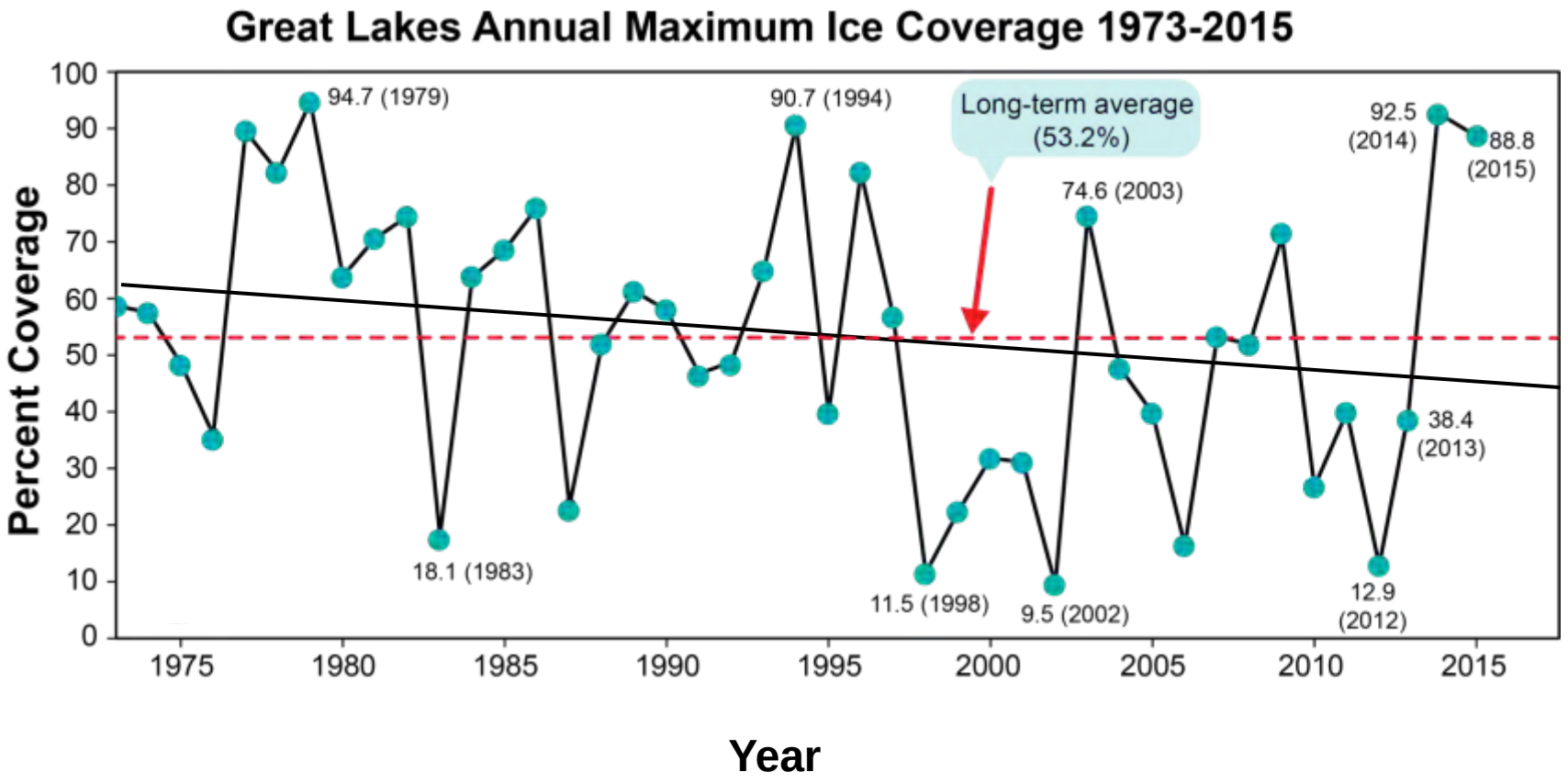
Surface Water Temperatures Are Increasing

Photo credit: NOAA

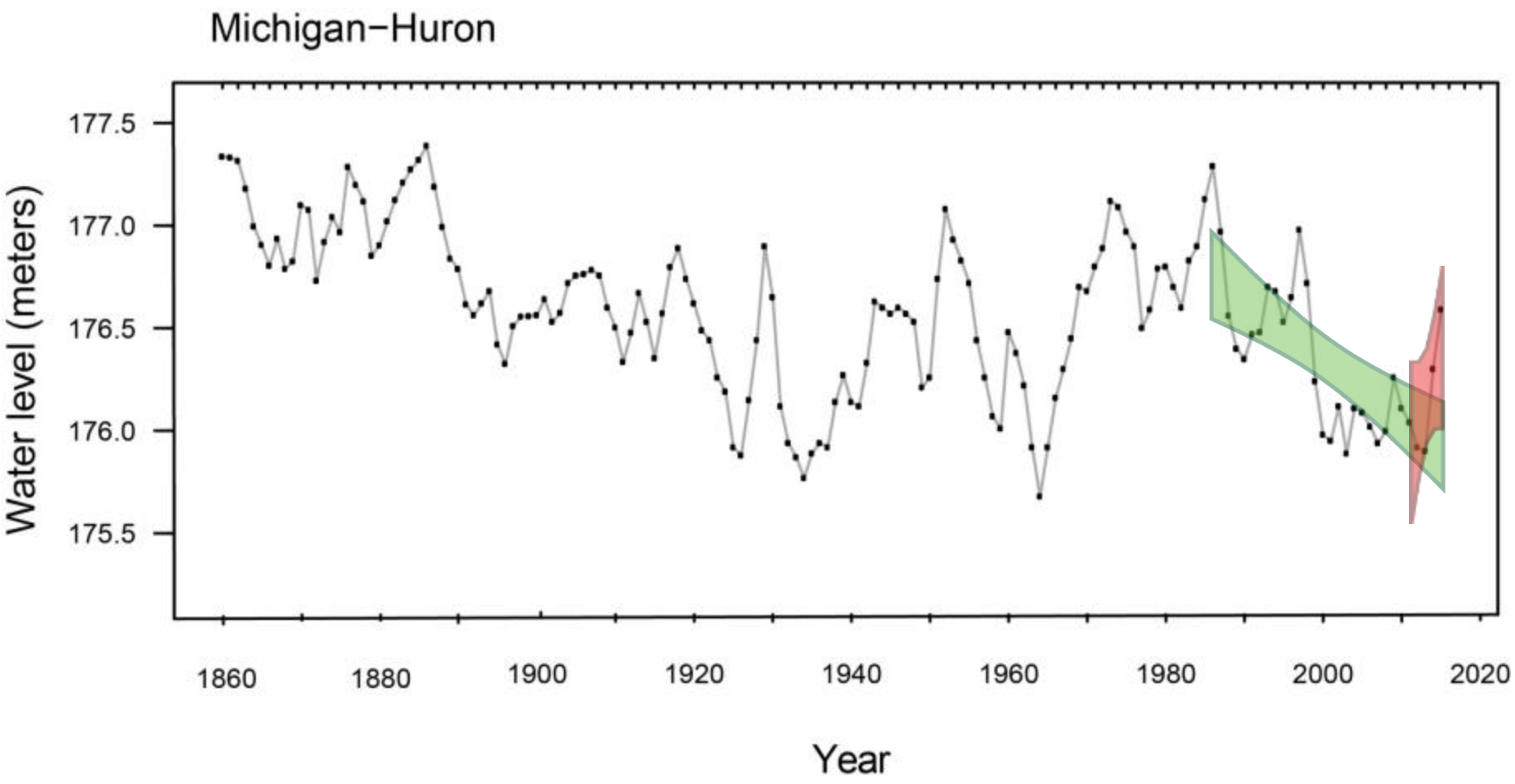
Surface Water Temperatures Are Increasing



Ice Cover Is Decreasing



Water Levels Are Decreasing Over The Past 30 Years



Climate Trends

↑ = increasing trend
↓ = decreasing trend

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Precipitation Events (1948-2015)	No lake was assessed separately Overall Great Lakes basin trend is ↑				
Surface Water Temperature (1979/1980-2014)	↑	↑	↑	Undetermined	Undetermined
Ice Cover (1973-2015)	↓	↓	↓	↓	↓
Water Levels (1985-2015)	↓	↓	↓	↓	No significant change
Baseflow Due to Groundwater	Overall the Great Lakes basin trend is **Undetermined**				

Watershed Impacts and Climate Trends

The Waters of the Great Lakes should be free from other substances, materials or conditions that may negatively impact the chemical, physical and biological integrity of the Waters of the Great Lakes

Photo credit: Stacey Cherwaty-Pergentile

Indicator: **Watershed Impacts** and Climate Trends

Watershed Impacts Sub-Indicators:

Forest Cover

Land Cover

Hardened Shorelines

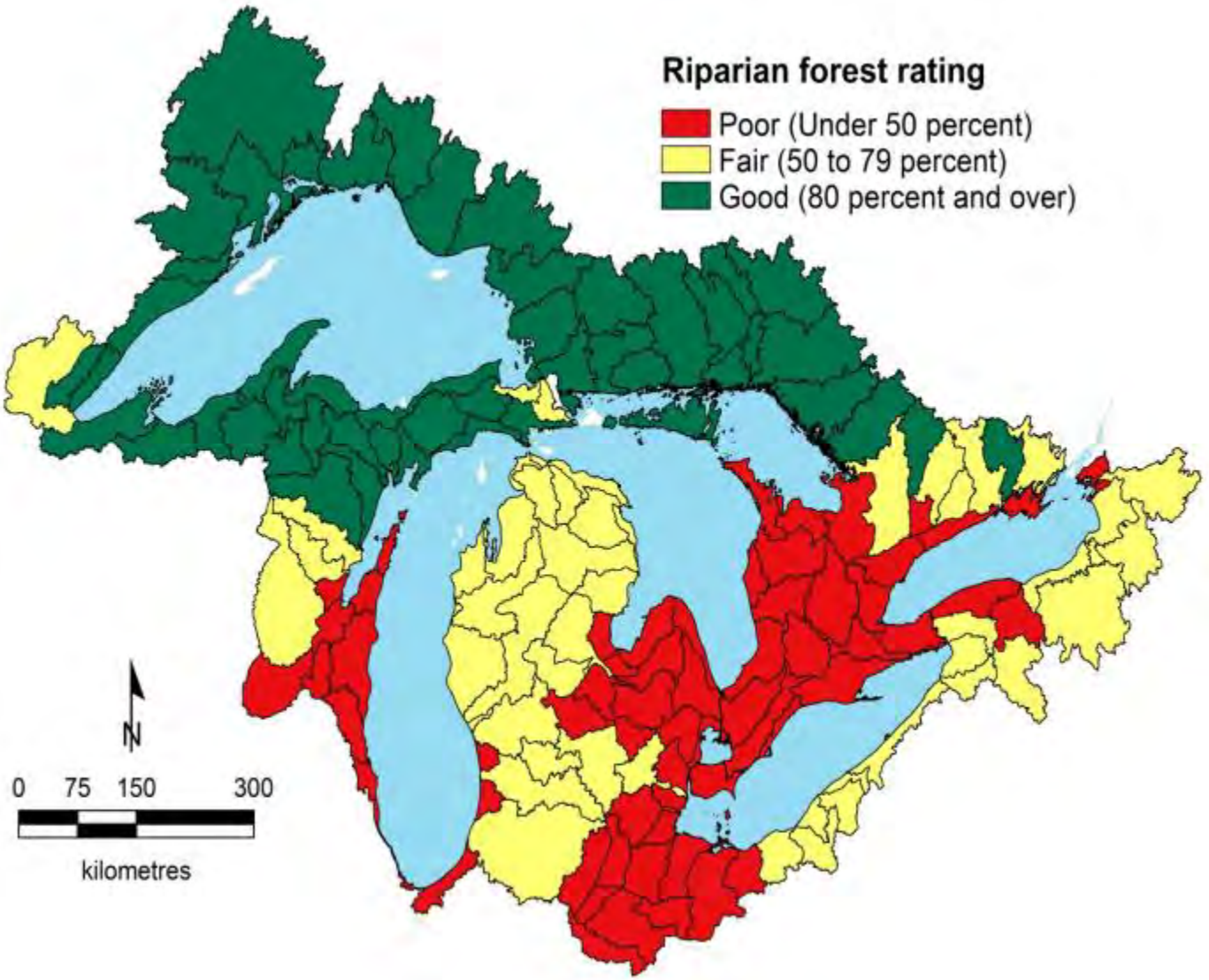
Watershed Stressor Index

Tributary Flashiness

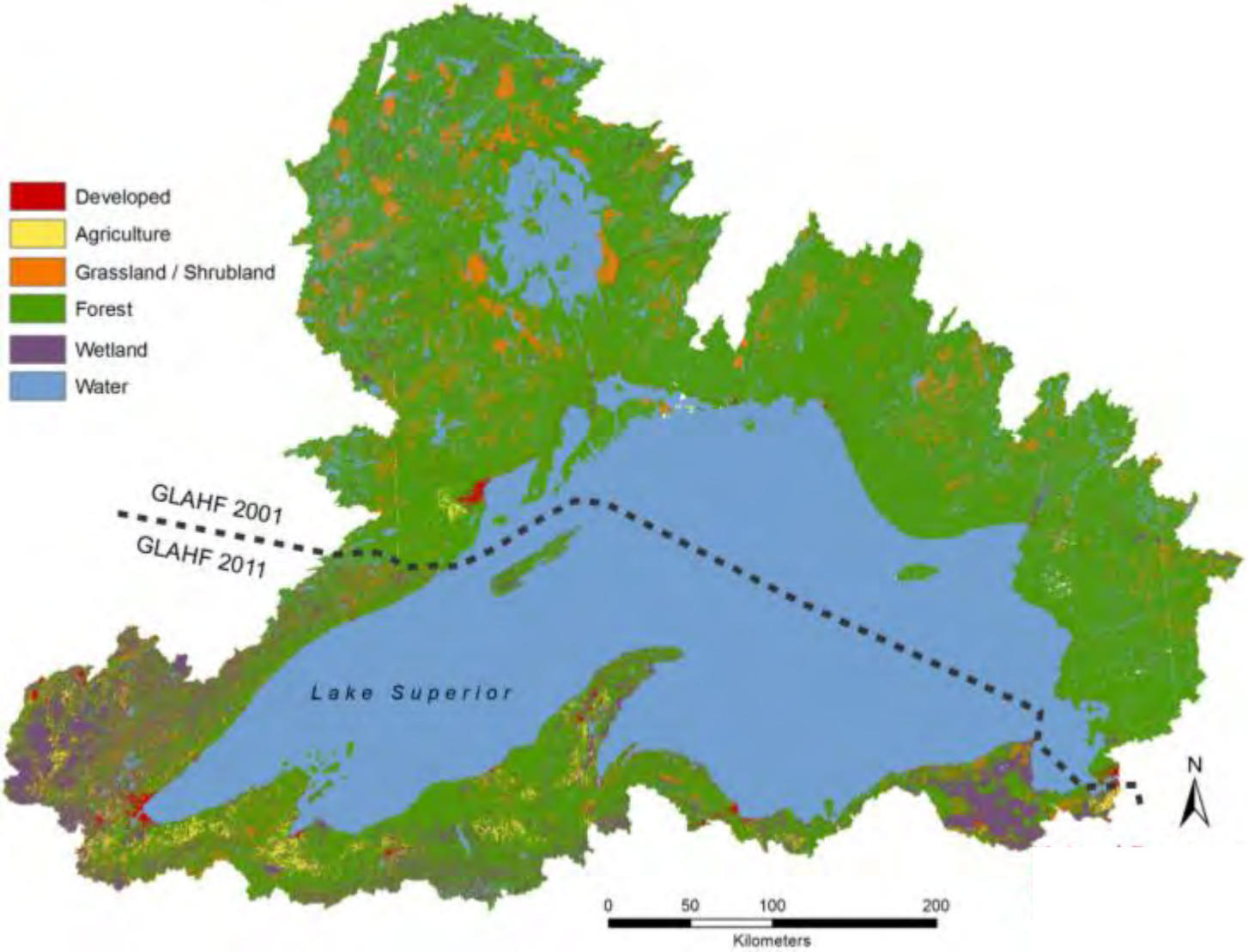
Human Population


Watershed Impacts
Status: FAIR
Trend: UNCHANGING

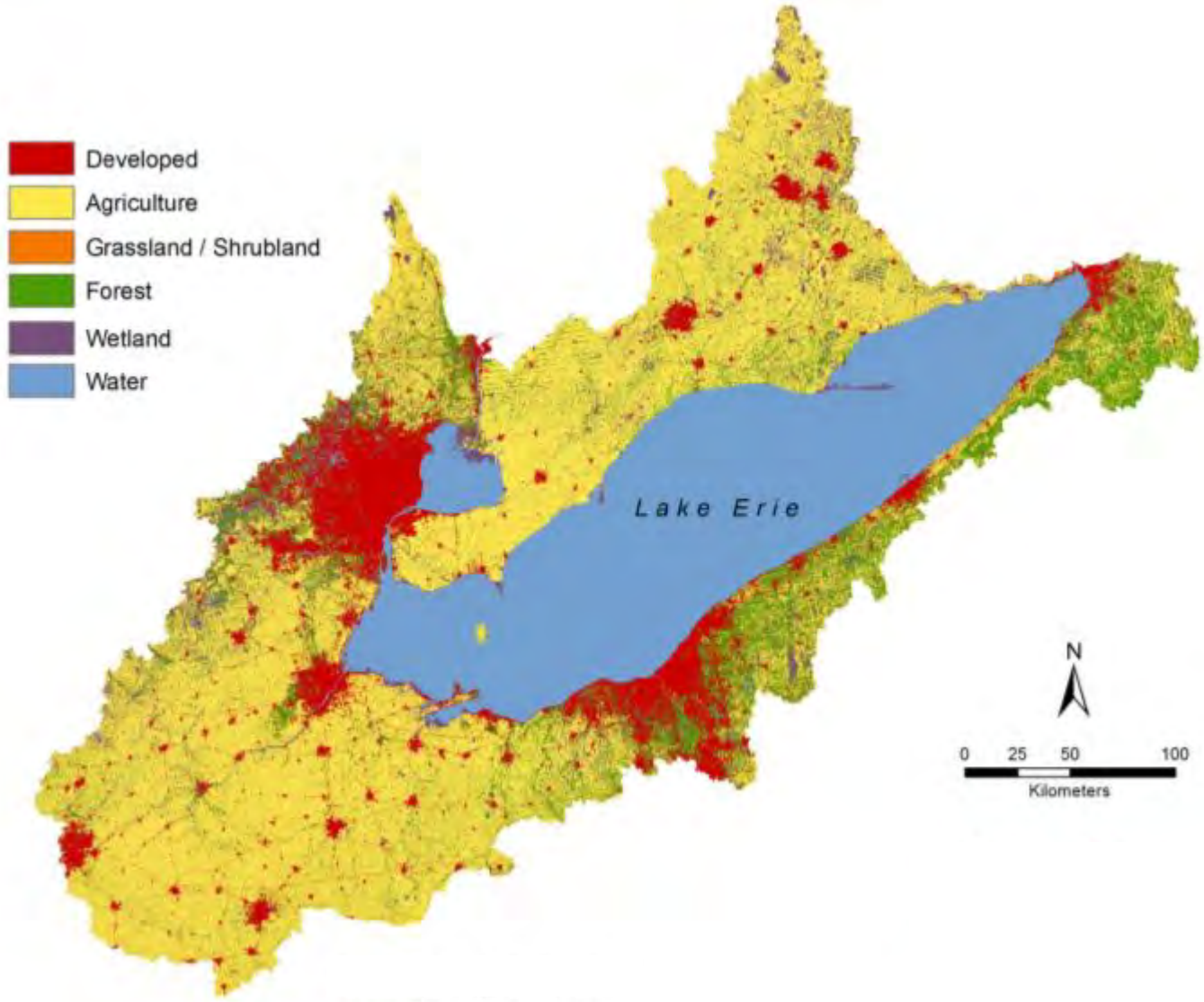
Forest Cover Helps To Improve Water Quality



Land Cover Impacts Water Quality



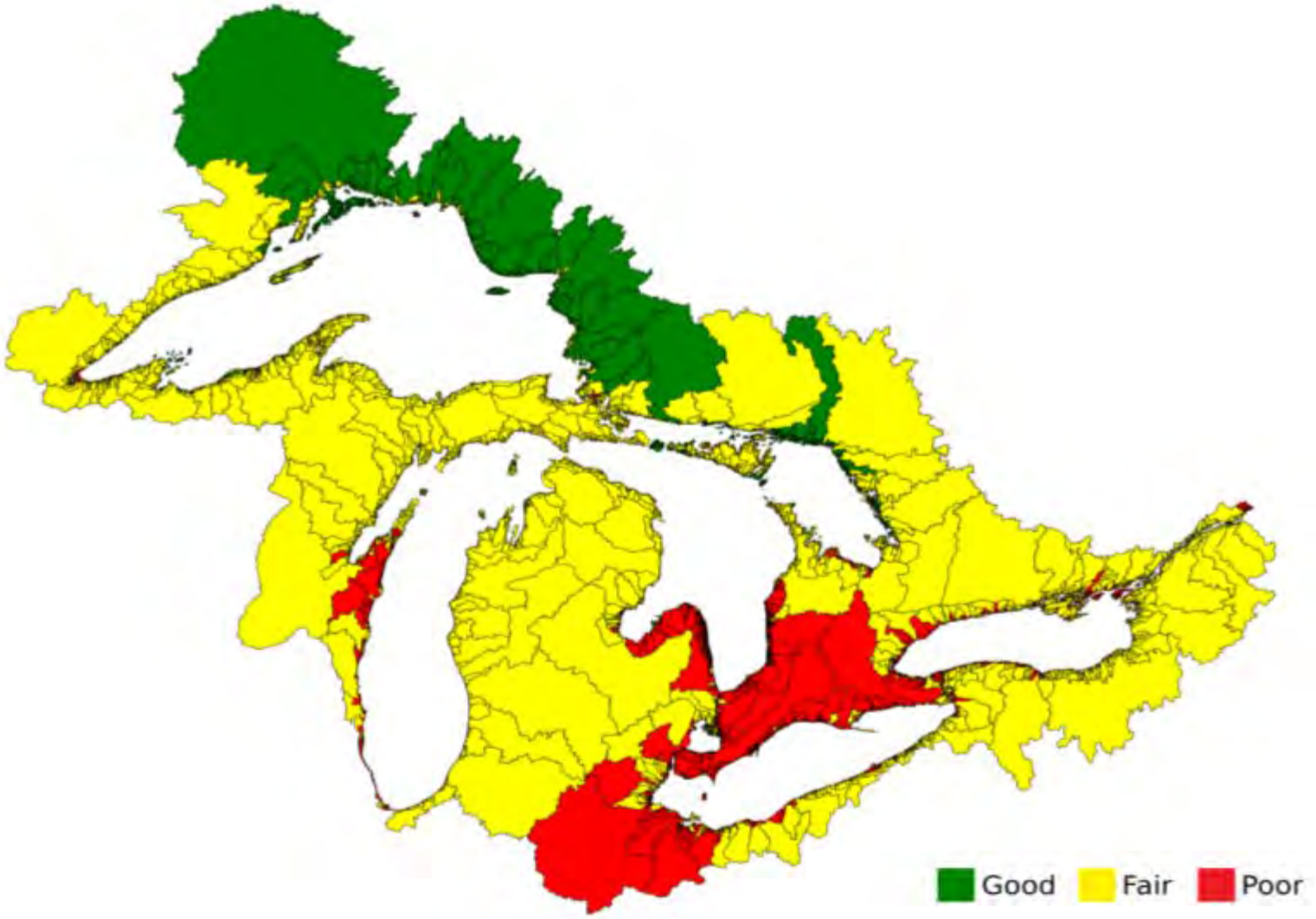
Land Cover Impacts Water Quality



Hardened Shorelines Impact The Ecosystem

Photo credit: Stacey Cherwaty-Pergentile

Watershed Stressors Help To Identify Areas Under Stress



Watershed Impacts

Status:

GOOD | FAIR | POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Forest Cover	Unchanging	Unchanging	Unchanging	Improving	Deteriorating
Land Cover	Unchanging	Unchanging	Unchanging	Unchanging	Unchanging
Hardened Shorelines	Undetermined	Undetermined	Undetermined	Undetermined	Deteriorating
Watershed Stressors	Unchanging	Unchanging	Unchanging	Unchanging	Unchanging
Tributary Flashiness	No lake was assessed separately Overall Great Lakes basin trend is **Unchanging**				
Human Population	Decreasing	Increasing	Increasing	Increasing	Increasing

Habitat and Species

The Waters of the Great Lakes should support healthy and productive wetlands and other habitats to sustain resilient populations of native species

Photo credit: Environment and Climate Change Canada

Indicator: Habitat and Species

Habitat and Species Sub-Indicators:

Phytoplankton
Diporeia
Lake Trout
Coastal Wetland Fish
Coastal Wetland Plants
Coastal Wetland Birds
Coastal Wetland Invertebrates
Coastal Wetland Amphibians
Coastal Wetlands: Extent and Composition
Aquatic Habitat Connectivity
Benthos
Zooplankton
Prey Fish
Walleye
Lake Sturgeon
Fish Eating and Colonial Nesting Waterbirds

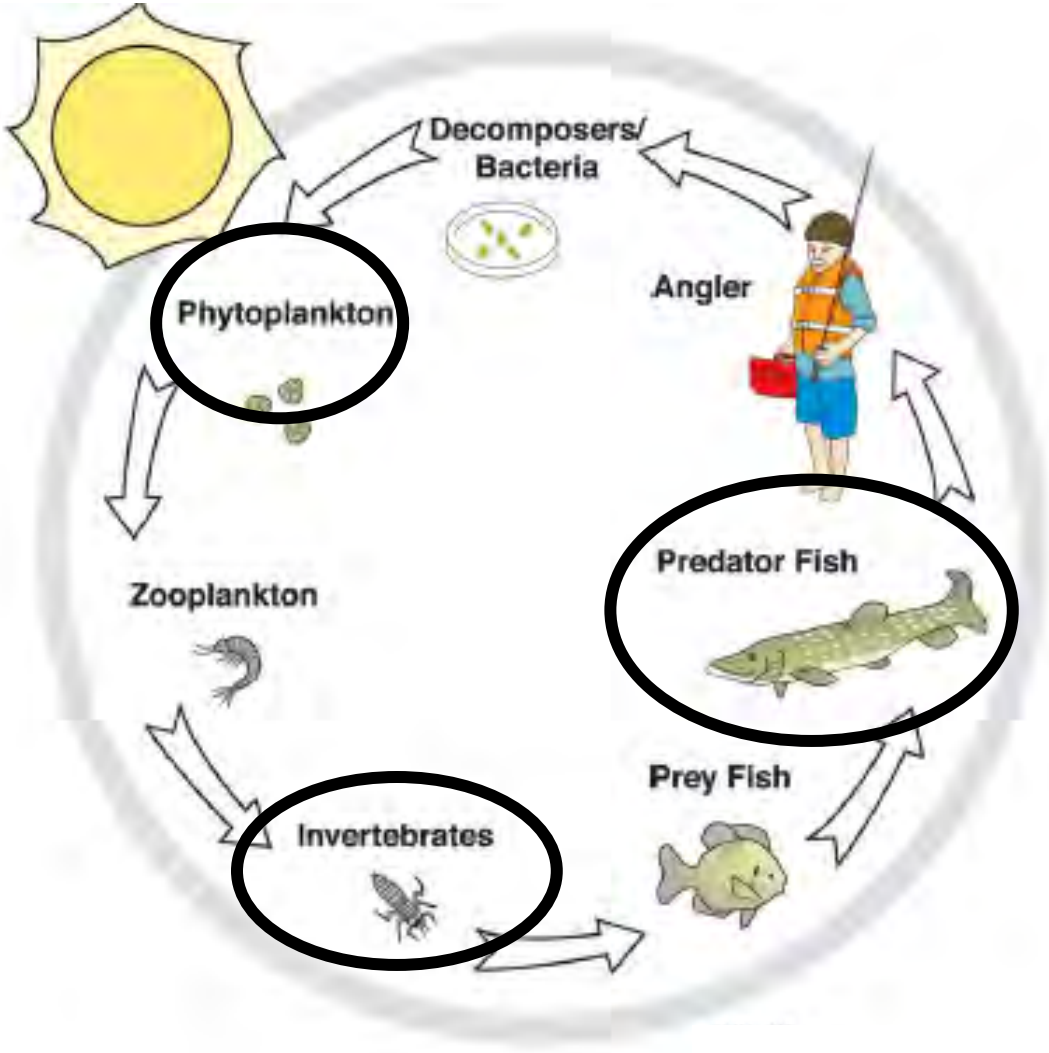
Habitat & Species

Status: **FAIR**

Trend: **UNCHANGING**

Photo credit: Pixabay

Understanding the Aquatic Food Web



Credit: Modified from Carlson et al. ES&T 2010

Phytoplankton Communities Are Changing

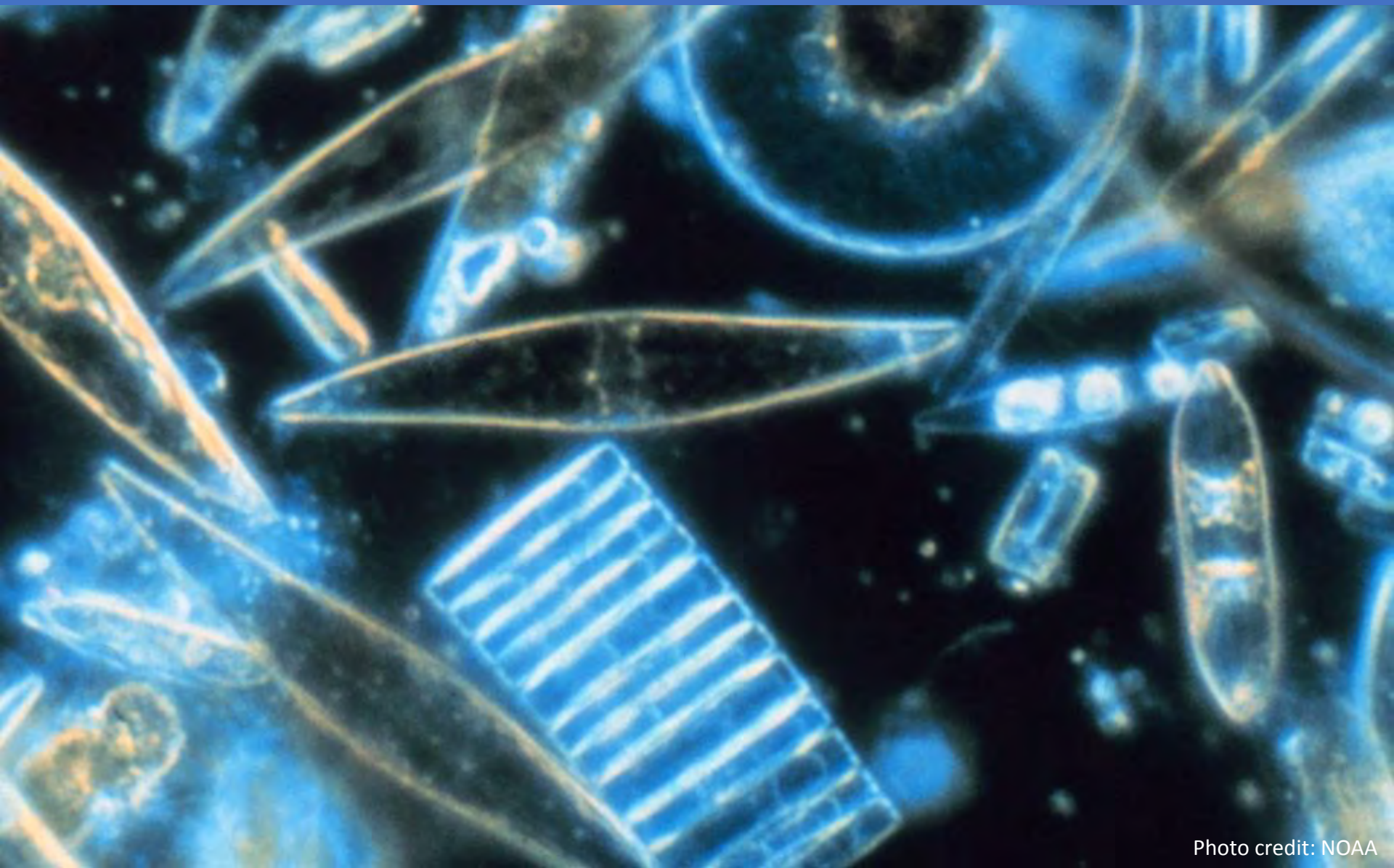
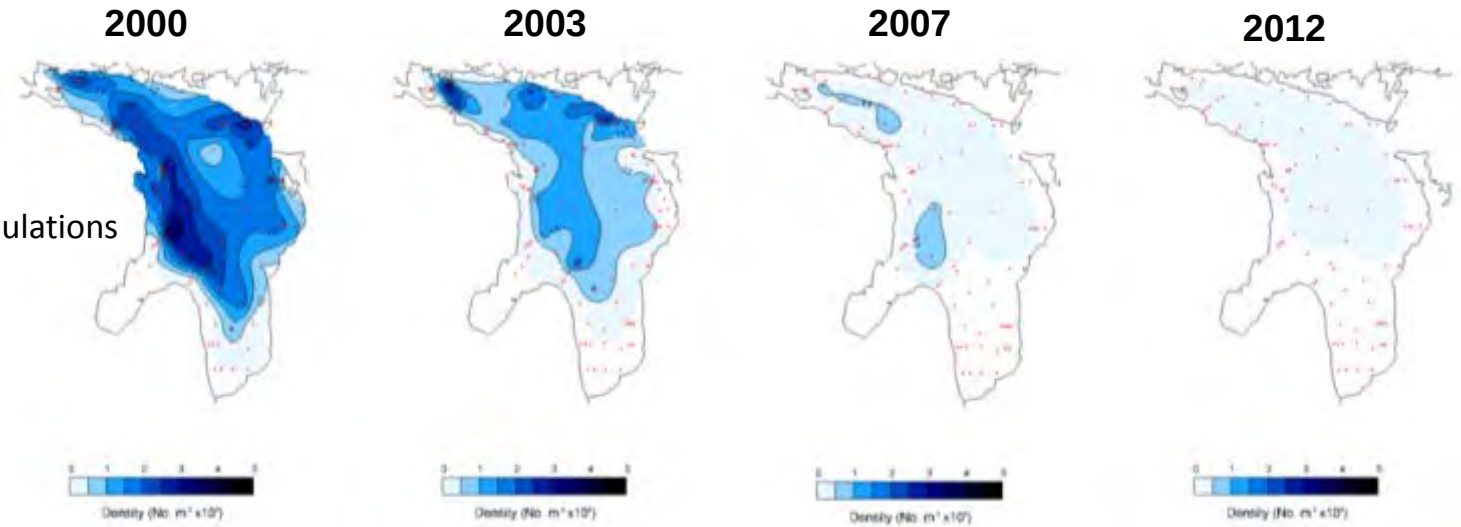


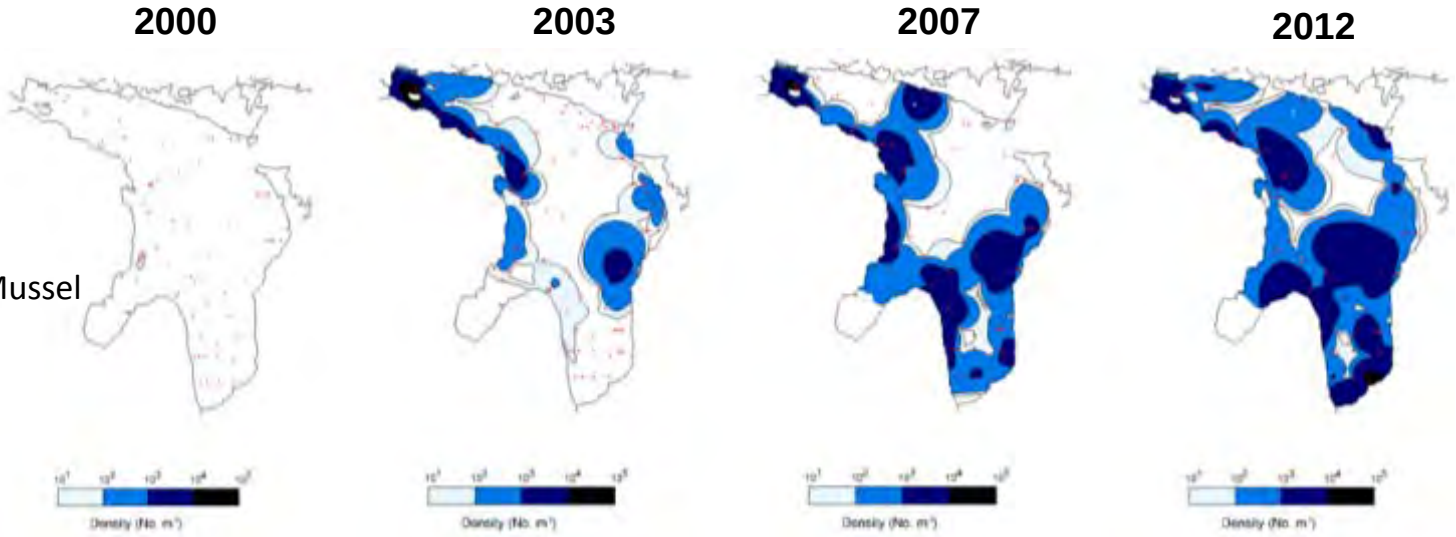
Photo credit: NOAA

Diporeia Are Disappearing

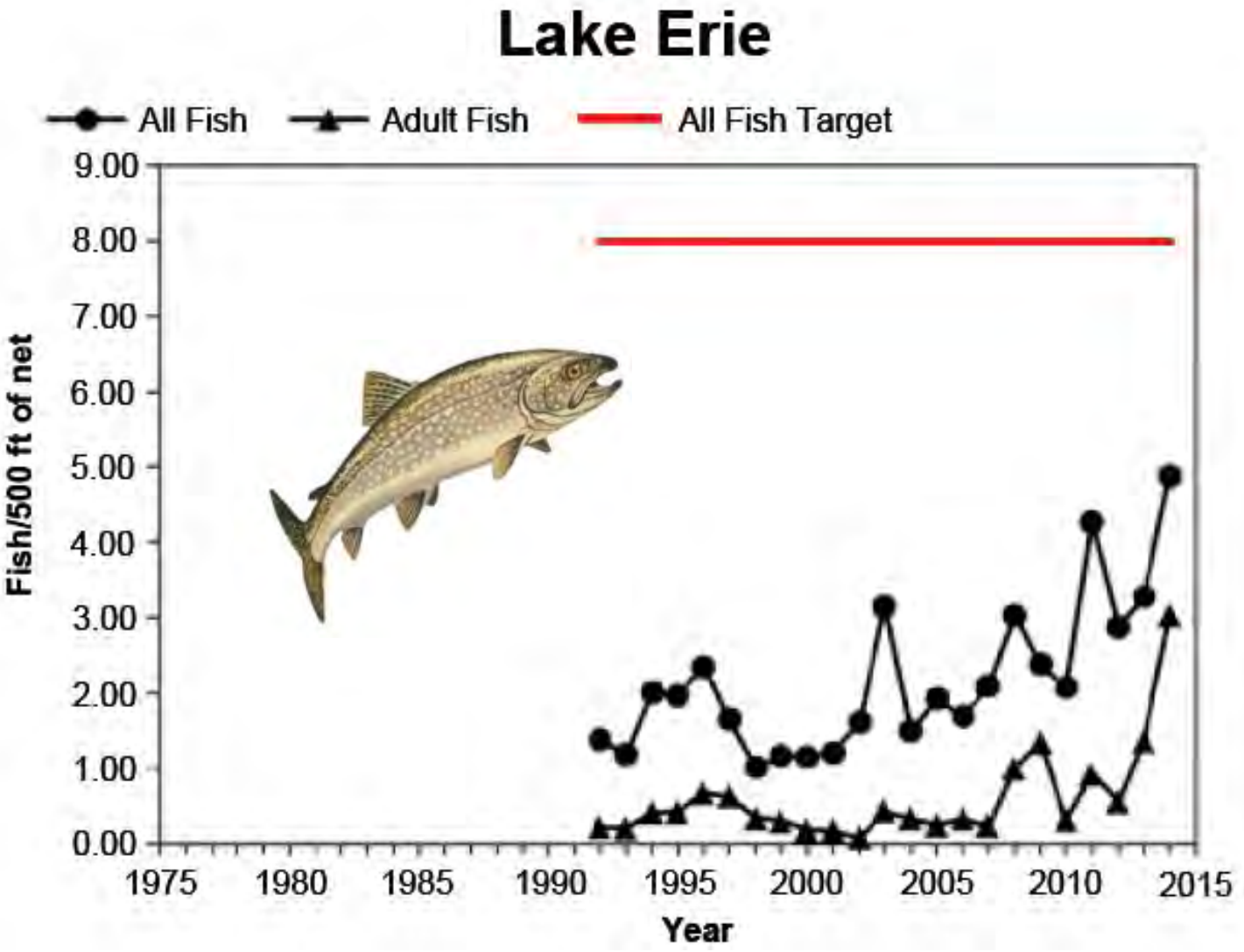
Diporeia Populations



Dreissenid Mussel Populations

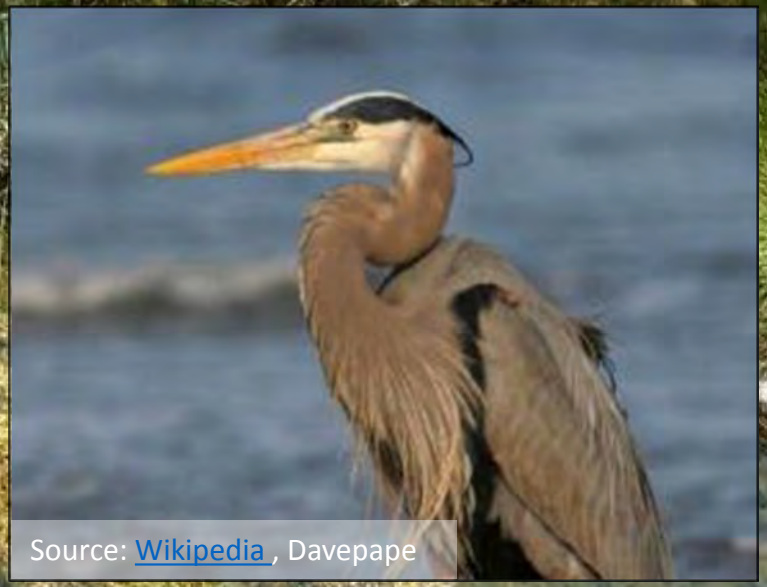


Lake Trout Populations Are Improving



Coastal Wetlands Are So Import**ant**

Coastal Wetlands Are So Important



Source: Wikipedia , Davepape

Aquatic Habitat Connectivity Is Important For Fish

Habitat and Species

Status:

GOOD | FAIR | POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Coastal Wetland Fish	No lake was assessed separately Overall Great Lakes basin assessment is **Fair** and **Improving**				
Coastal Wetlands: Extent an Composition	No lake was assessed separately Overall Great Lakes basin assessment is **Undetermined**				
Coastal Wetland Invertebrates	No lake was assessed separately Overall Great Lakes basin assessment is **Fair** and **Deteriorating**				
Coastal Wetland Amphibians	Unchanging	Unchanging	Unchanging	Unchanging	Unchanging
Coastal Wetland Birds	Unchanging	Unchanging	Unchanging	Deteriorating	Improving
Coastal Wetland Plants	Undetermined	Undetermined	Deteriorating	Deteriorating	Unchanging
Aquatic Habitat Connectivity	Improving	Improving	Improving	Improving	Improving

Habitat and Species

Status:

GOOD | FAIR | POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Zooplankton	Unchanging	Unchanging	Unchanging	Unchanging	Unchanging
Benthos	Unchanging	Unchanging	Unchanging	Deteriorating	Unchanging
Diporeia	Unchanging	Deteriorating	Deteriorating	Deteriorating	Deteriorating
Lake Trout	Unchanging	Improving	Improving	Improving	Improving
Phytoplankton	Unchanging	Deteriorating	Deteriorating	Deteriorating	Unchanging
Preyfish	Unchanging	Deteriorating	Undetermined	Improving	Deteriorating
Walleye	Unchanging	Unchanging	Unchanging	Improving	Unchanging
Lake Sturgeon	Improving	Improving	Improving	Improving	Improving
Fish Eating and Colonial Nesting Birds	Unchanging	Unchanging	Unchanging	Unchanging	Unchanging

Invasive Species

The Waters of the Great Lakes should be free from the introduction and spread of aquatic invasive species and free from the introduction and spread of terrestrial invasive species that adversely impact the quality of the Water of the Great Lakes

Indicator: Invasive Species

Invasive Species Sub-Indicators:

Aquatic Invasive Species

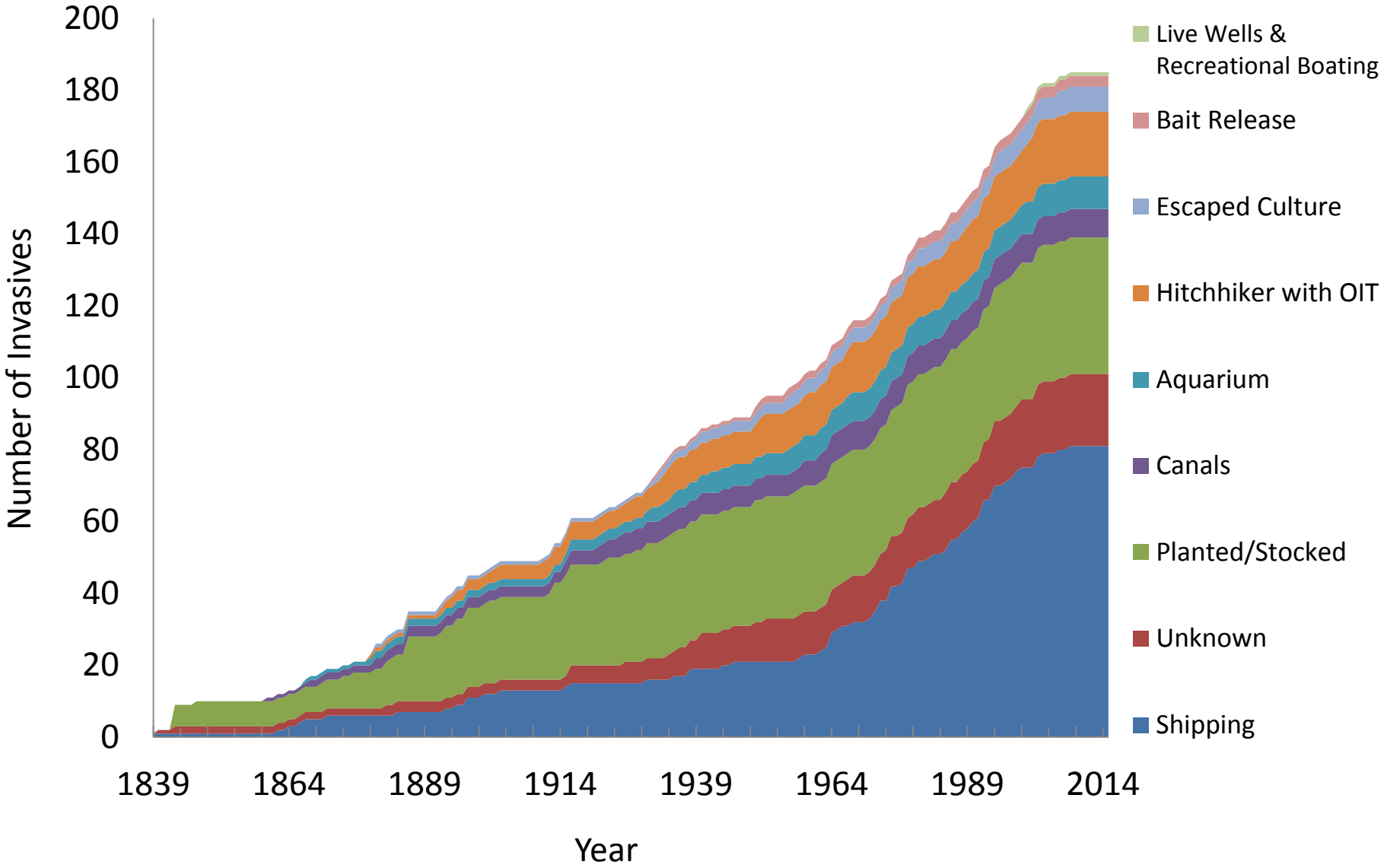
Sea Lamprey

Dreissenid Mussels

Terrestrial Invasive Species

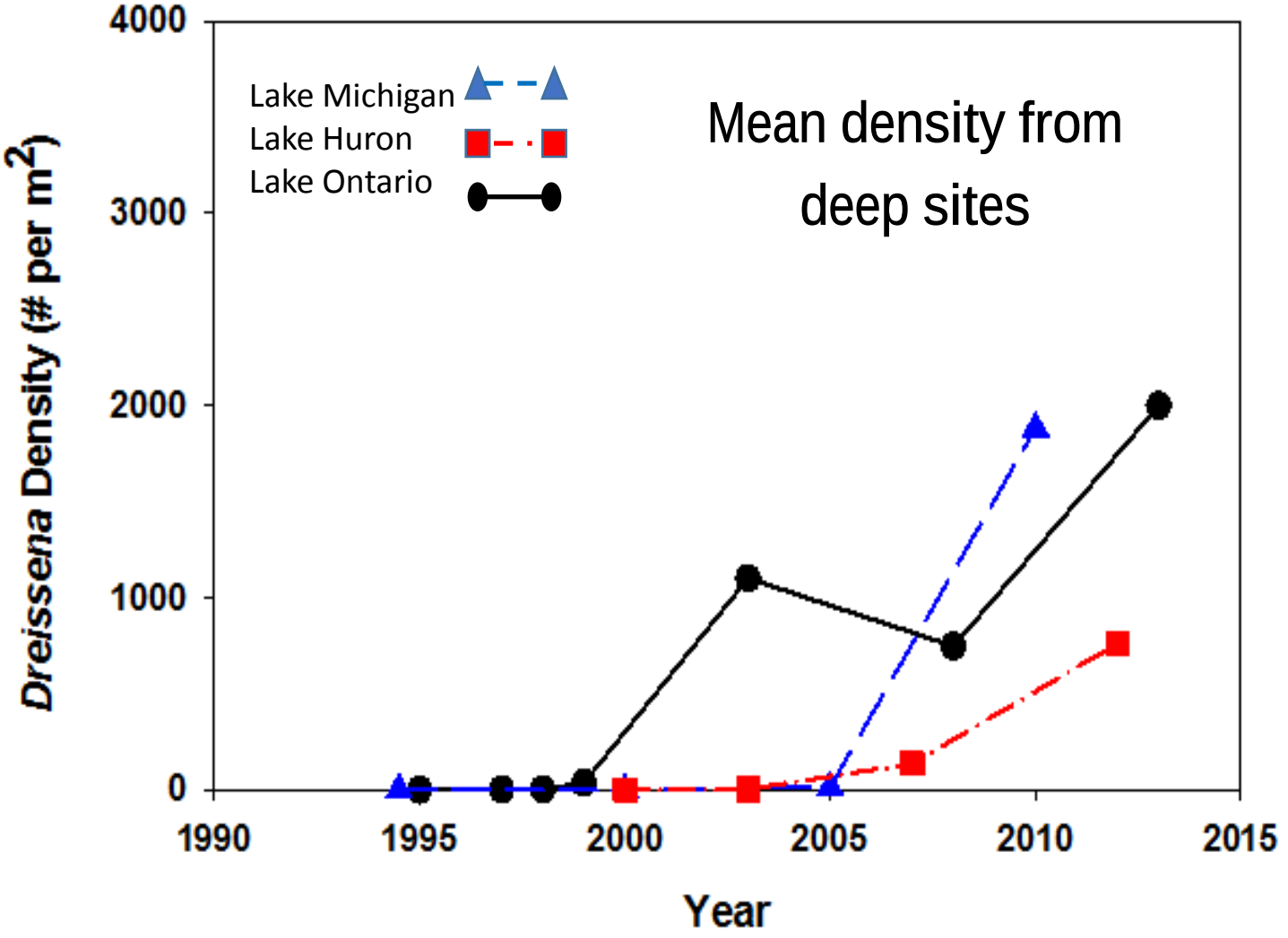
Photo credit: Pixabay

Aquatic Invasive Species - No New Invaders Since 2006



Sea Lamprey Controls Are Essential

Dreissenid Mussels Have Caused Devastation



Terrestrial Invasive Species Can Impact Water Quality

Photo credit: Michigan Sea Grant

Emerald Ash Borer Is Wreaking Havoc

Asian Carp Are Threatening the Great Lakes

Invasive Species

Status:

GOOD | FAIR | POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Aquatic Invasive Species	Deteriorating	Deteriorating	Deteriorating	Deteriorating	Deteriorating
Sea Lamprey	Improving	Improving	Improving	Improving	Unchanging
Dreissenid Mussels	Unchanging	Deteriorating	Deteriorating	Improving	Deteriorating
Terrestrial Invasive Species	Deteriorating	Deteriorating	Deteriorating	Deteriorating	Deteriorating

Nutrients and Algae

The Waters of the Great Lakes should be free from nutrients that directly or indirectly enter the water as a result of human activity, in amounts that promote growth of algae and cyanobacteria that interfere with aquatic ecosystem health, or human use of the ecosystem.

Photo credit: Stacey Cherwaty-Pergentile

Indicator: Nutrients and Algae

Nutrients and Algae Sub-Indicators:

Nutrients in Lakes

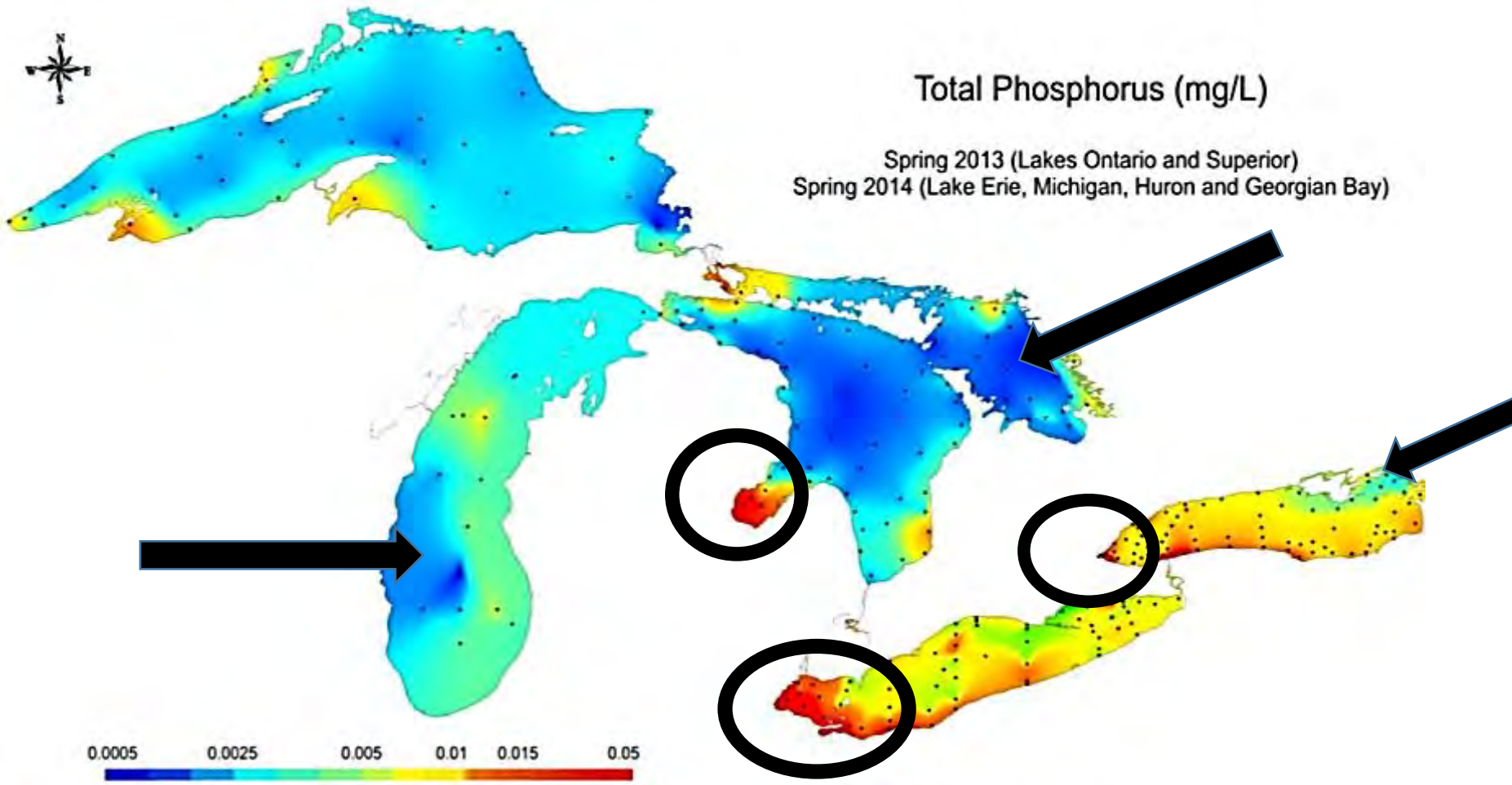
Harmful Algal Blooms (HABs)

Cladophora

Water Quality in Tributaries

Photo credit: NOAA

Nutrients in Lakes Are Imbalanced



Harmful Algal Blooms Can Be Toxic

Photo credit: NOAA

Cladophora Is A Nuisance

Photo credit: USGS

Nutrients and Algae

Status:

GOOD | FAIR | POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Nutrients in Lakes	Unchanging	Deteriorating	Deteriorating	Deteriorating	Deteriorating
Harmful Algal Blooms	Undetermined	Undetermined	Undetermined	Deteriorating	Deteriorating
Cladophora	Unchanging	Undetermined	Undetermined	Undetermined	Undetermined
Water Quality in Tributaries	Unchanging	Undetermined	Unchanging	Unchanging	Unchanging

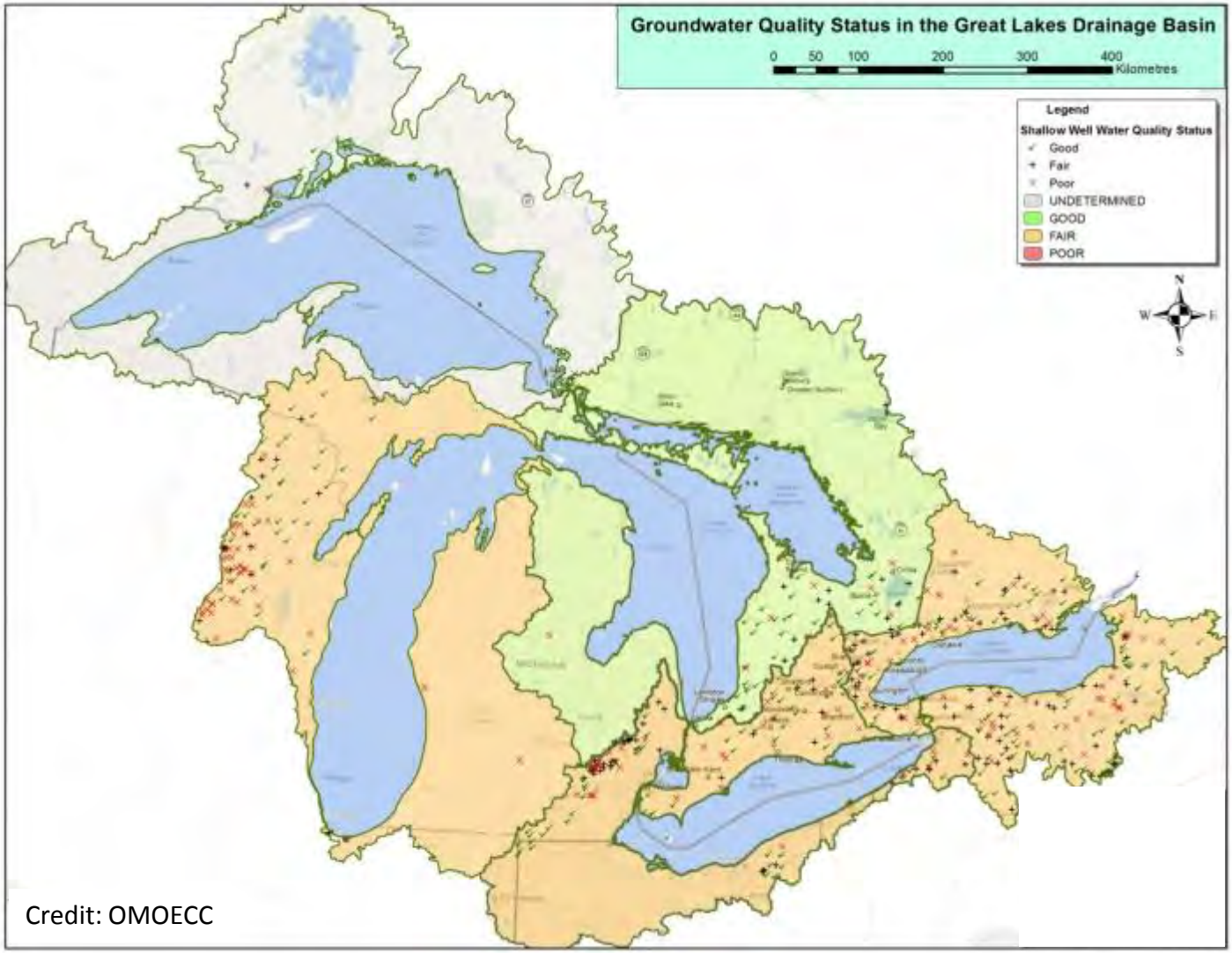
Photo credit: Norm Grannemann, USGS

Indicator: Groundwater

Groundwater Sub-Indicator:
Groundwater Quality


Groundwater
Status: FAIR
Trend: UNDETERMINED

Groundwater Quality Is Important to the Great Lakes



Credit: OMOECC

Groundwater

Status:

GOOD | FAIR | POOR

SUB-INDICATOR	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Groundwater Quality	Undetermined	Undetermined	Undetermined	Undetermined	Undetermined

Toxic Chemicals

The Waters of the Great Lakes should be free from pollutants in quantities or concentrations that could be harmful to human health, wildlife, or aquatic organisms, through direct exposure or indirect exposure through the food chain

Indicator: Toxic Chemicals

Toxic Chemicals Sub-Indicators:

Atmospheric Deposition of Toxic Chemicals

Toxic Chemicals in Great Lakes Herring Gull Eggs

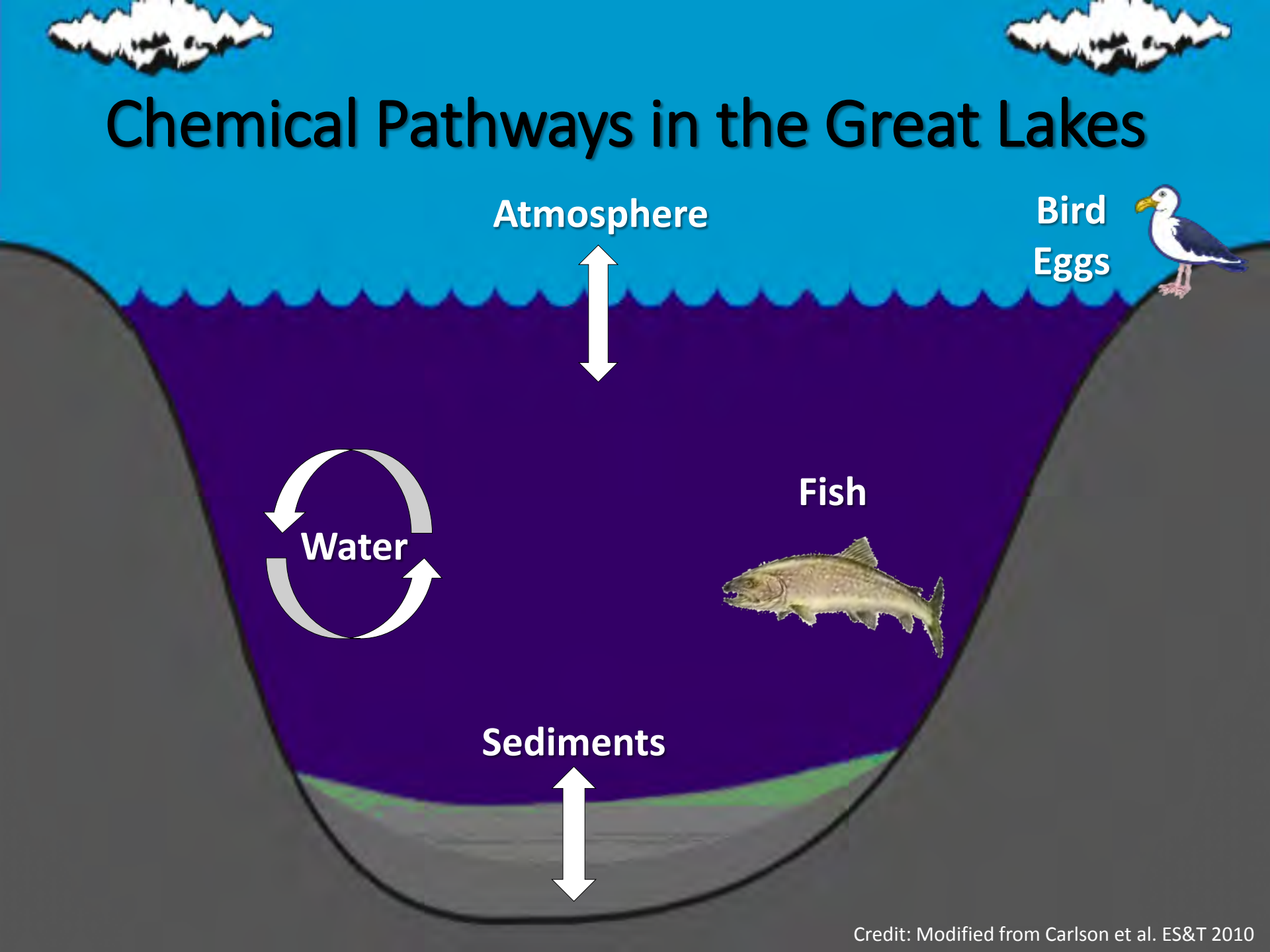
Toxic Chemical Concentrations

Toxic Chemicals in Great Lakes Whole Fish

Toxic Chemicals in Sediments

Photo credit: OMAFRA

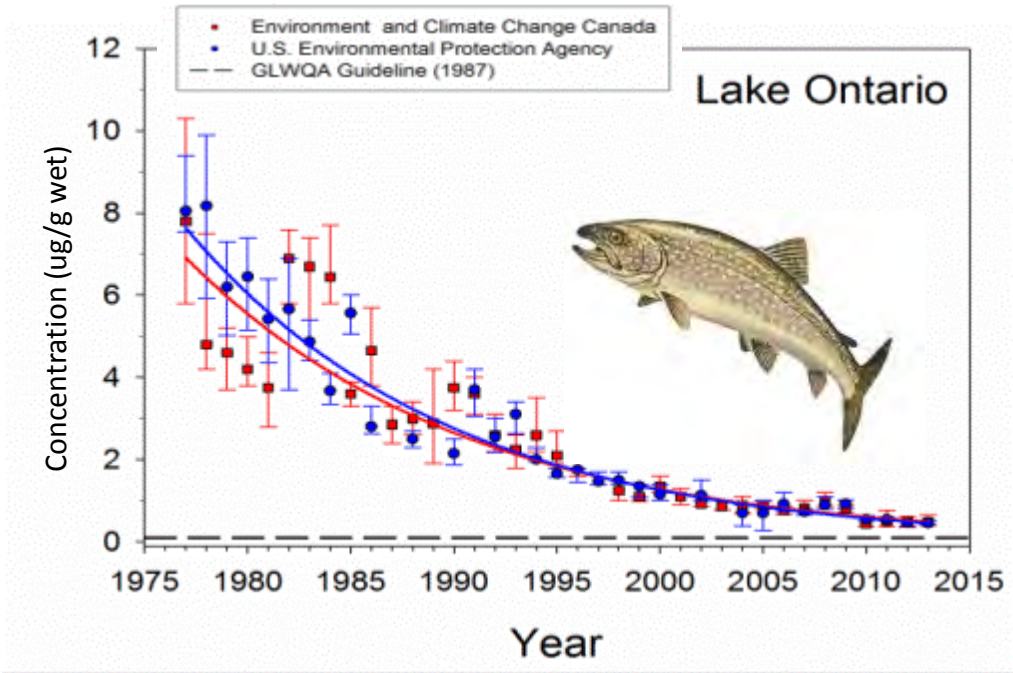
Chemical Pathways in the Great Lakes



Credit: Modified from Carlson et al. ES&T 2010

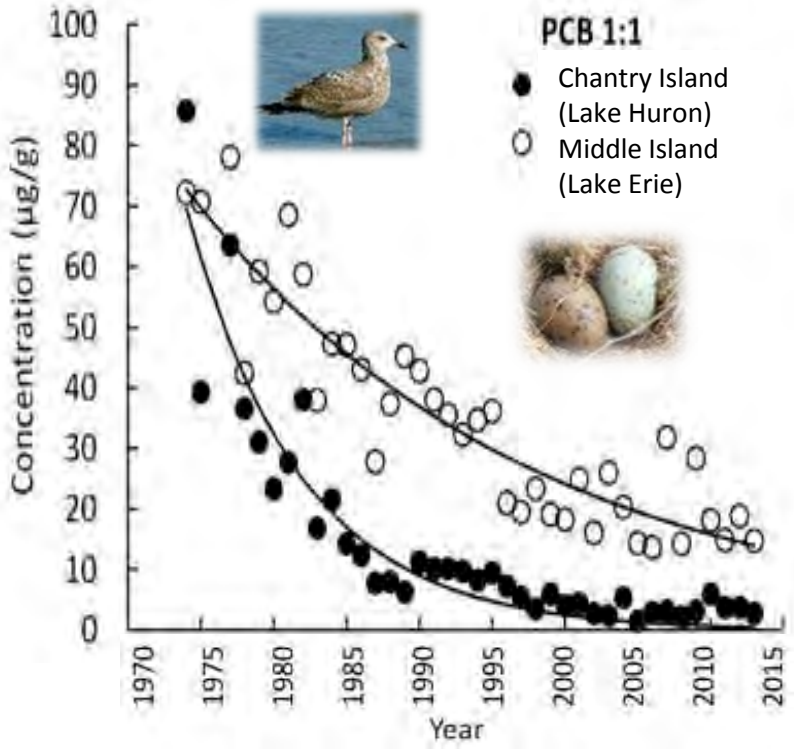
PCBs in Fish and Bird Eggs Have Dramatically Decreased

Whole Fish



80%

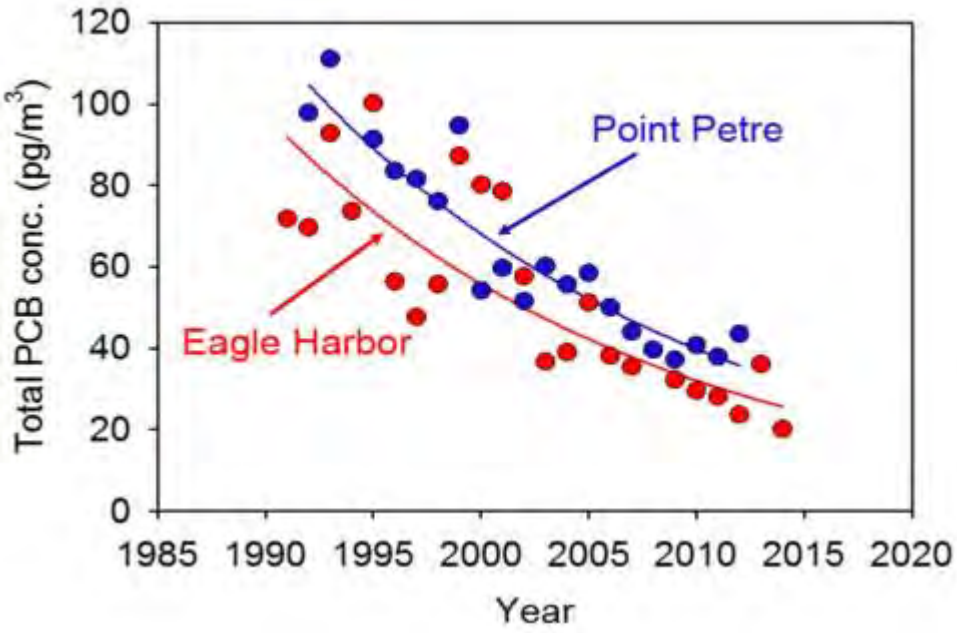
Herring Gull Eggs



65%

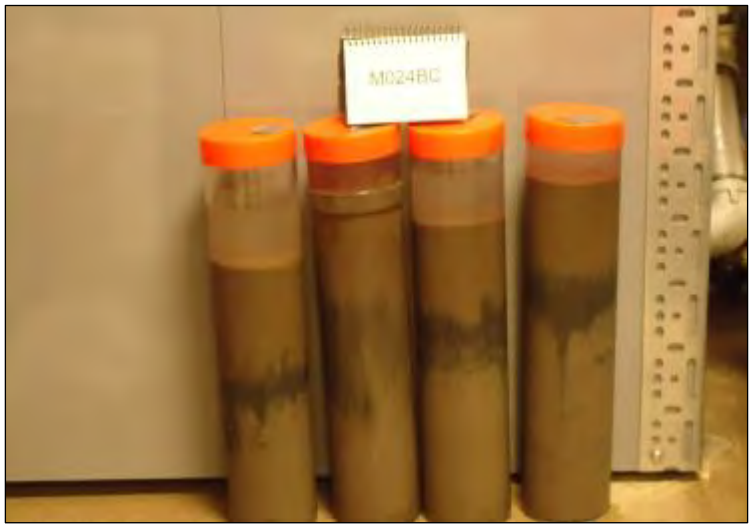
PCBs In Air and Sediment Have Decreased

Atmosphere



60-70%

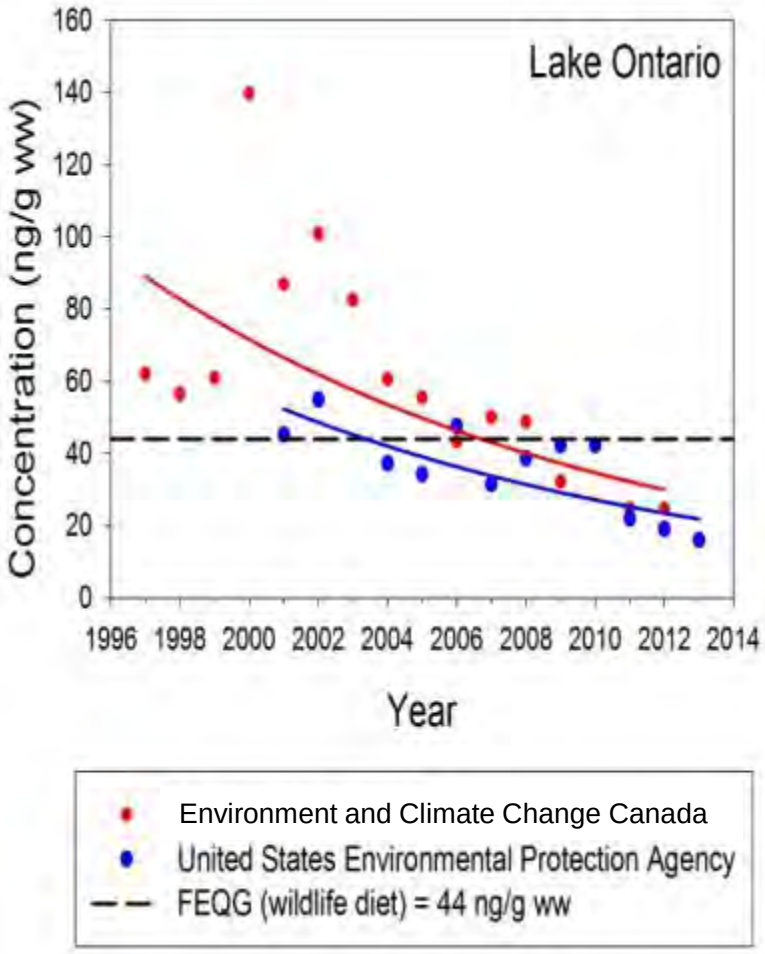
Sediment



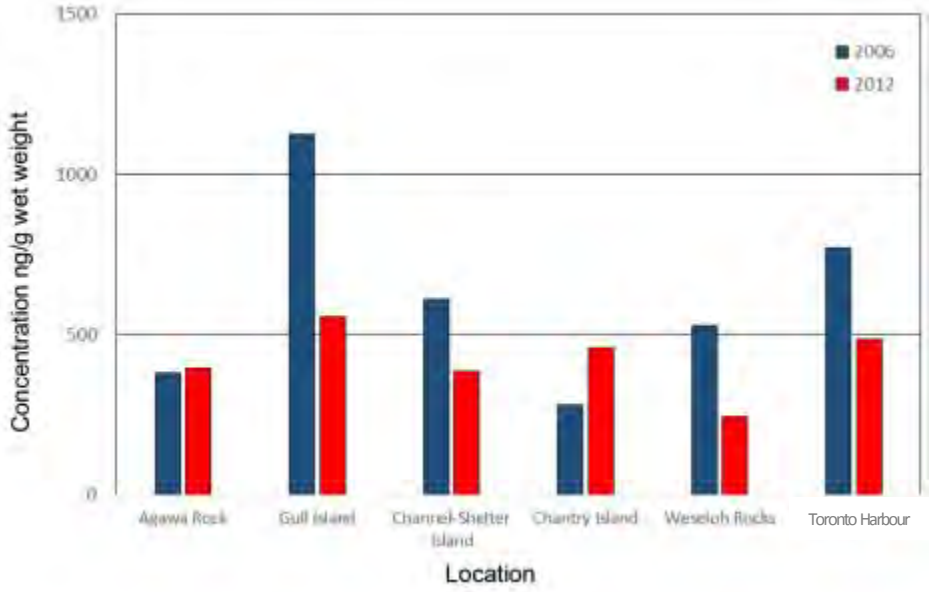
30-40%

PBDEs Are Everywhere In The Environment

Whole Fish

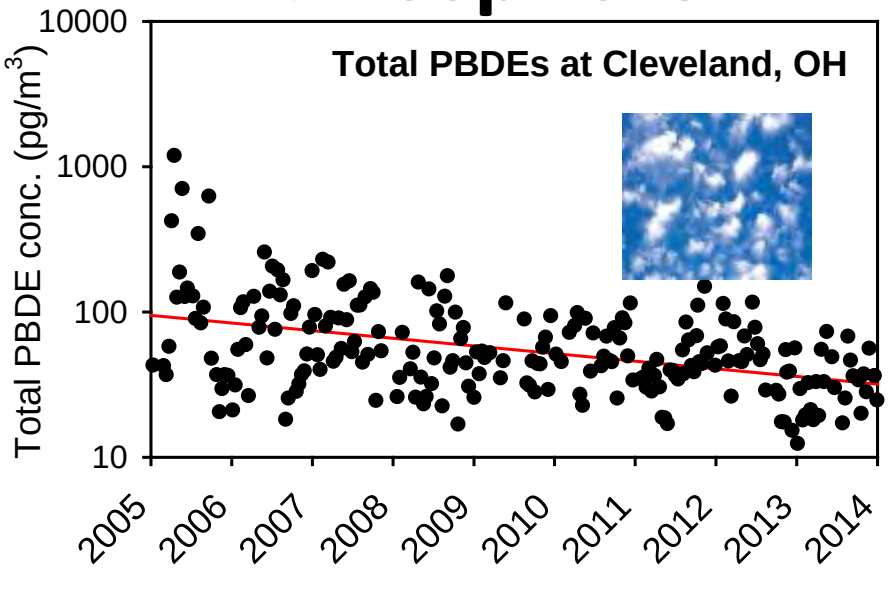


Herring Gull Eggs

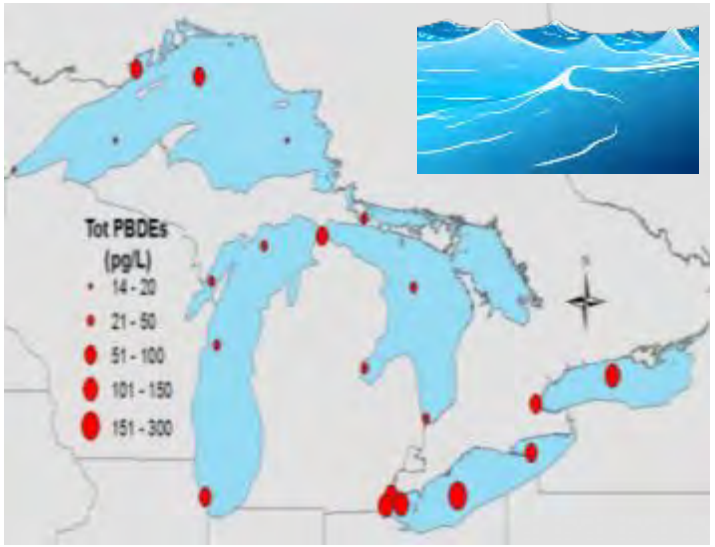


PBDEs Are Everywhere In The Environment

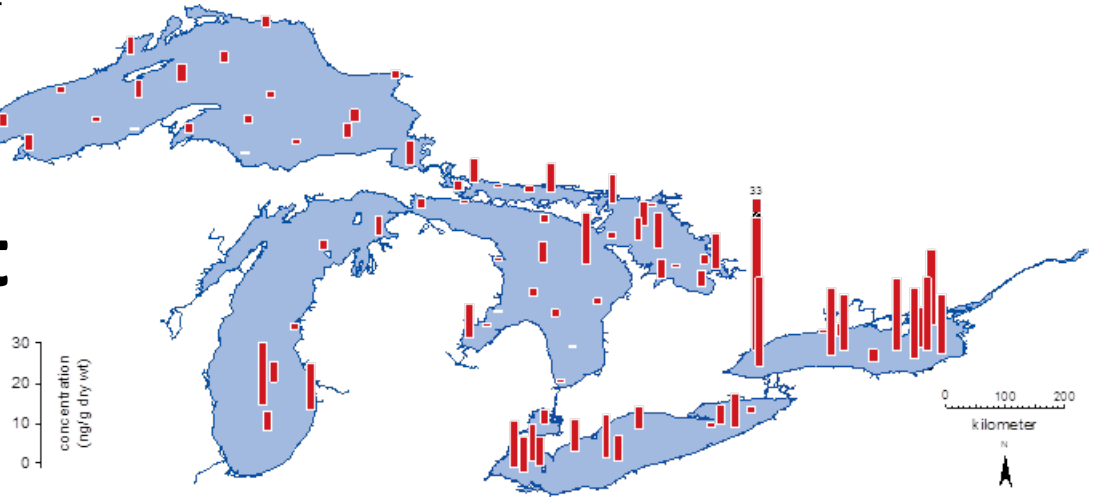
Atmosphere



Water



Sediment



Toxic Chemicals

Status:

GOOD | FAIR | POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Toxic Chemicals in Great Lakes Whole Fish (Trout/Walleye)	Unchanging	Improving	Unchanging	Unchanging	Improving
Toxic Chemicals in Great Lakes Herring Gull Eggs	Improving	Improving	Improving	Unchanging	Unchanging
Toxic Chemical Concentrations	Improving	Unchanging	Unchanging	Unchanging	Unchanging
Atmospheric Deposition of Toxic Chemicals	No lake was assessed separately. Great Lakes basin assessment is **Fair** and **Improving**				
Toxic Chemicals in Sediments	Unchanging	Unchanging	Unchanging	Improving	Improving

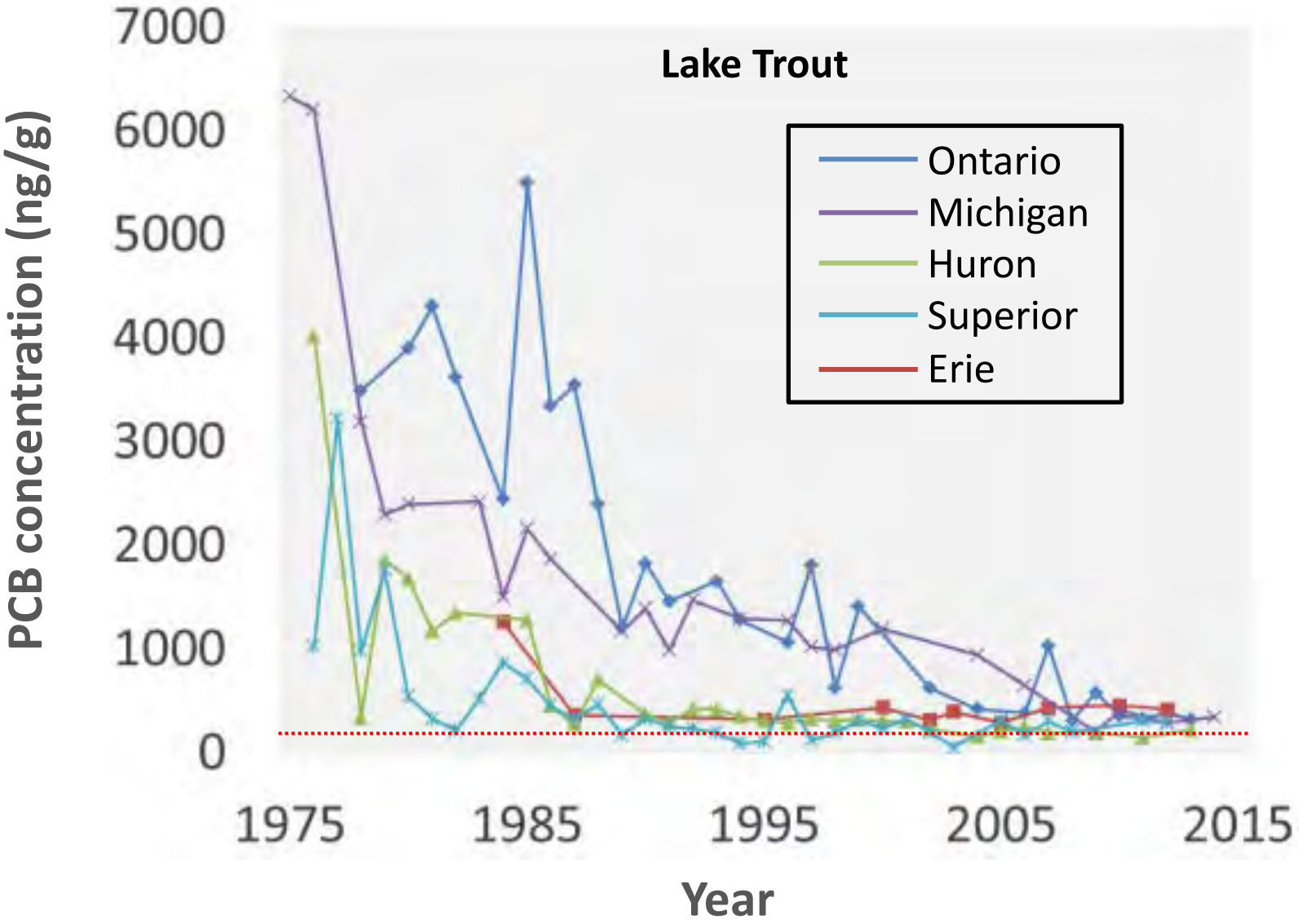
Can We Eat the Fish?

Indicator: Fish Consumption

Fish Consumption Sub-Indicator:
Contaminants in Edible Fish


Fish Consumption
Status: FAIR
Trend: UNCHANGING-IMPROVING

PCBs in Edible Fish Have Declined But Are Still Above Guidelines



Fish Consumption

Status:

GOOD FAIR POOR

SUB-INDICATOR	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Contaminants in Edible Fish	Unchanging	Improving	Unchanging	Deteriorating	Improving


The Waters of the Great Lakes should be a source of high-quality drinking water
Can We Drink the Water?
Photo credit: OMAFRA

Indicator: Drinking Water

Drinking Water Sub-indicator:
Treated Drinking Water


Drinking Water
Status: GOOD
Trend: UNCHANGING

Treated Drinking Water in the US Great Lakes States is Good

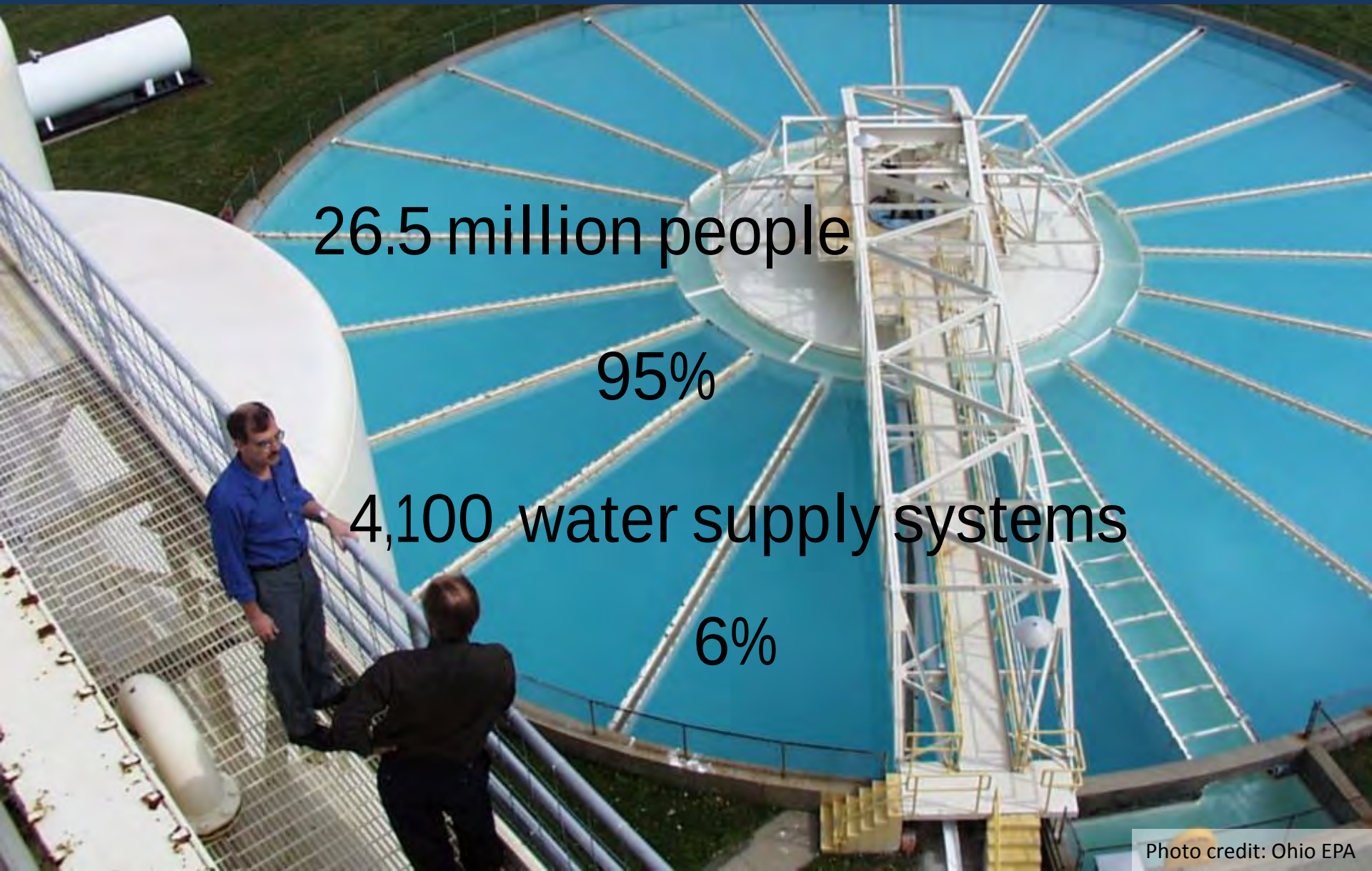


Photo credit: Ohio EPA

Treated **Drinking Water** in Ontario is Good

Microbial: 99.85% or better

Chemical: 99.67% or better

Radiological: 100%

Overall: between 99.8 - 99.9%

Drinking Water

Status:

GOOD FAIR POOR

SUB-INDICATORS	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Treated Drinking Water	No lake was assessed separately. Great Lakes basin assessment is **Good** and **Unchanging**				

The Waters of the Great Lakes should allow for swimming and other recreational use, unrestricted by environmental quality concerns

Can We Swim at the Beach?

Indicator: Beaches

Beaches Sub-indicator:
Beach Advisories

Beaches

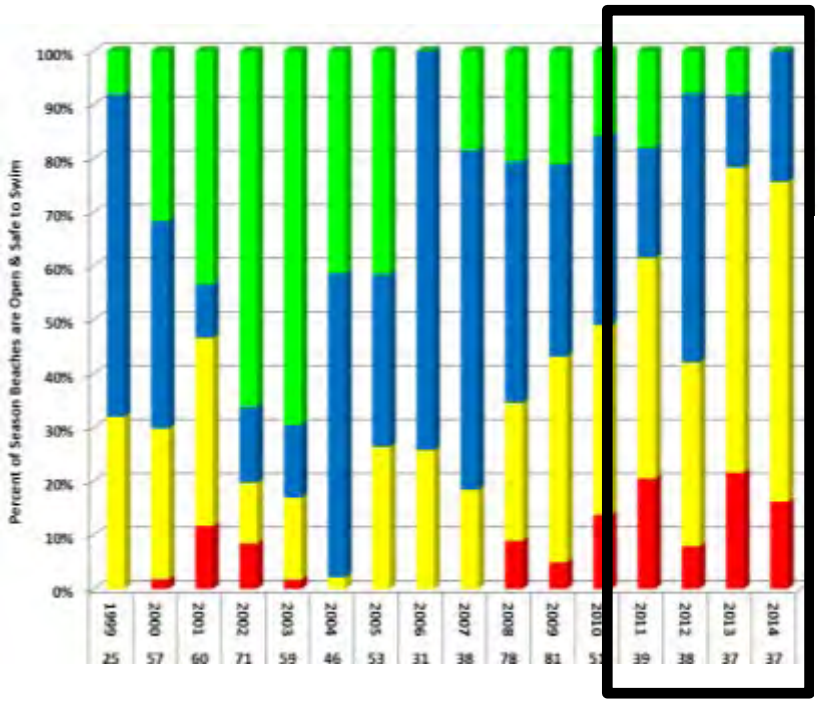
Status: **FAIR-GOOD**

Trend: **UNCHANGING**

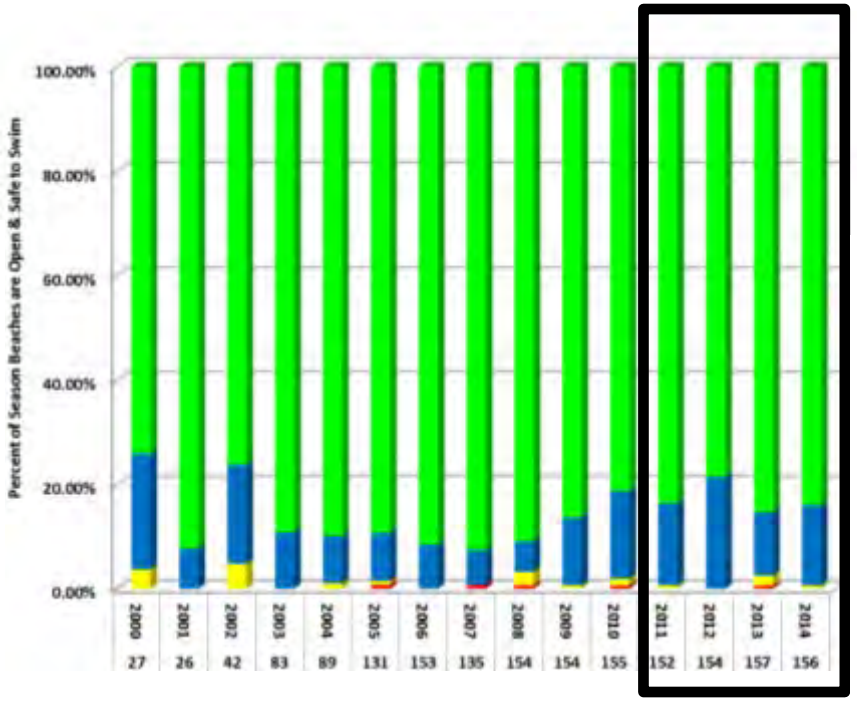
Photo credit: Stacey Cherwaty-Pergentile

Beach Advisories Reduce the Risk of Exposure

Canadian Lake Erie Beaches



US Lake Huron Beaches



100% 80-100% 50-80% <50%

Beaches

Status:

GOOD | FAIR | POOR

SUB-INDICATOR	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Beach Advisories	Unchanging	Unchanging	Unchanging	Deteriorating	Unchanging

Overall Assessments

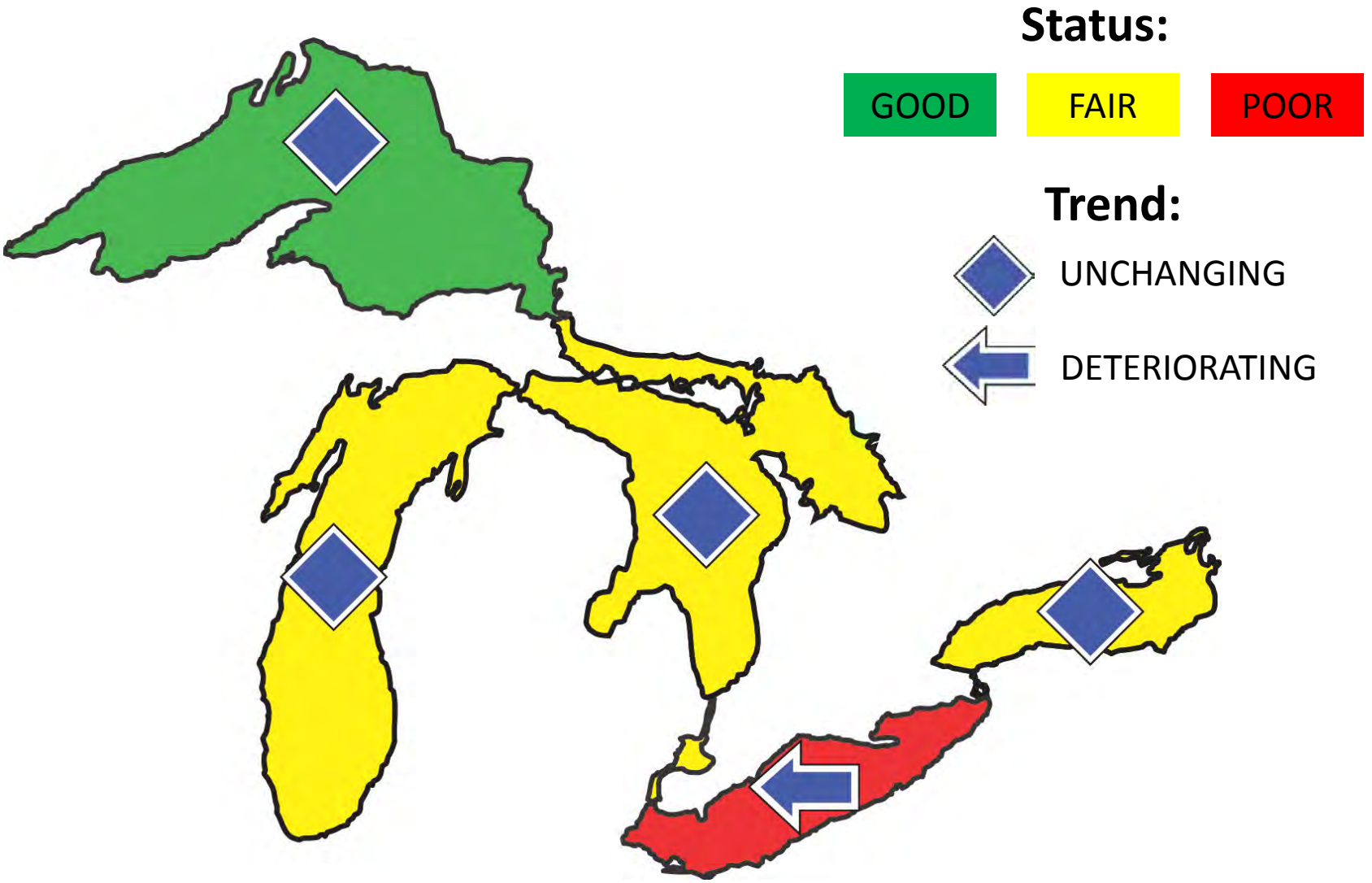
Status:

GOOD | FAIR | POOR

Great Lakes Indicators/ GLWQA General Objectives	Status and Trend
Watershed Impacts and Climate Trends	Watershed Impacts: *Status:* Fair; *Trend:* Unchanging
	Climate Trends: Not Assessed
Habitats and Species	*Status:* Fair; *Trend:* Unchanging
Invasive Species	*Status:* Poor; *Trend:* Deteriorating
Nutrients and Algae	*Status:* Fair; *Trend:* Unchanging-Deteriorating
Groundwater	*Status:* Fair; *Trend:* Undetermined
Toxic Chemicals	*Status:* Fair; *Trend:* Unchanging-Improving
Fish Consumption	*Status:* Fair; *Trend:* Unchanging-Improving
Drinking Water	*Status*: Good; *Trend:* Unchanging
Beaches	*Status*: Fair-Good; *Trend:* Unchanging

Photo credit: Stacey Cherwaty-Pergentile

Lake-by-Lake Overall Assessments



Our Great Lakes:
Economy. Environment. Home.

Photo credit: Environment and Climate Change Canada