Experiences with Forward-looking Goal Setting and Targets in the Great Lakes: Perspectives Pertinent to the Chesapeake

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Chesapeake Bay Program
Scientific Advisory Committee Meeting
Rose Haven, MD
March 27, 2012

Outline

The Setting: Great Lakes Features/Issues

Beneficial Use Impairments (BUIs)

Lake Ecosystem Objectives

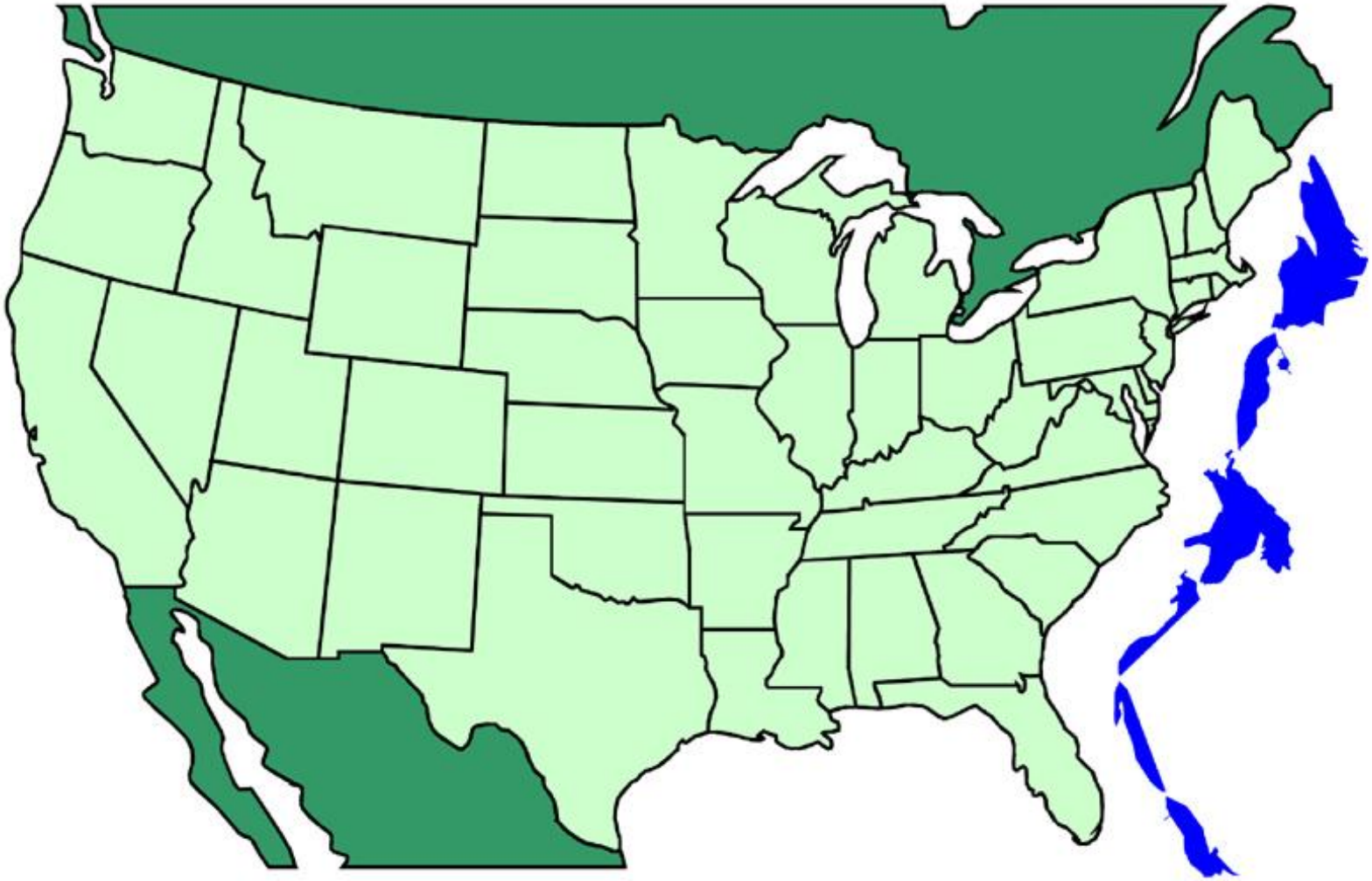
State of the Lakes Ecosystem Conference (SOLEC)

The Nearshore: Coupling Water and Land

GREAT LAKES FACTS I

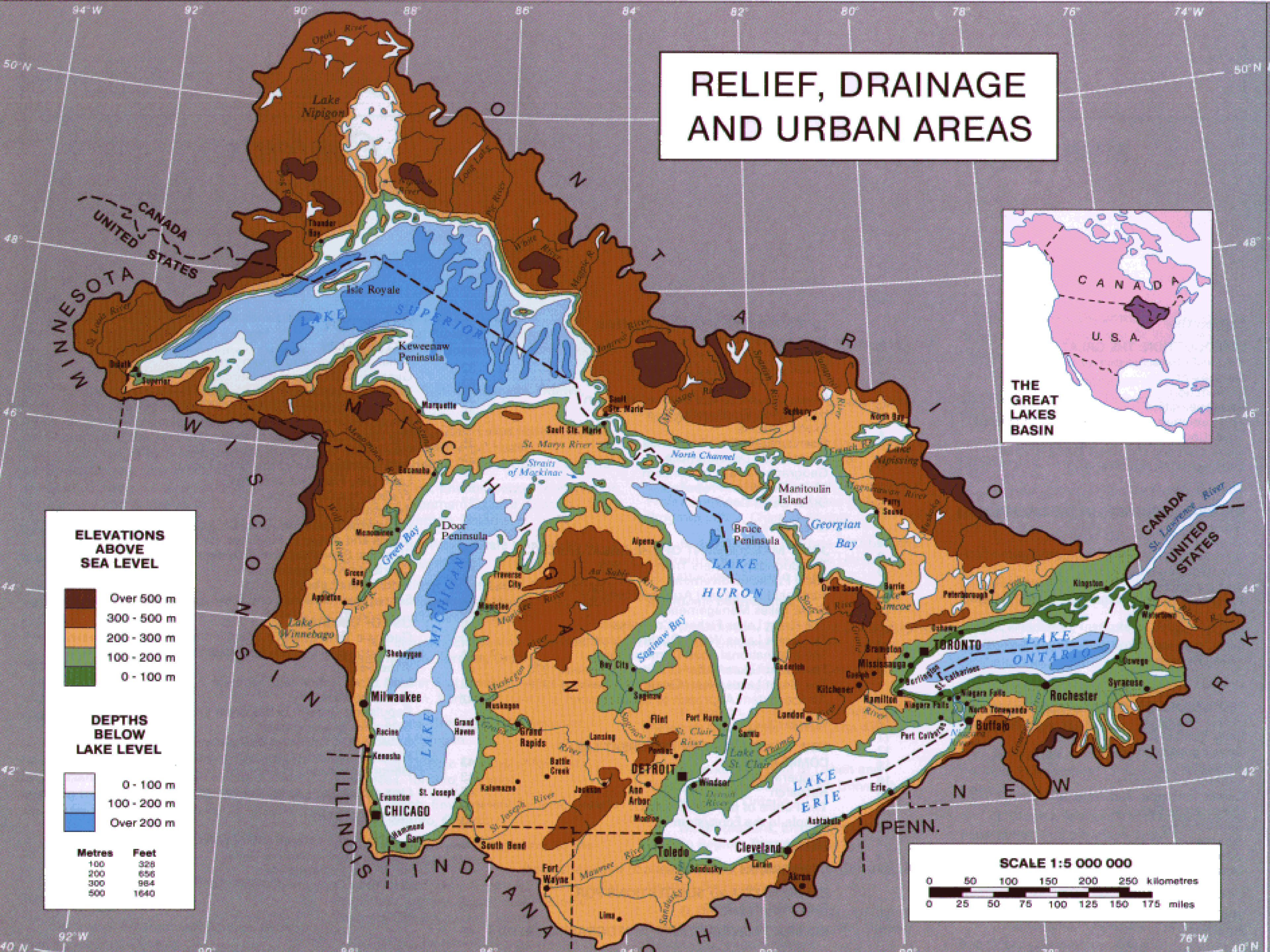
- Geologically Young: ~ 20,000 years
- Surface Area: 94,000 Miles^2 (244,000 Km^2)
- Watershed: 201,500 Miles^2 (522,000 Km^2)
- Volume: 5,400 Miles^3 (22,700 Km^3)
- Shoreline: 10, 200 Miles (17,000 Km)

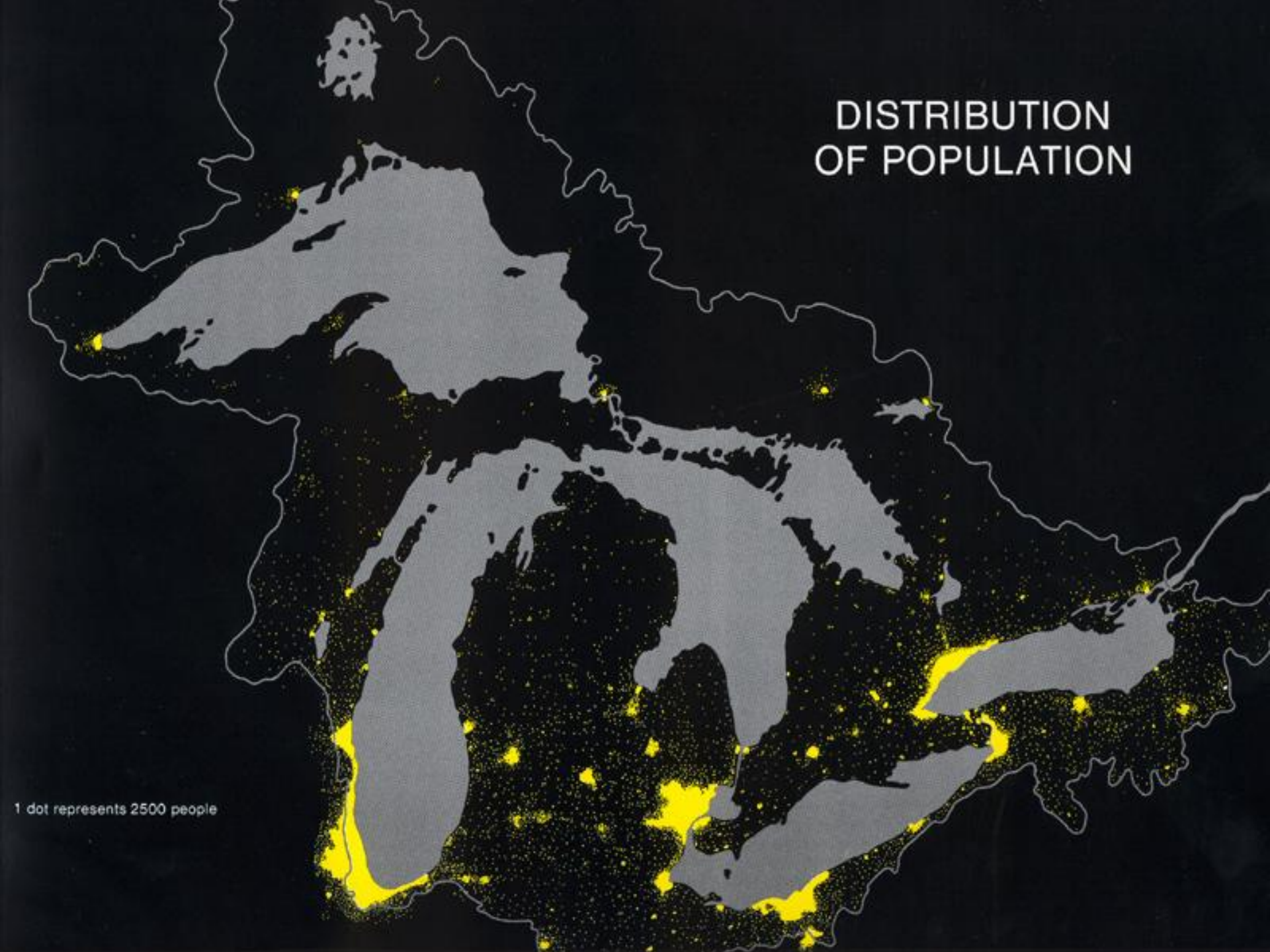
Great Lakes Coastlines

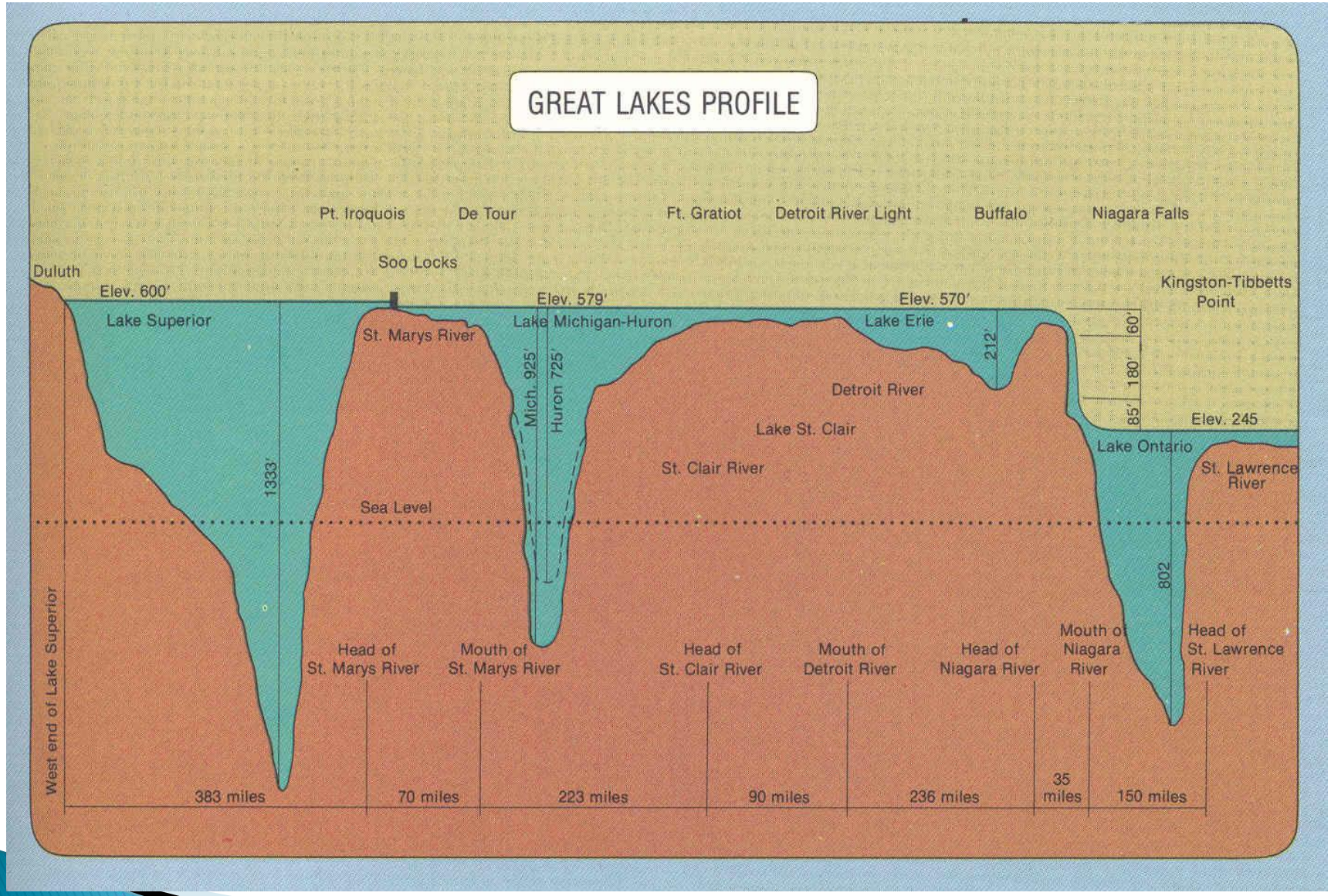


GREAT LAKES FACTS II

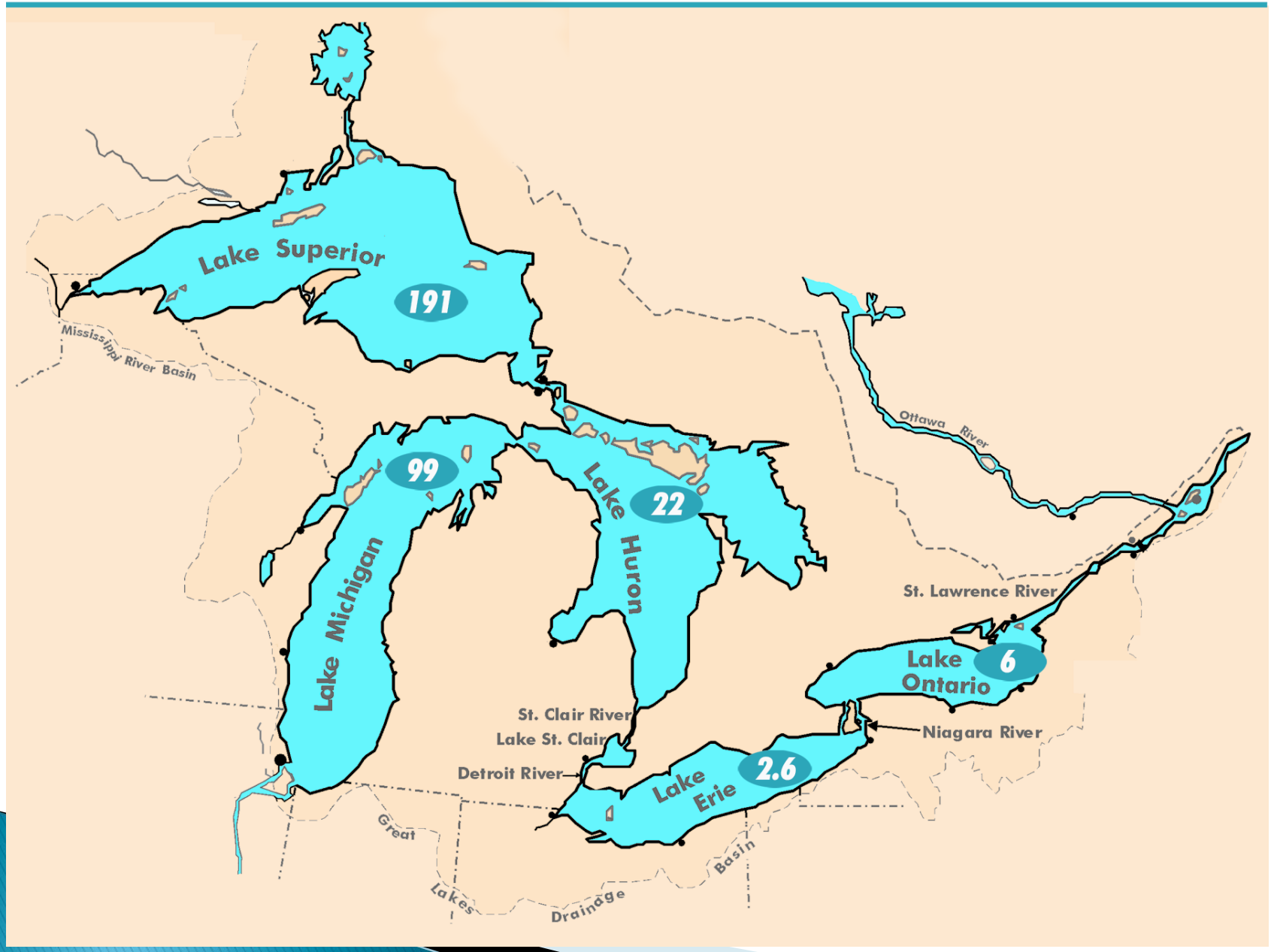
- Population: 35 million
- Agriculture
- Recreation & Tourism
- Drinking Water
- Industry
- Fishing
- Power Generation and Cooling Water


RELIEF, DRAINAGE AND URBAN AREAS
THE GREAT LAKES BASIN
CANADA
U. S. A.
ELEVATIONS ABOVE SEA LEVEL
Over 500 m
300 - 500 m
200 - 300 m
100 - 200 m
0 - 100 m
DEPTHS BELOW LAKE LEVEL
0 - 100 m
100 - 200 m
Over 200 m
Metres Feet
100 328
200 656
300 984
500 1640
SCALE 1:5 000 000
0 50 100 150 200 250 kilometres
0 25 50 75 100 125 150 175 miles
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
Georgian Bay
Green Bay
Saginaw Bay
North Channel
Straits of Mackinac
Lake Nipigon
Lake Nipissing
Lake Simcoe
Lake Winnebago
Lake St. Clair
Isle Royale
Keweenaw Peninsula
Door Peninsula
Bruce Peninsula
Manitoulin Island
St. Marys River
St. Lawrence River
ONTARIO
MINNESOTA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENN.
NEW YORK
CANADA
UNITED STATES
Thunder Bay
Duluth
Superior
Marquette
Sault Ste. Marie
Sudbury
North Bay
Escanaba
Menominee
Green Bay
Appleton
Sheboygan
Milwaukee
Racine
Kenosha
Evanston
CHICAGO
Hammond
Gary
South Bend
St. Joseph
Kalamazoo
Battle Creek
Jackson
Lansing
Grand Rapids
Grand Haven
Muskegon
Manistee
Traverse City
Alpena
Bay City
Saginaw
Flint
Port Huron
Sarnia
Pontiac
DETROIT
Windsor
Ann Arbor
Monroe
Toledo
Sandusky
Lorain
Cleveland
Akron
Ashtabula
Erie
Port Colborne
Buffalo
North Tonawanda
Niagara Falls
St. Catharines
Hamilton
Burlington
Brampton
Mississauga
TORONTO
Oshawa
Peterborough
Kingston
Watertown
Oswego
Syracuse
Rochester
Kitchener
Guelph
London
Goderich
Owen Sound
Barrie
Parry Sound
Fort Wayne
Lima
Maumee River
Sandusky River
St. Joseph River
Grand River
Muskegon River
Au Sable River
Saginaw River
Thames River
Fox River
Wolf River
Menominee River
St. Louis River
Nipigon River
Ogoki River
Long Lake
White River
Magpie R.
Mississagi R.
French R.
Magnetawan River
Genesee River
Detroit River
St. Clair River
Niagara
94° W
92°
90°
88°
86°
84°
82°
80°
78°
76°
74° W
50° N
48°
46°
44°
42°
40° N


DISTRIBUTION
OF POPULATION
1 dot represents 2500 people


GREAT LAKES PROFILE
Pt. Iroquois
De Tour
Ft. Gratiot
Detroit River Light
Buffalo
Niagara Falls
Duluth
Soo Locks
Elev. 600'
Lake Superior
Elev. 579'
Lake Michigan-Huron
Elev. 570'
Lake Erie
Kingston-Tibbetts Point
St. Marys River
Mich. 925'
Huron 725'
212'
60'
180'
85'
Elev. 245
Detroit River
Lake St. Clair
St. Clair River
Lake Ontario
St. Lawrence River
1333'
Sea Level
802
West end of Lake Superior
Head of St. Marys River
Mouth of St. Marys River
Head of St. Clair River
Mouth of Detroit River
Head of Niagara River
Mouth of Niagara River
Head of St. Lawrence River
383 miles
70 miles
223 miles
90 miles
236 miles
35 miles
150 miles

Great Lakes Water Retention/Replacement Time (years)




Ontario
Quebec
Superior
Minnesota
Wisconsin
Michigan
Huron
Michigan
Ontario
New York
Erie
Pennsylvania
Illinois
Indiana
Ohio
Image © GLIN

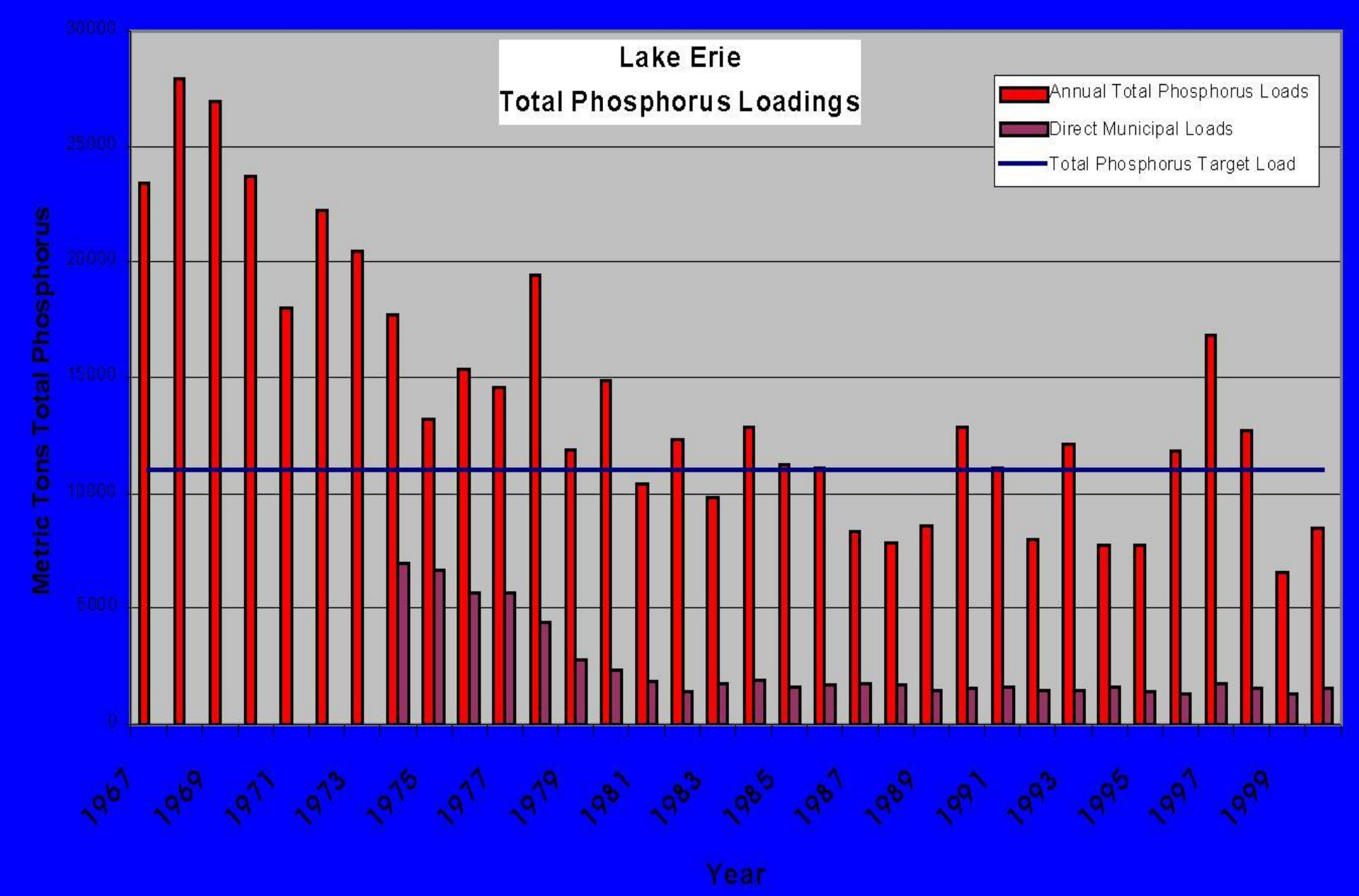
Important Timelines

- Early 1800's — Habitat Destruction
- Late 1800's — Public Health Crisis; Fishery Declines
- 1950's — Sea Lamprey Crisis
- 1960's — Eutrophication; Lake Erie Proclaimed "*DEAD*"
- 1980's — Toxic Contaminants
- 1990's — Aquatic Nuisance Species
- 2000's — Multiplicity of Nagging and Emerging Issues

Challenges to the Integrity of the Great Lakes Basin Ecosystem

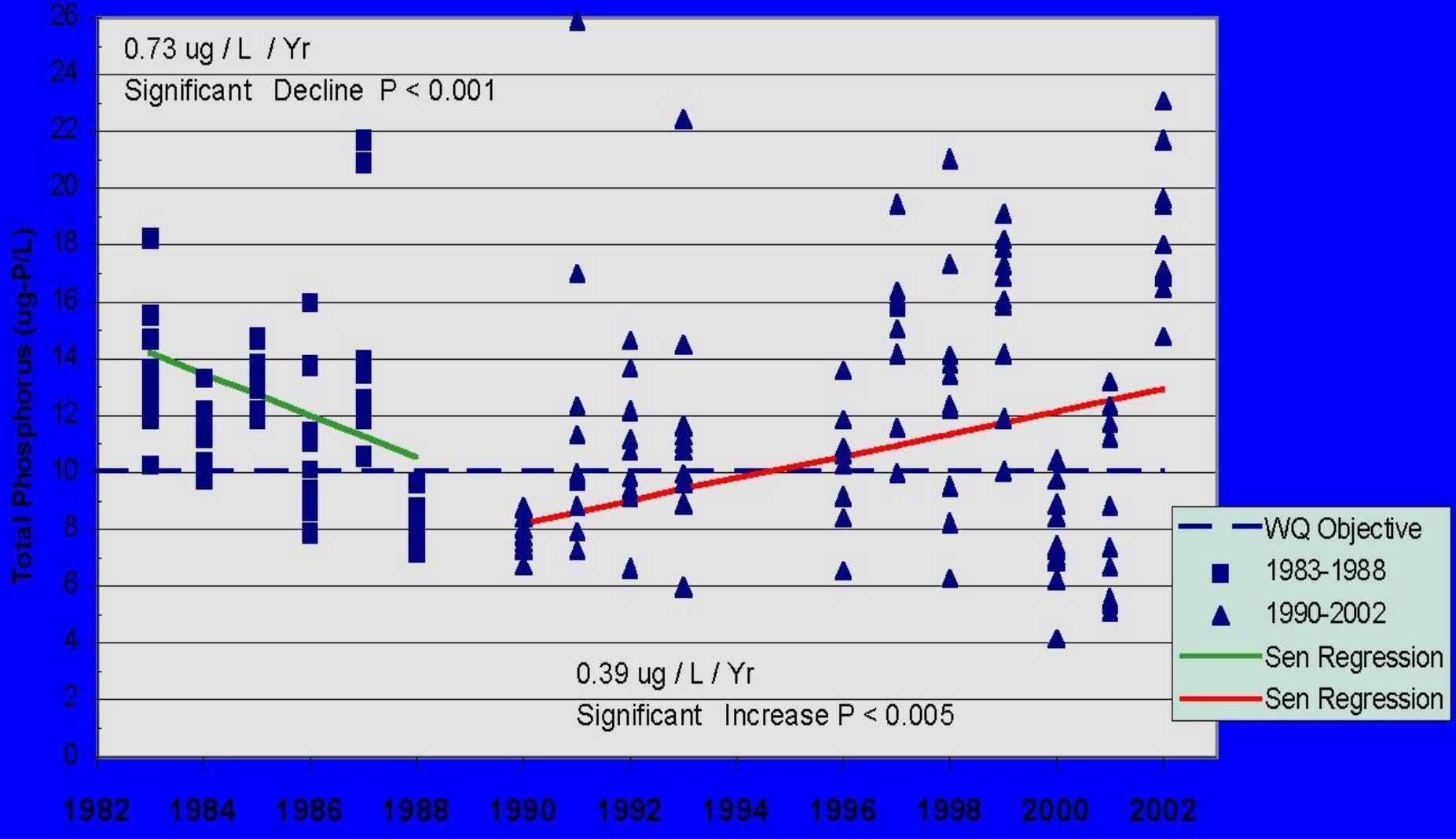
- Eutrophication
- Toxic chemicals
- Unplanned growth (sprawl)
- Habitat destruction
- Nuisance invasive species
- Long range transport
- Climate change

Blue-green Algae Bloom circa 1970, Lake Erie



D. Rockwell, US EPA - GLNPO

Central Lake Erie Total Phosphorus
Spring Station Means



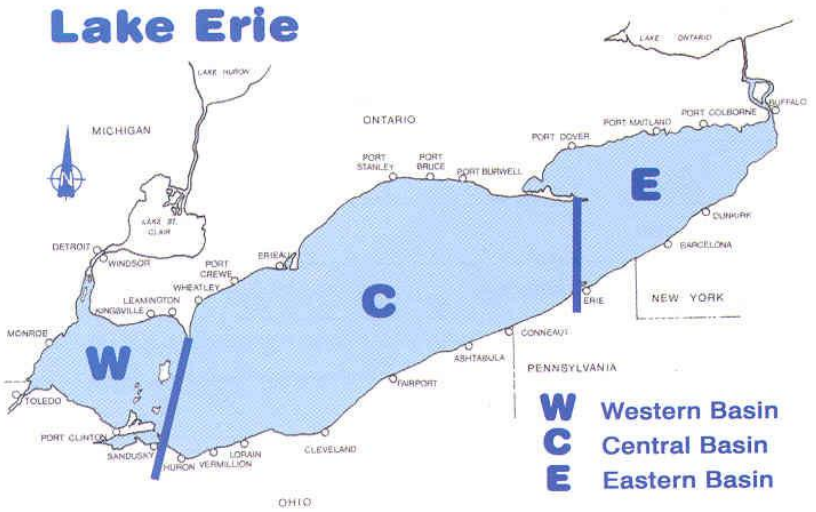
D. Rockwell, US EPA - GLNPO

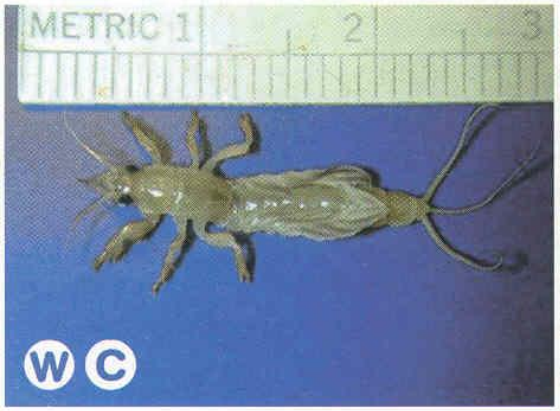

Detroit
River Flow
Maumee
Bay
Sandusky Bay

Microcystis, Stone Lab, 8/10/10

Satellite Image 9 October 2011

Microcystis near Marblehead on 9 October 2011 by Richard Kraus, USGS


Lake Erie
LAKE HURON
MICHIGAN
ONTARIO
LAKE ONTARIO
BUFFALO
PORT COLBORNE
PORT MAITLAND
PORT DOVER
PORT STANLEY
PORT BRUCE
PORT BURWELL
E
DUNKIRK
BARCELONA
NEW YORK
LAKE ST. CLAIR
DETROIT
WINDSOR
ERIEAU
PORT CREWE
WHEATLEY
LEAMINGTON
KINGSVILLE
C
ERIE
MONROE
W
CONNEAUT
ASHTABULA
PENNSYLVANIA
TOLEDO
FAIRPORT
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
CLEVELAND
OHIO
W Western Basin
C Central Basin
E Eastern Basin


METRIC 1
2
3
W C

(c)

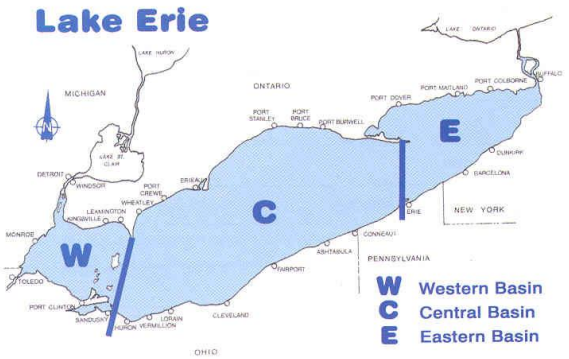

W C

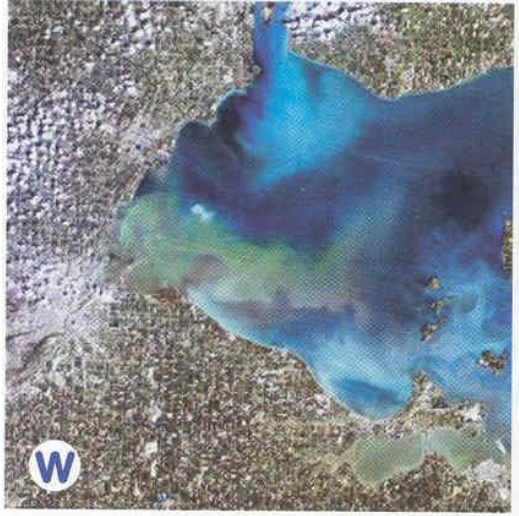
(d)


W

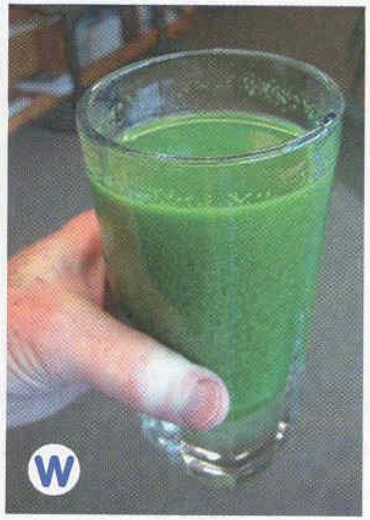

W C

Lake Erie





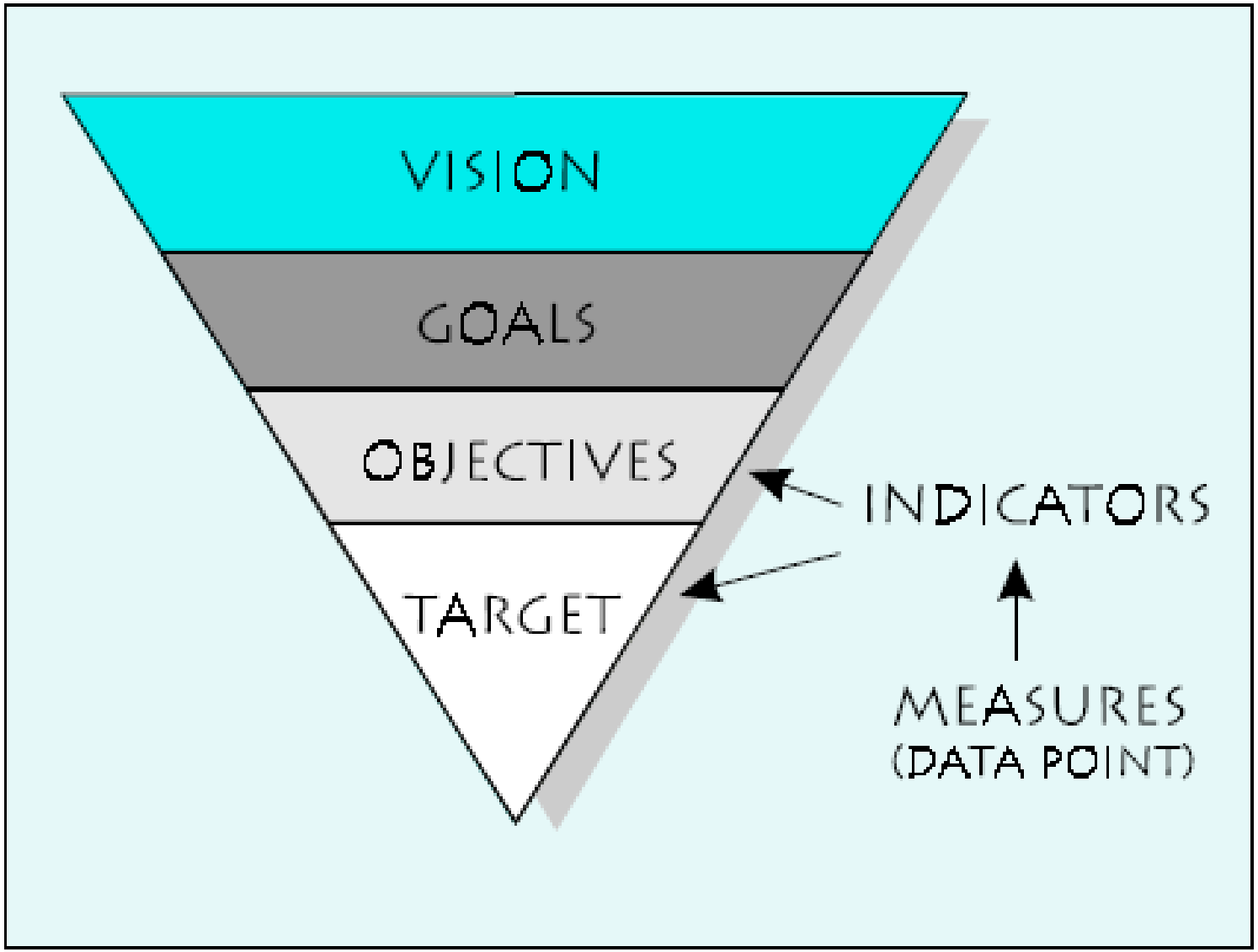
(c)



(d)

(e)

(f)



Conceptual Model of the Relationships between Indicators,Measures, Targets, Objectives, Goals and Visions.

Evolution of Areas of Concern (AOC)

- Late 1960s "Problem Areas of the Great Lakes"
- Late 1970s "Areas of Concern"
- Early 1980s
  - Class "A" AOCs – Severely Polluted
  - Class "B" AOCs – "Polluted"
- 1983 Appendix A to the WQB Report on Great Lakes Water Quality – Class "A" Areas of Concern Update
- 1985 – Class B Areas of Concern Report aborted – lack of information for update.
- 1987 – WQB Report on Great Lakes Water Quality – Recommended RAPs

The "How Clean is Clean" Project

- **How did the AOCs get on the list in the first place?**
- **Development of Listing/Delisting Criteria**
  - White Papers to WQB in mid-1980s
  - IAGLR Conference Symposium 1988
  - 14 BUIs developed by WQB, approved by IJC and incorporated into Great Lakes Water Quality Agreement Revision by Protocol in 1987
- **1987 Agreement Revision by Protocol**
  - Replaced old "Limited Use Zones" Annex 2
  - Called for RAPs and LaMPs
  - RAPs: broad ecosystem approach; LaMPs: critical pollutants
  - Specified processes for staged implementation and reporting; IJC review
  - IJC issues 1991 AOC Listing Delisting Guidelines
  - 1991 "Roles and Responsibilities" report – shift in coordination from IJC/WQB to BEC

List of Beneficial Use Impairments

- Restrictions on fish and wildlife consumption
- Tainting of fish and wildlife flavour
- Degradation of fish wildlife populations
- Fish tumors or other deformities
- Bird or animal deformities or reproduction problems
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Restrictions on drinking water consumption, or taste and odor problems
- Beach closings
- Degradation of aesthetics
- Added costs to agriculture or industry
- Degradation of phytoplankton and zooplankton populations
- Loss of fish and wildlife habitat

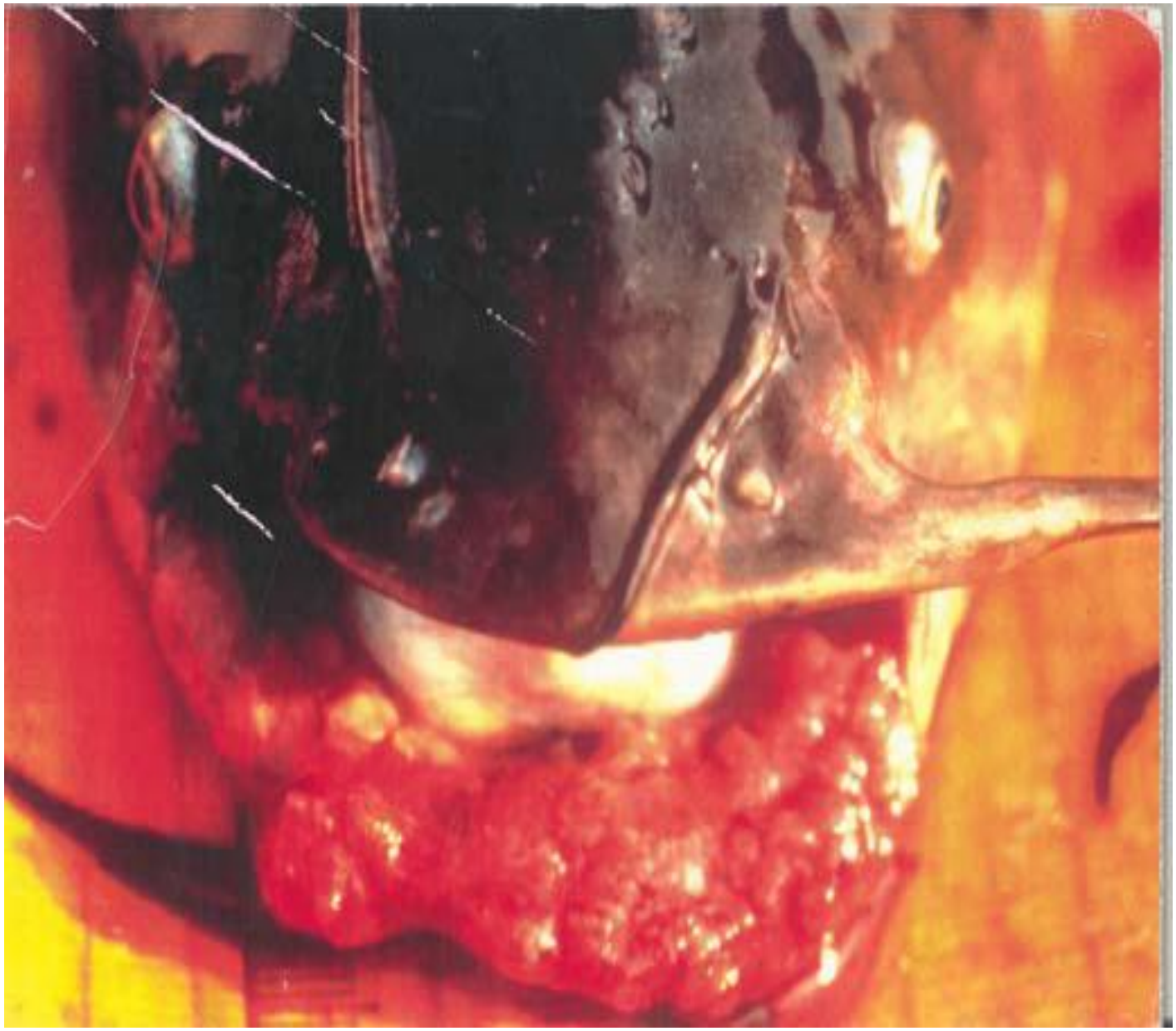
BUI Example

Fish Tumors or Other Deformities Delisting Criteria (1991)

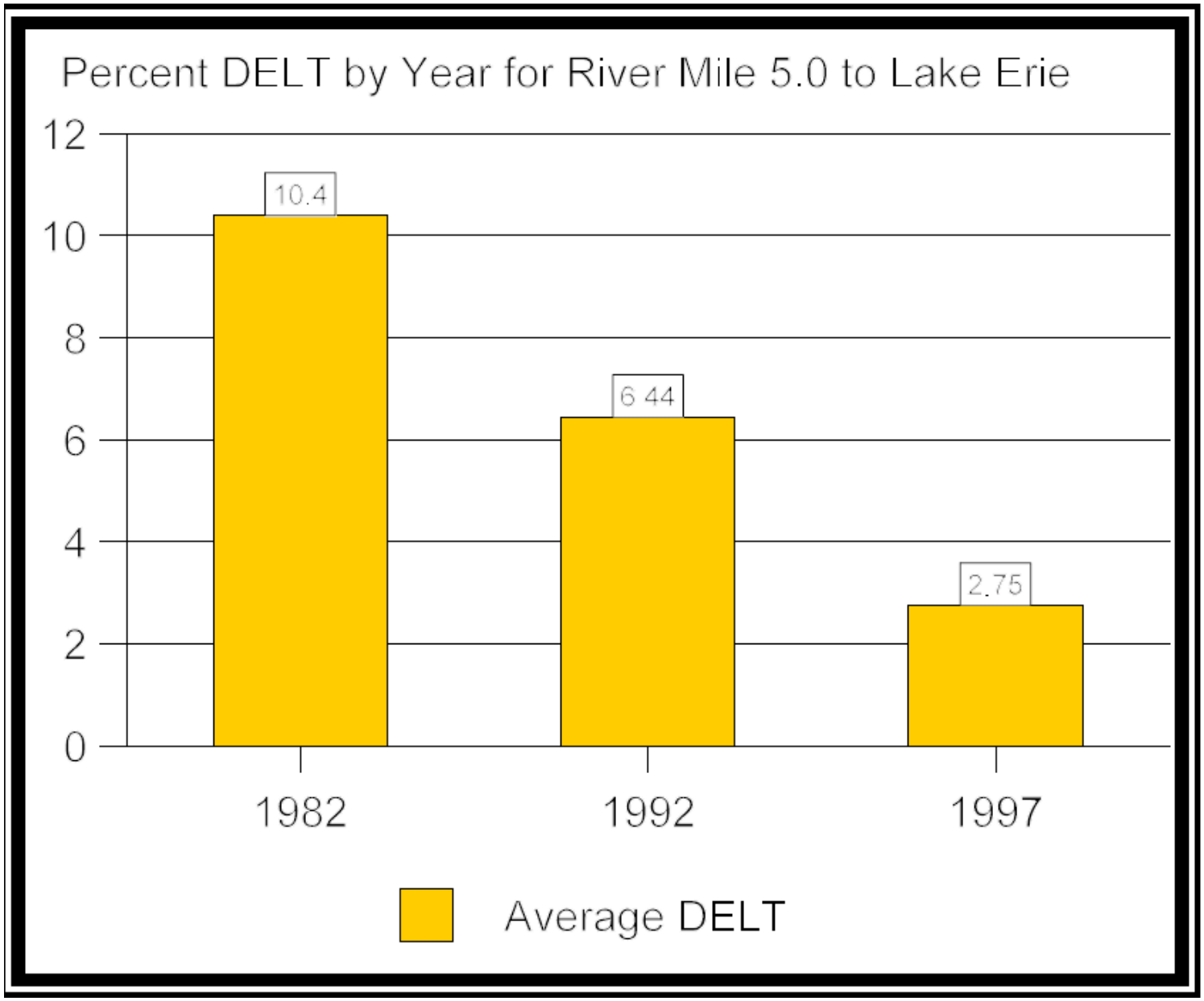
"When the incidence of fish tumors or other deformities do not exceed rates at unimpacted control sites and when survey data confirm the absence of neoplastic or preneoplastic live tumors in bulheads or suckers"

<u>DELT</u>
Deformities
Eroded fins
Lesions
Tumors

<u>Target</u>
DELT <0.5% (frequency of one anomaly in every 200 fish)



Lip Tumor in Black River Bullhead



Yearly DELT Averages for the lower 5 miles

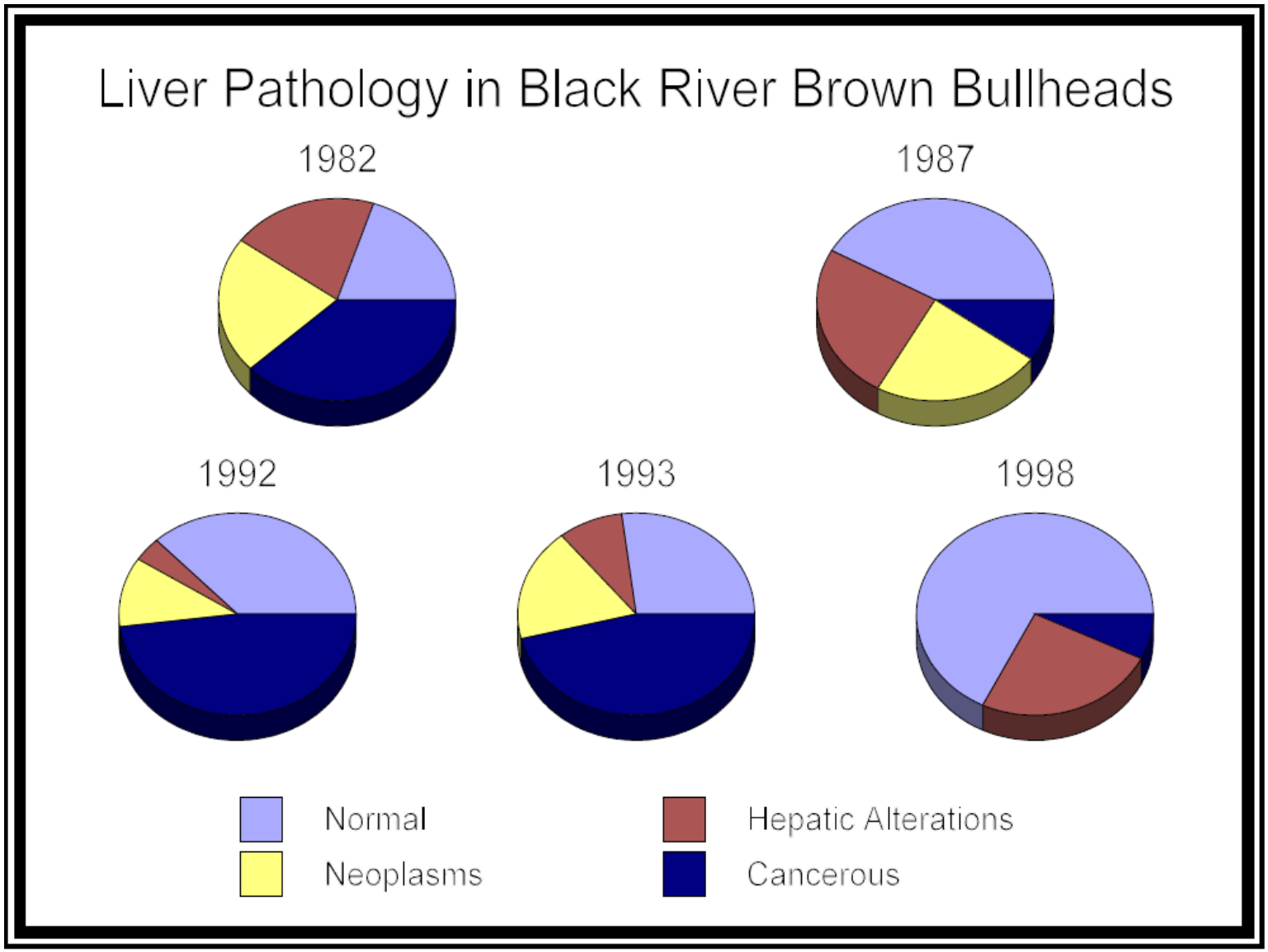
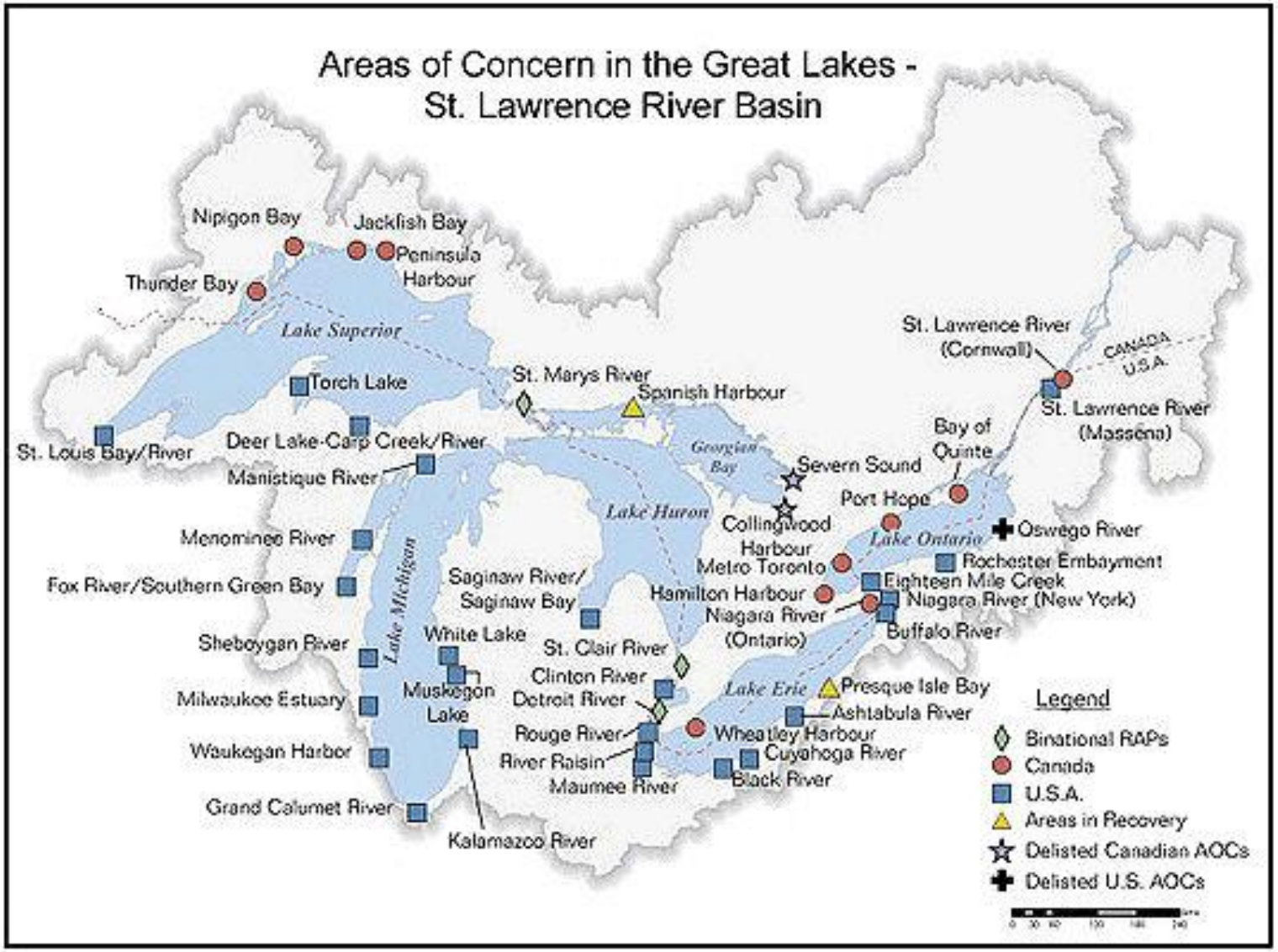


Figure 15. Liver Pathology by Year

From Baumann 2000


Areas of Concern in the Great Lakes -
St. Lawrence River Basin
Nipigon Bay
Jackfish Bay
Peninsula Harbour
Thunder Bay
Lake Superior
Torch Lake
St. Marys River
Spanish Harbour
St. Louis Bay/River
Deer Lake-Carp Creek/River
Manistique River
Georgian Bay
Severn Sound
Lake Huron
Menominee River
Fox River/Southern Green Bay
Lake Michigan
Saginaw River/ Saginaw Bay
Sheboygan River
White Lake
St. Clair River
Clinton River
Muskegon Lake
Milwaukee Estuary
Detroit River
Lake Erie
Waukegan Harbor
Rouge River
River Raisin
Maumee River
Grand Calumet River
Kalamazoo River
Collingwood Harbour
Metro Toronto
Hamilton Harbour
Niagara River (Ontario)
Presque Isle Bay
Ashtabula River
Wheatley Harbour
Cuyahoga River
Black River
St. Lawrence River (Cornwall)
CANADA
U.S.A.
St. Lawrence River (Massena)
Bay of Quinte
Port Hope
Lake Ontario
Oswego River
Rochester Embayment
Eighteen Mile Creek
Niagara River (New York)
Buffalo River
Legend
Binational RAPs
Canada
U.S.A.
Areas in Recovery
Delisted Canadian AOCs
Delisted U.S. AOCs

Lake Ecosystem Objectives

Lake Superior: The lake should be maintained as a balanced and stable oligotrophic ecosystem with lake trout as a top predator of a cold-water community.

Indicators (targets/end points)

- Stable, self-producing stocks
- Productivity greater than 0.38 kg/Ha
- Free from contaminants at concentrations that adversely affect the trout themselves or the quality of the harvested products.

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www.ijc/en/activities/consultations/glwqa/GLWQA_e.pdf

SOLEC
State of the Lakes Ecosystem Conference

- Literature Review – over 800 indicators
- Biennial conferences since 1994
- Settled on suite of 80 indicators – Aquatic, Land use, Resource Utilization, etc.
- Are conditions getting better or worse?
  - "gas gauge"
  - no targets/end points

- Used OECD (2003) DPSIR Framework
  - **D**river
  - **P**ressure
  - **S**tate
  - **I**mpacts
  - **R**esponse

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http://binational.net/solec

SOLEC

Indicators Color and Symbol – Guide

Status

- Good – green
- Fair – yellow
- Poor – red
- Mixed – brown

Trend

→ Improving

■ Unchanging

←Deteriorating

International Joint Commission Indicators and Evaluation Task Force Reports in 1996 and 1998

"Nine desired, positive outcomes to which the public and decision-makers can relate and strive to achieve"

- Fishability
- Swimmability
- Drinkability
- Healthy Human Populations
- Economic Viability
- Biological Community Integrity and Diversity
- Virtual Elimination of Inputs in Persistent Toxic Substances
- Absence of Excess Phosphorus
- Physical Environment Integrity

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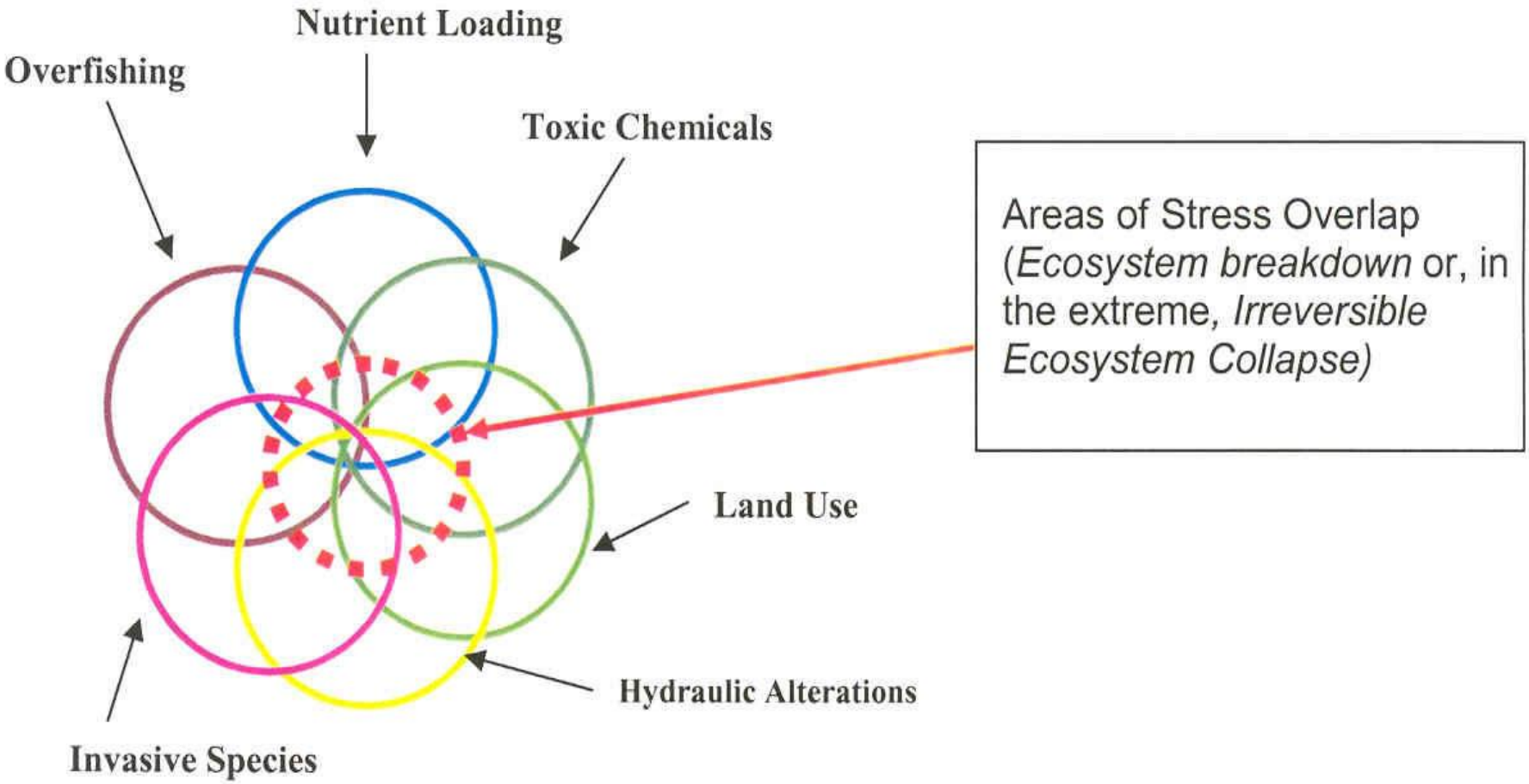
http:/www.ijc.org/php/publications/html/ietf.htm/

Great Lakes Stressors Overlap



http://www.miseagrant.umich.edu/downloads/habitat/PrescriptionforGreatLakes.pdf

Prescription for Great Lakes Ecosystem Protection and Restoration: Avoiding the Tipping Point of Irreversible Changes (2005)

- Restore and enhance critical nearshore areas, tributaries and connecting channels
- Remediate basinwide sources of stress (physical, chemical, biological)
- Protect healthy functioning elements
- Monitor ecosystem health

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http://www.snre.umich.edu/scavia/wp-content/uploads/2009/11/prescription_for_great_lakes_08_30_2006.pdf

Great Lakes Environmental Indicator Project (GLEI)

- Developing Condition Index by Watershed

- Based on 207 individual stressors
  - Type of land use
  - Amount of agricultural activity
  - Point sources of pollution
  - Human population density

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http://glei.nrri.umn.edu/default/resultsnewindex


Toxics
Birds
Plants
Frogs
Bugs
Fish
Algae
Water

Great Lakes Water Quality Agreement Purpose

"To restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem"

(Article II)

Great Lakes Water Quality Agreement

- 1972: Eutrophication
  - Great Lakes Waters
- 1978: Ecosystem Approach
  - Great Lakes Basin Ecosystem
  - Toxic Contaminants
- 1987: RAPS and LaMPs
  - Broaden Pollution Sources
  - Atmospheric Deposition
  - Groundwater
- 2012: Revisions and Updates
  - Nearshore

Summary
Great Lakes Targets – Lessons Learned

- Beneficial Use Impairments (BUIs)
- Lake Ecosystem Objectives
- Status of the Lakes Ecosystem Conference (SOLEC)
- Linking Land and Water – The Nearshore and Coastal Zones