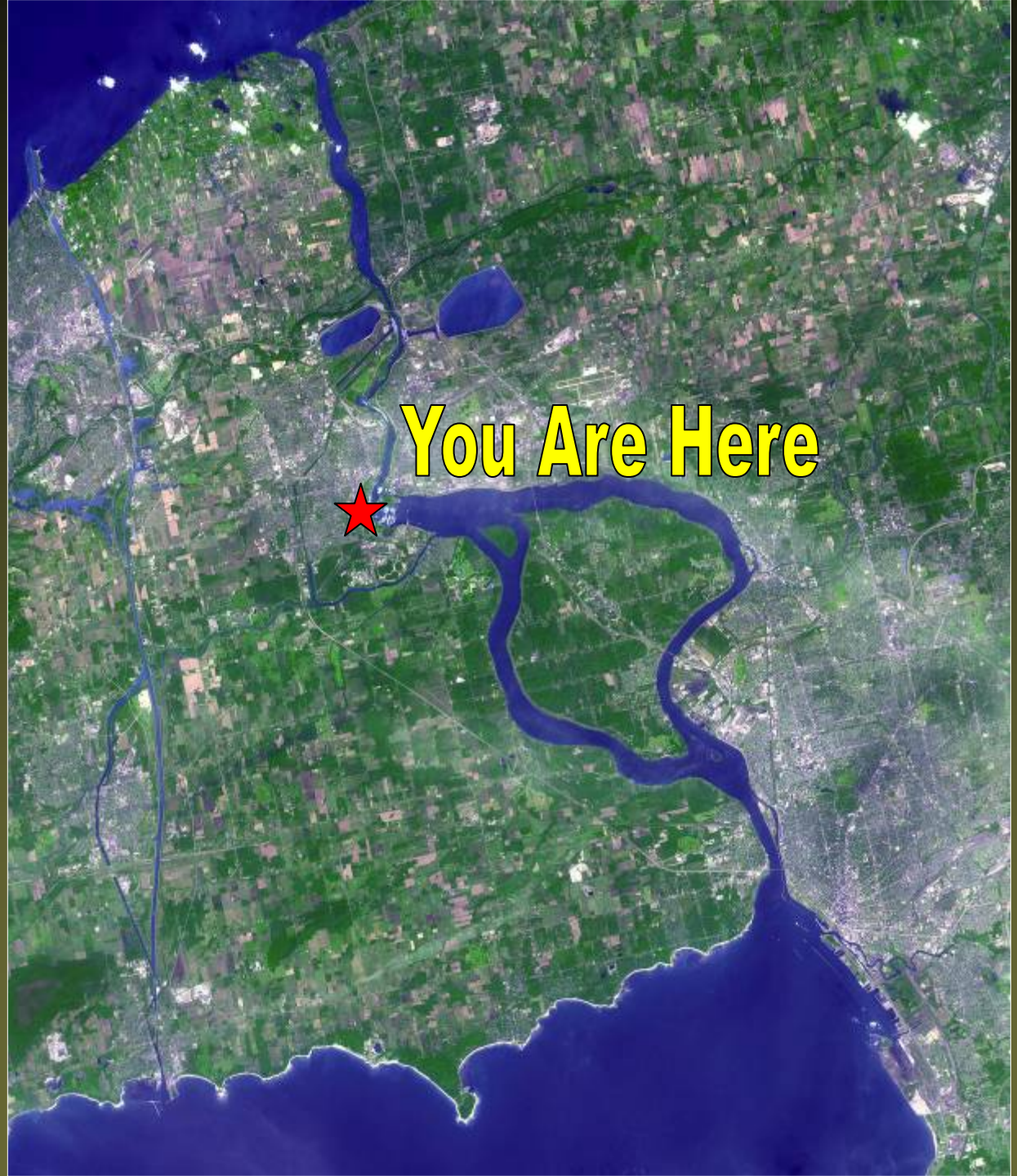
Niagara River

Brad Hill
Environment Canada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Background

- Created by Wisconsin glaciation, about 10,000 years ago
- Approximately 56 km (35 mi) long
- Peak season flow ~ 5,720 m^3/s (200,000 ft^3/s)
- Total drainage area ~ 684,000 sq km (264,000 sq mi)
- Empties approx. 2/5^{ths} of the fresh water in North America
- Currently divert 50% - 75% of flow for power generation

Historical Context

- 1950s: IJC reports on pollution problems
- 1973: IJC designates Niagara River as “Problem Area”
- Late 1970s: Love Canal
- 1980 & 1981: Canada/Ontario Review Board Baseline Reports summarize environmental conditions in the Niagara River
- 1981: IJC Special Report on Pollution of the Niagara River
- 1981 – 1983: Niagara River Toxics Committee report
- 1987: Niagara River Declaration of Intent - NRTMP
- 1996: “Letter of Support”

Programs

- 3 main components:
  - Upstream/Downstream
    - Water and suspended sediment
  - Biomonitoring
    - Mussels and fish
  - Tributary screening & trackdown
    - Sediment investigations in tributaries
- Additional components:
  - Point & Non-point Sources
    - Landfills, STPs, HWS

Objectives

- Establish the existence and relative concentrations of contaminants
- Distinguish between Niagara River contaminant sources and upstream sources
- Identify exceedences to existing criteria
- Examine long term trends
- Quantify loadings to Lake Ontario
- Measure concentrations in fish, mussels and other wildlife

1,3-Dichlorobenzene
1,3,5-Trichlorobenzene
1,2,3,4-Tetrachlorobenzene
Hexachlorobutadiene
Aldrin
p,p'-DDD
DDT Total
α-BHC
Total Chlordane
Dieldrin
Methoxychlor
1-Methyl Naphthalene
Fluorene
Beta-Chloronaphthalene
Fluoranthene
Chrysene/Triphenylene
Indeno(1,2,3-c,d)pyrene
Aluminum
Barium
Cadmium
Copper
Iron
Molybdenum
Rubidium
Strontium
Vanadium

1,4-Dichlorobenzene
1,2,4-Trichlorobenzene
Pentachlorobenzene
Hexachlorocyclopetadiene
Octachlorosytrene
o,p'-DDT
Photomirex
γ-BHC
α-Endosulfan
Endrin
TCPCB
Naphthalene
Phenanthrene
Atrazine
Pyrene
Benzo(b+k)fluoranthene
Dibenzo(a,h)anthracene
Antimony
Boron
Cobalt
Gallium
Lithium
Nickel
Selenium
Tellurium
Zinc

1,2-Dichlorobenzene
1,2,3-Trichlorobenzene
Hexachlorobenzene
Heptachlor
p,p'-DDE
p,p'-DDT
Mirex
Heptachlor Epoxide
β-Endosulfan
Endrin Aldehyde
2-Methyl Naphthalene
Acenaphthylene
Anthracene
Metolachlor
Benz(a)anthracene
Benzo(a)pyrene
Benzo(g,h,i)perylene
Arsenic
Beryllium
Chromium
Lanthanum
Manganese
Lead
Silver
Uranium
Mercury

Hexachlorobenzene

p,p’-DDE
p,p’-DDT
DDT Total
Mirex

Total Chlordane
Dieldrin

TCPCB

Benz(a)anthracene
Chrysene/Triphenylene
Benzo(b+k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-c,d)pyrene
Benzo(g,h,i)perylene
Aluminum

Iron

Mercury

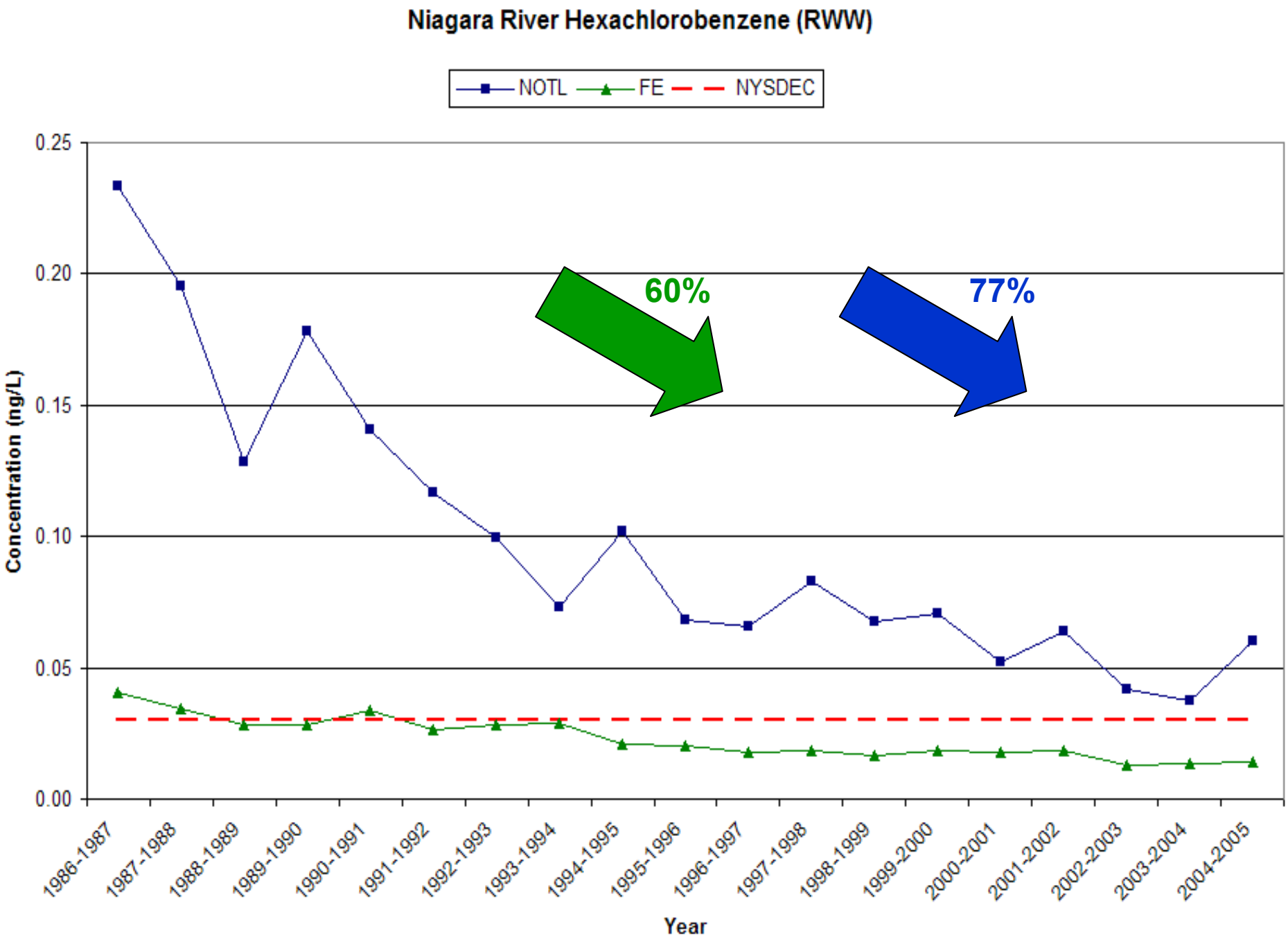
Hexachlorobenzene

Mirex

Chrysene/Triphenylene

Benzo(a)pyrene

Iron


Niagara River Hexachlorobenzene (RWW)
NOTL
FE
NYSDEC
60%
77%
Concentration (ng/L)
0.25
0.20
0.15
0.10
0.05
0.00
1986-1987
1987-1988
1988-1989
1989-1990
1990-1991
1991-1992
1992-1993
1993-1994
1994-1995
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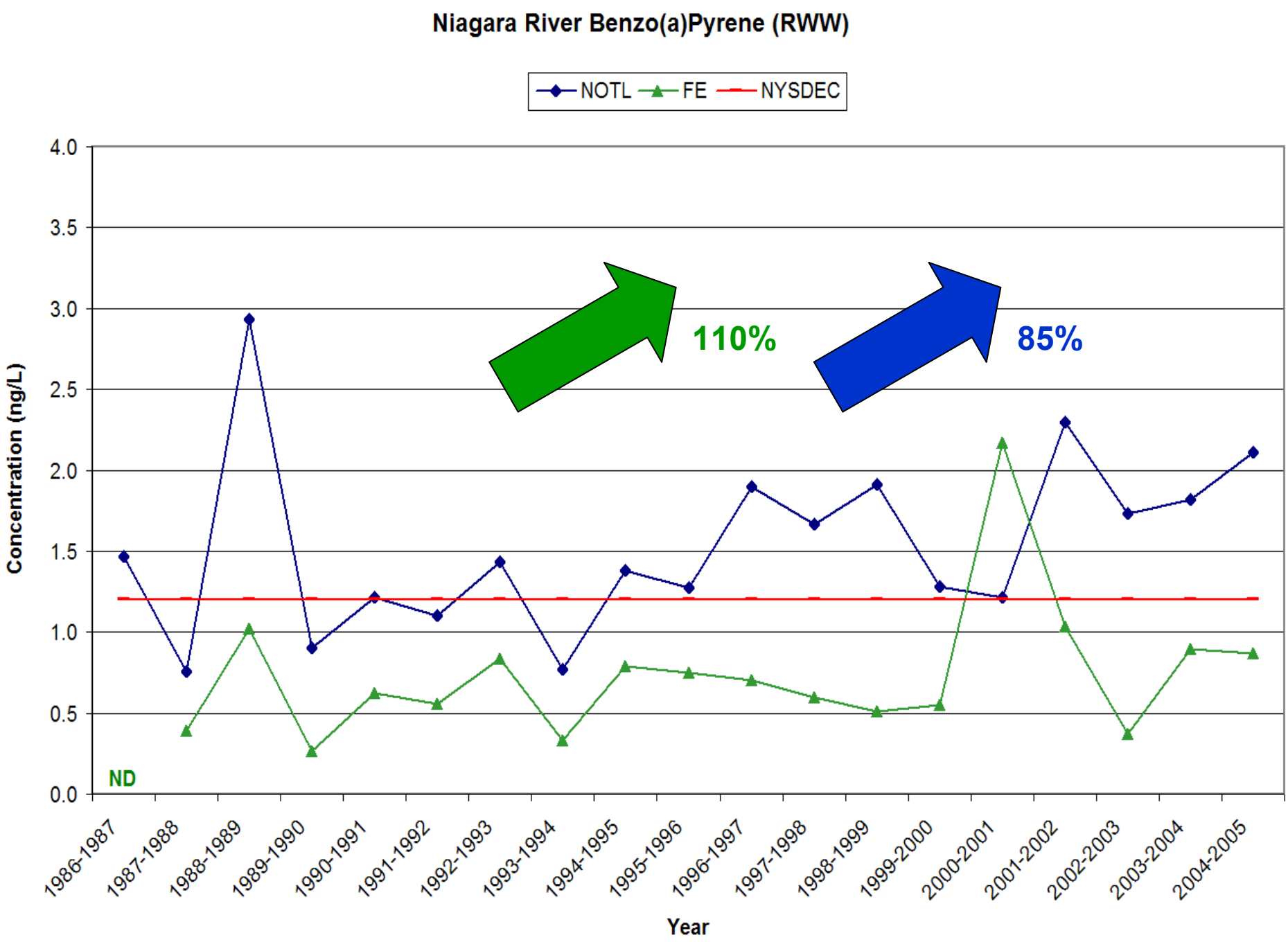
2002-2003
2003-2004
2004-2005
Year


Niagara River Benzo(a)Pyrene (RWW)
NOTL
FE
NYSDEC
110%
85%
ND
Concentration (ng/L)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1986-1987
1987-1988
1988-1989
1989-1990
1990-1991
1991-1992
1992-1993
1993-1994
1994-1995
1995-1996
1996-1997
1997-1998
1998-1999
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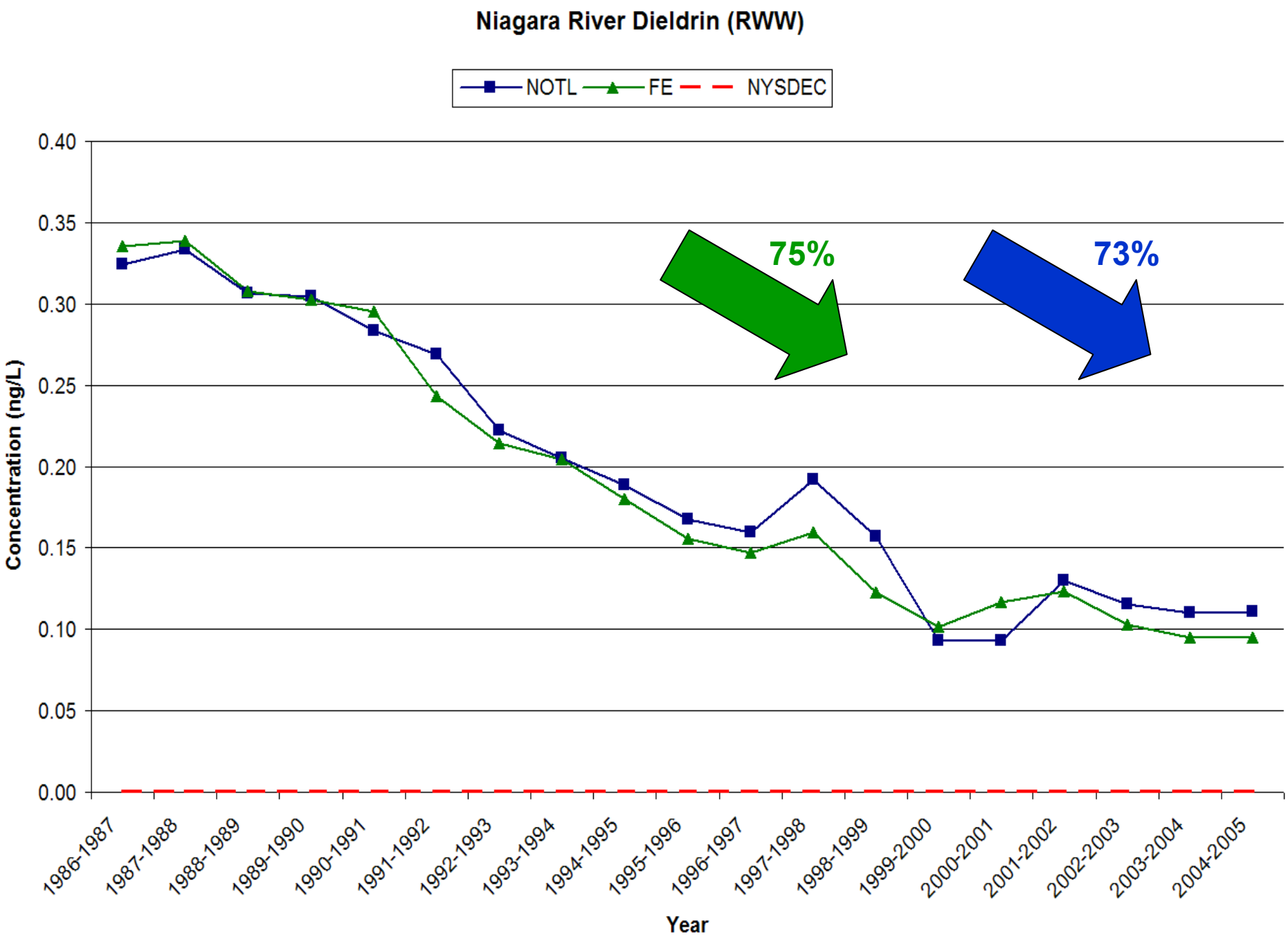
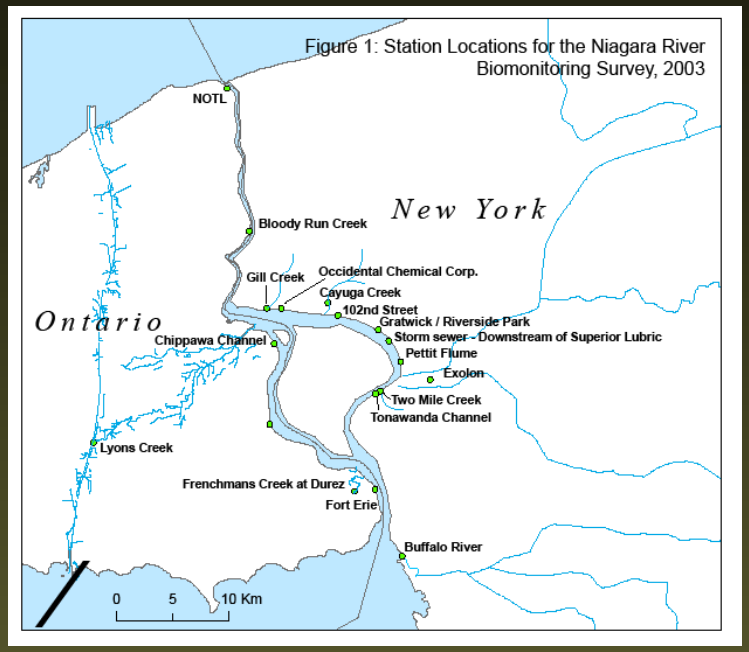
2001-2002
2002-2003
2003-2004
2004-2005
Year


Niagara River Dieldrin (RWW)
NOTL
FE
NYSDEC
75%
73%
Concentration (ng/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1986-1987
1987-1988
1988-1989
1989-1990
1990-1991
1991-1992
1992-1993
1993-1994
1994-1995
1995-1996
1996-1997
1997-1998
1998-1999
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
Year

Biomonitoring

- Contaminant sources within the River as well as basin-wide
- Potential watershed sources for:
  - HCB, PAHs, Dioxins/Furans
- Wildlife criteria exceedences of:
  - PCB, DDT, Mirex and Photomirex
  - Most likely related to residual sediment contamination



- Fish consumption advisories continue
  - Species and location specific (PCBs, Dioxins/Furans, Mirex, Mercury)
- Total PCBs and total DDT levels are declining
- Mercury was detected at concentrations similar to other sites in the Great Lakes

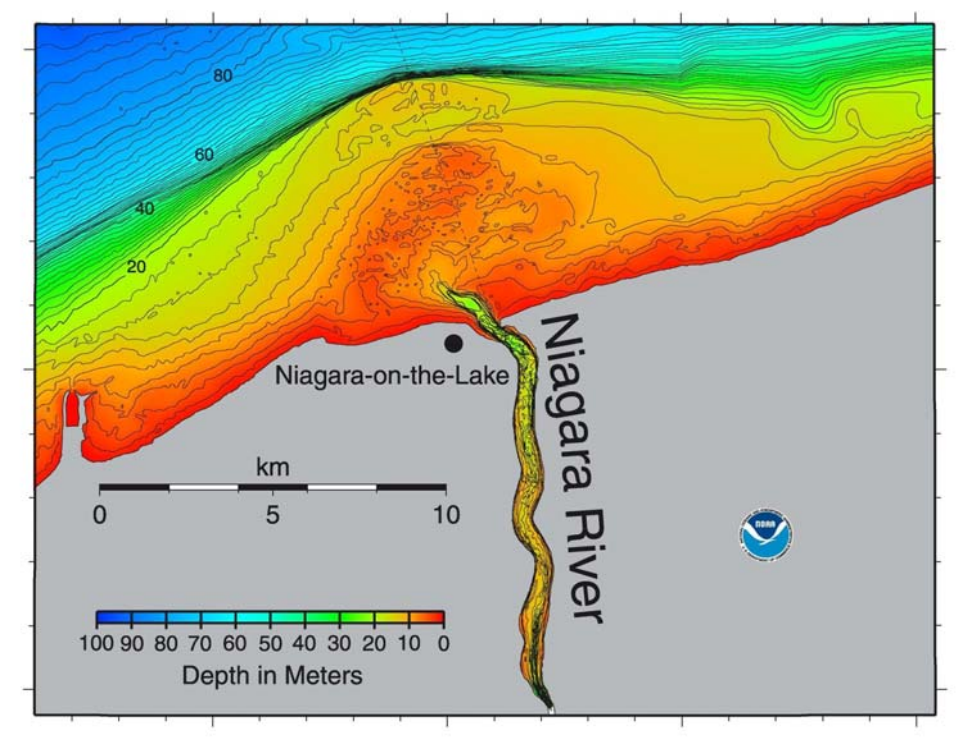
Tributary Screening

- DEC/EPA study of 4 tributaries in 2004
- No “hot spots” found that trigger immediate action
- Certain areas may deserve further attention
  - Guideline exceedences of PCBs, Mercury, Lindane and Zinc
  - Low levels and non-detects validate effectiveness of remediation
- On going monitoring by MOE and assessment by RAP show some tributaries may no longer be sources of contaminants

Monitoring Summary

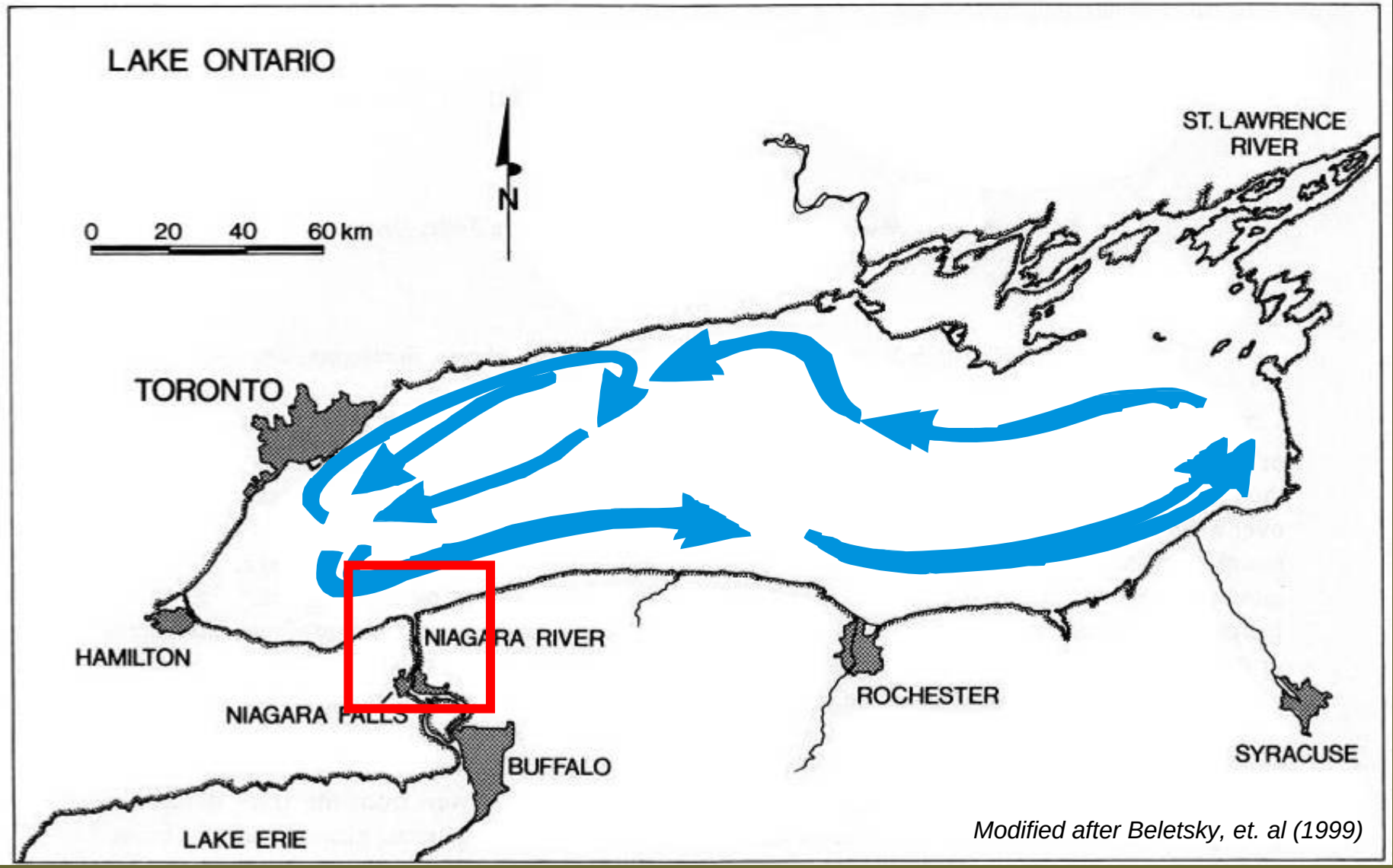
- Significant decreases in concentrations for most compounds between 1986 and 2005
- Some compounds still exceed strictest agency criteria
- Local sources continue to contribute contaminants to the Niagara River
- Upstream and/or basin-wide sources may be more significant for certain chemicals

Niagara's Influence On Lake Ontario



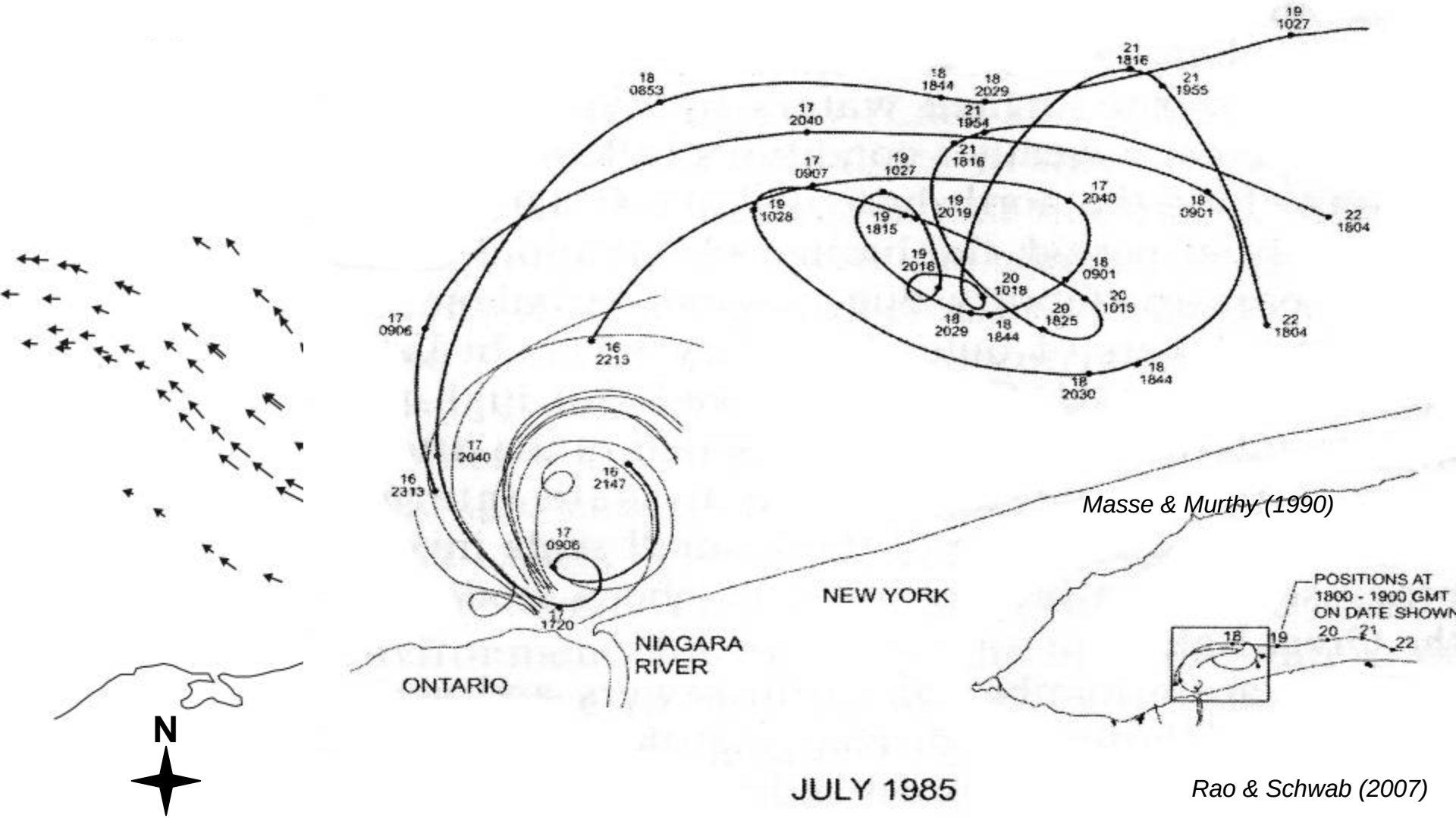
- *>80% input water budget*
- *~50% incoming fine grain sediment*
- *a primary source of contaminants*

Lake Ontario Circulation



Modified after Beletsky, et. al (1999)

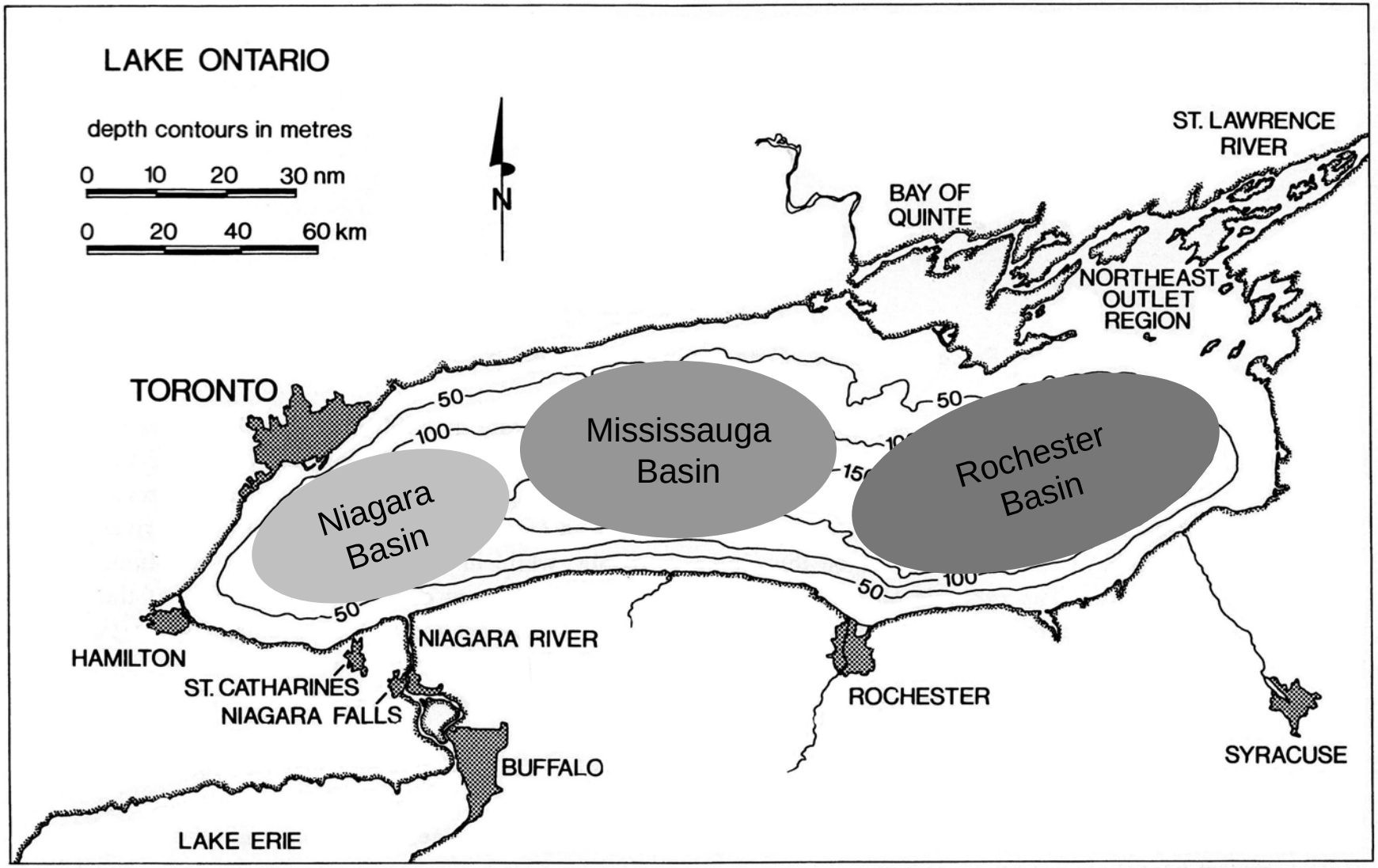
Lake Ontario Circulation



Masse & Murthy (1990)

Rao & Schwab (2007)

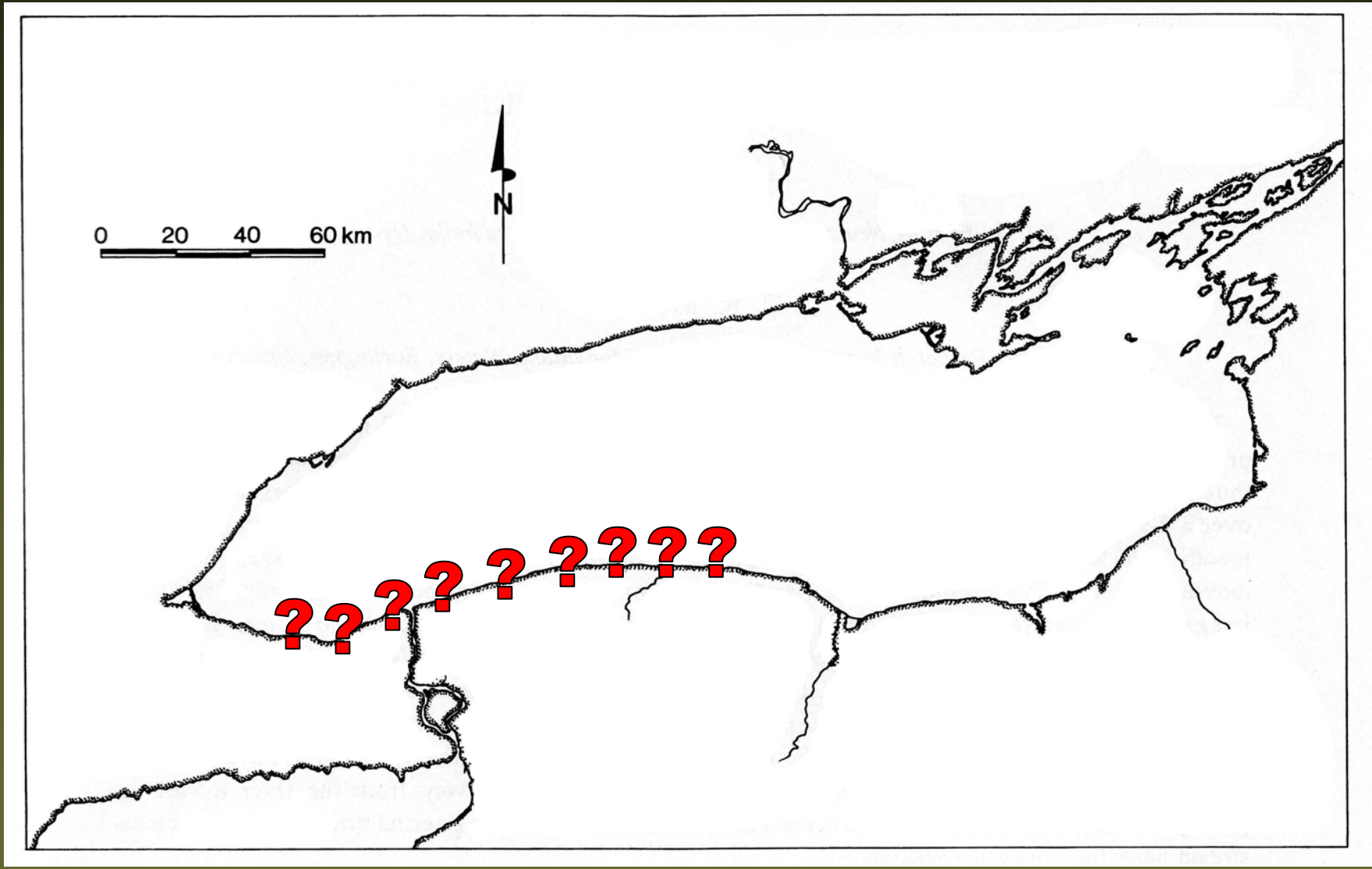
Lake Ontario Bathymetry

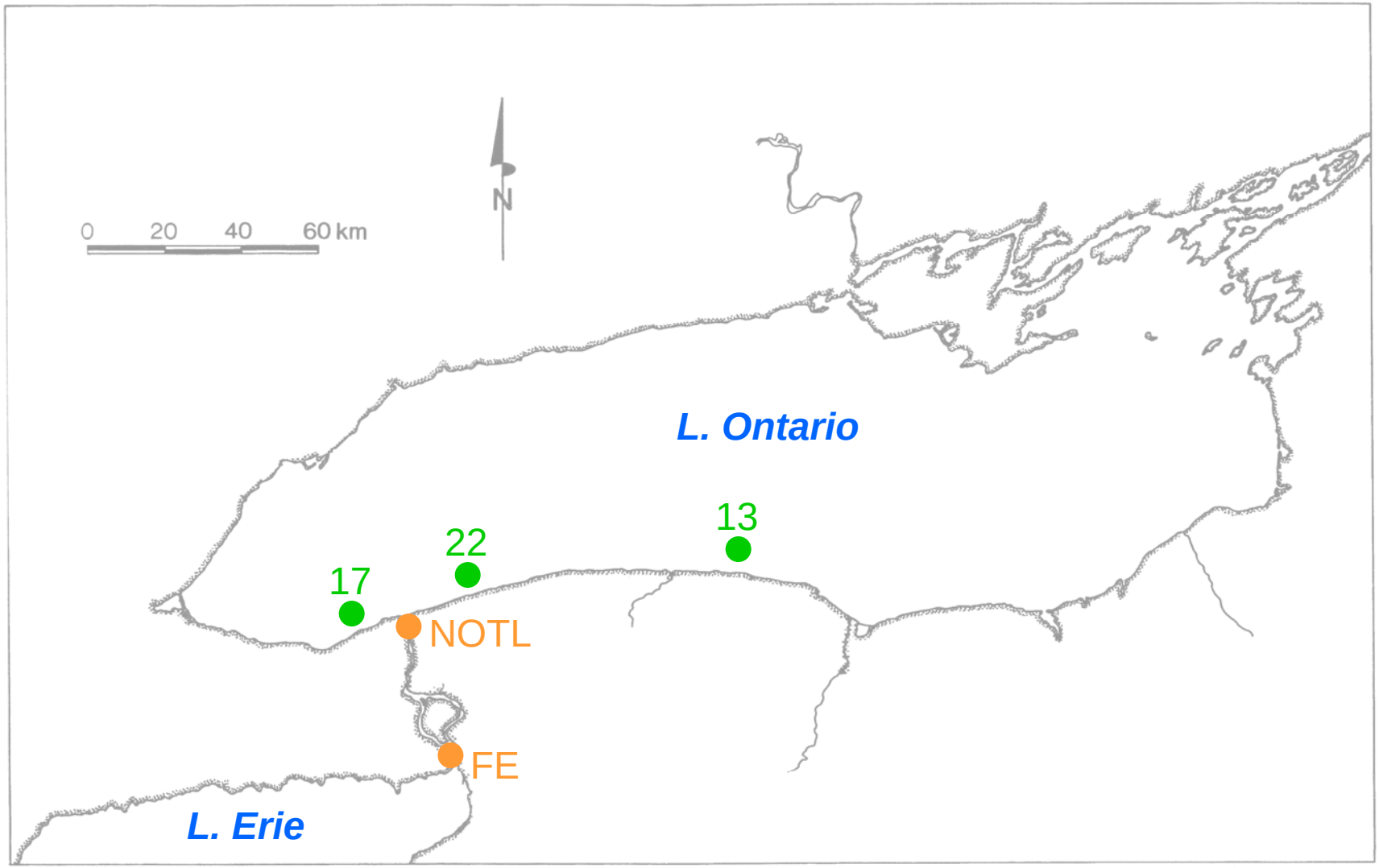


Phase Distribution

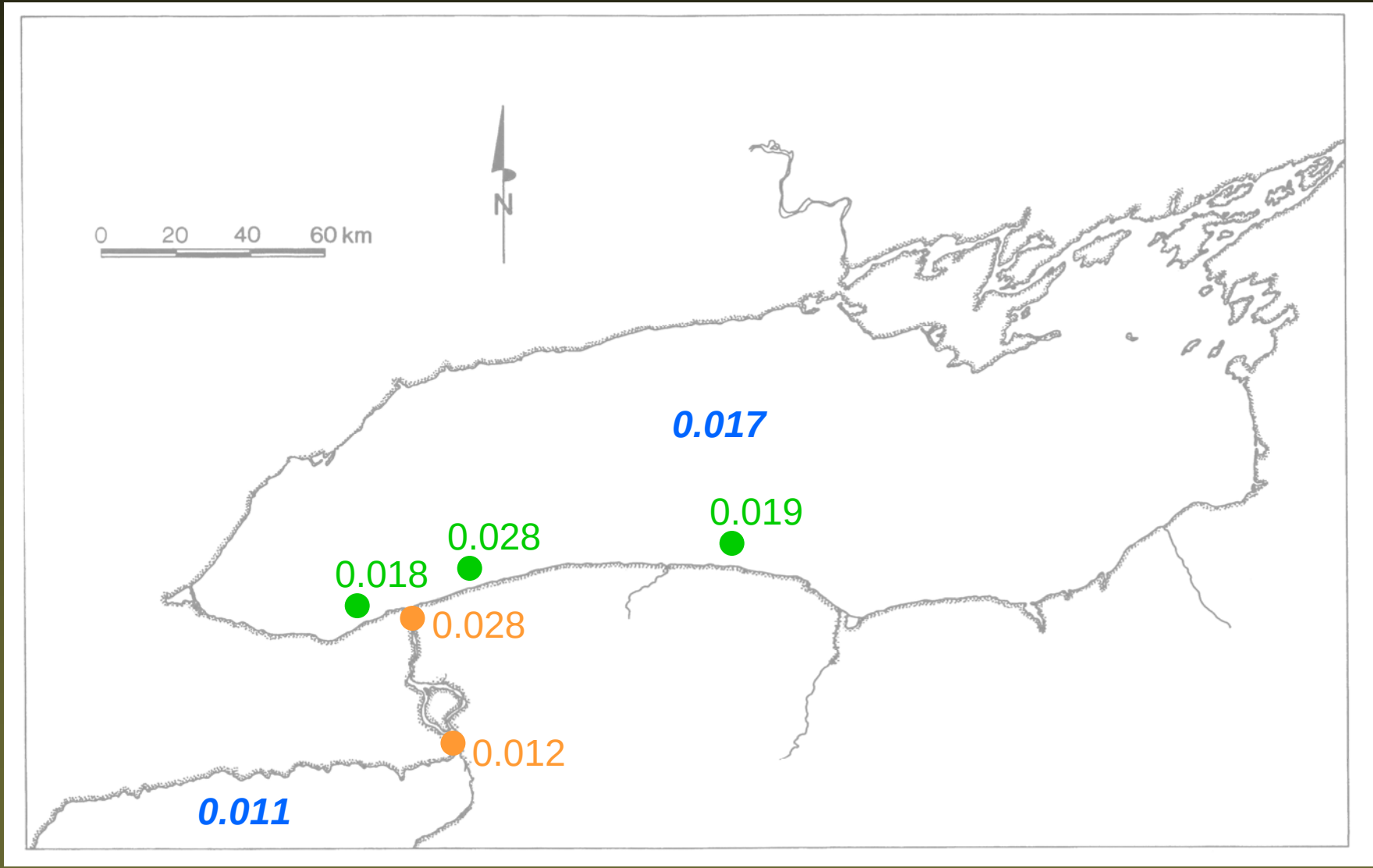
Compound	% in dissolved phase	% in particulate phase
Mirex	0	100
Benzo(a)pyrene	6	94
1,2,4-TCB	90	10
Dieldrin	94	6
1,2,3,4-TTCB	95	5
Atrazine	100	0
Metolachlor	100	0

Current Knowledge

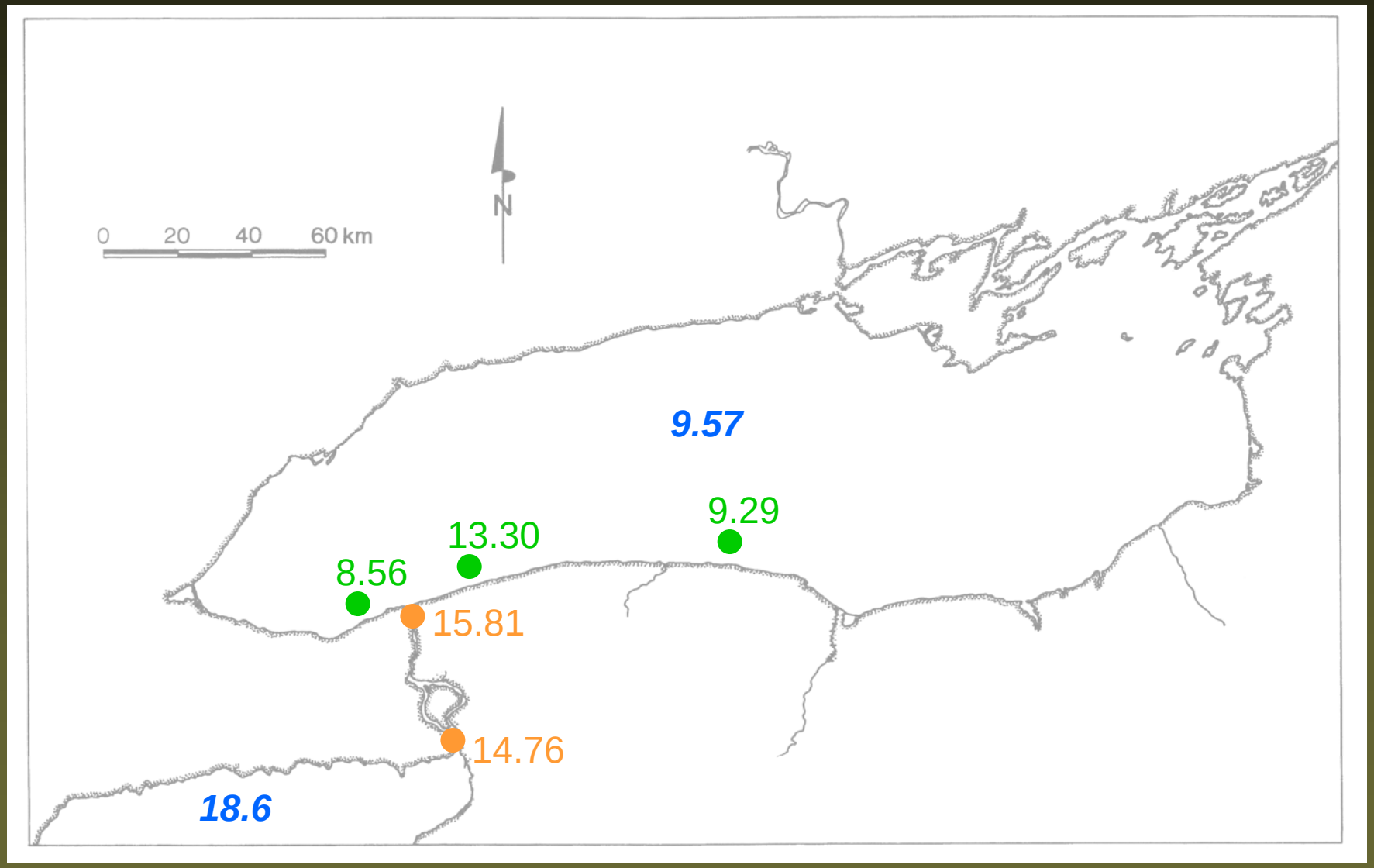



0 20 40 60 km
N
L. Ontario
13
22
17
NOTL
FE
L. Erie

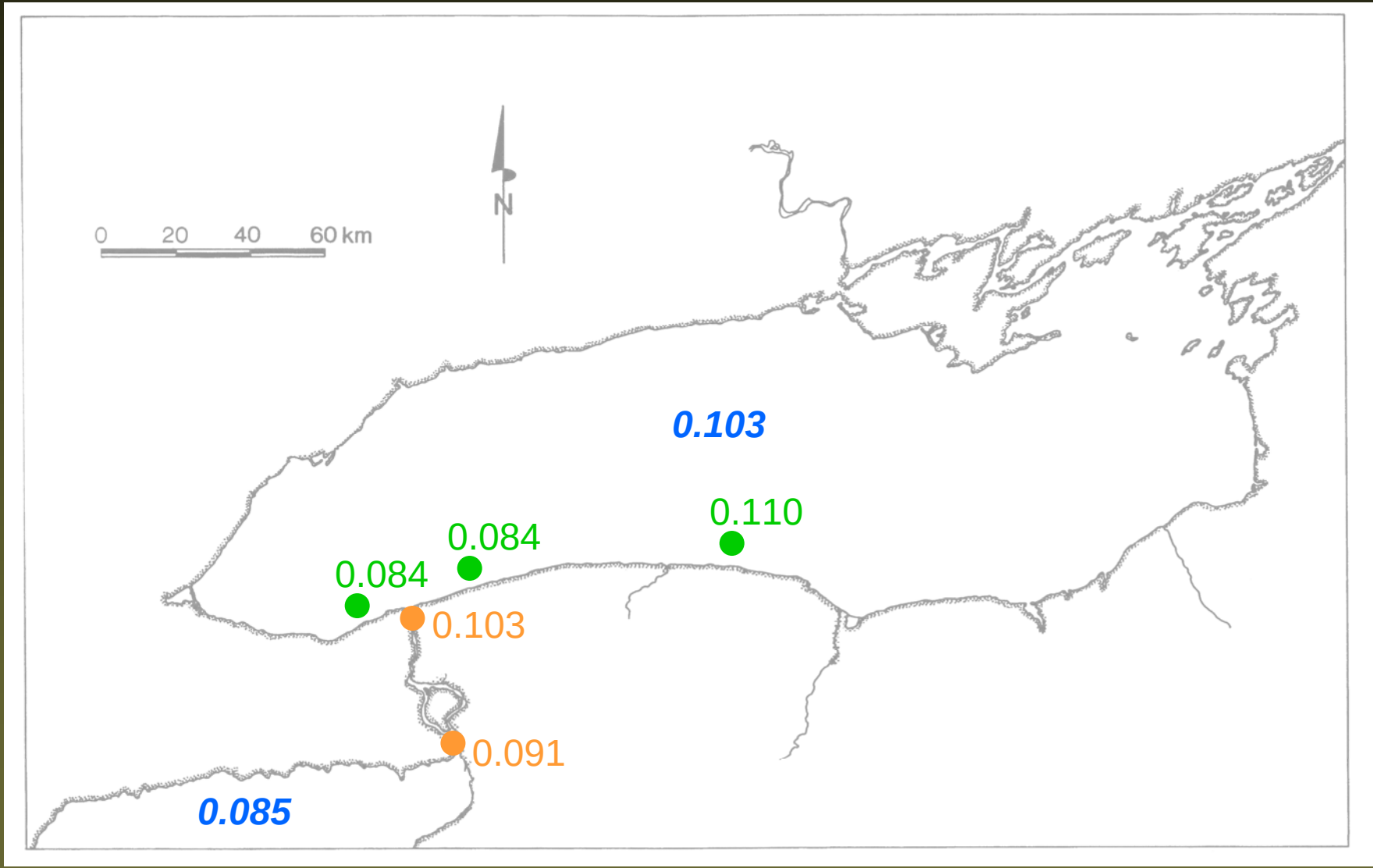
Hexachlorobenzene (ng/L)



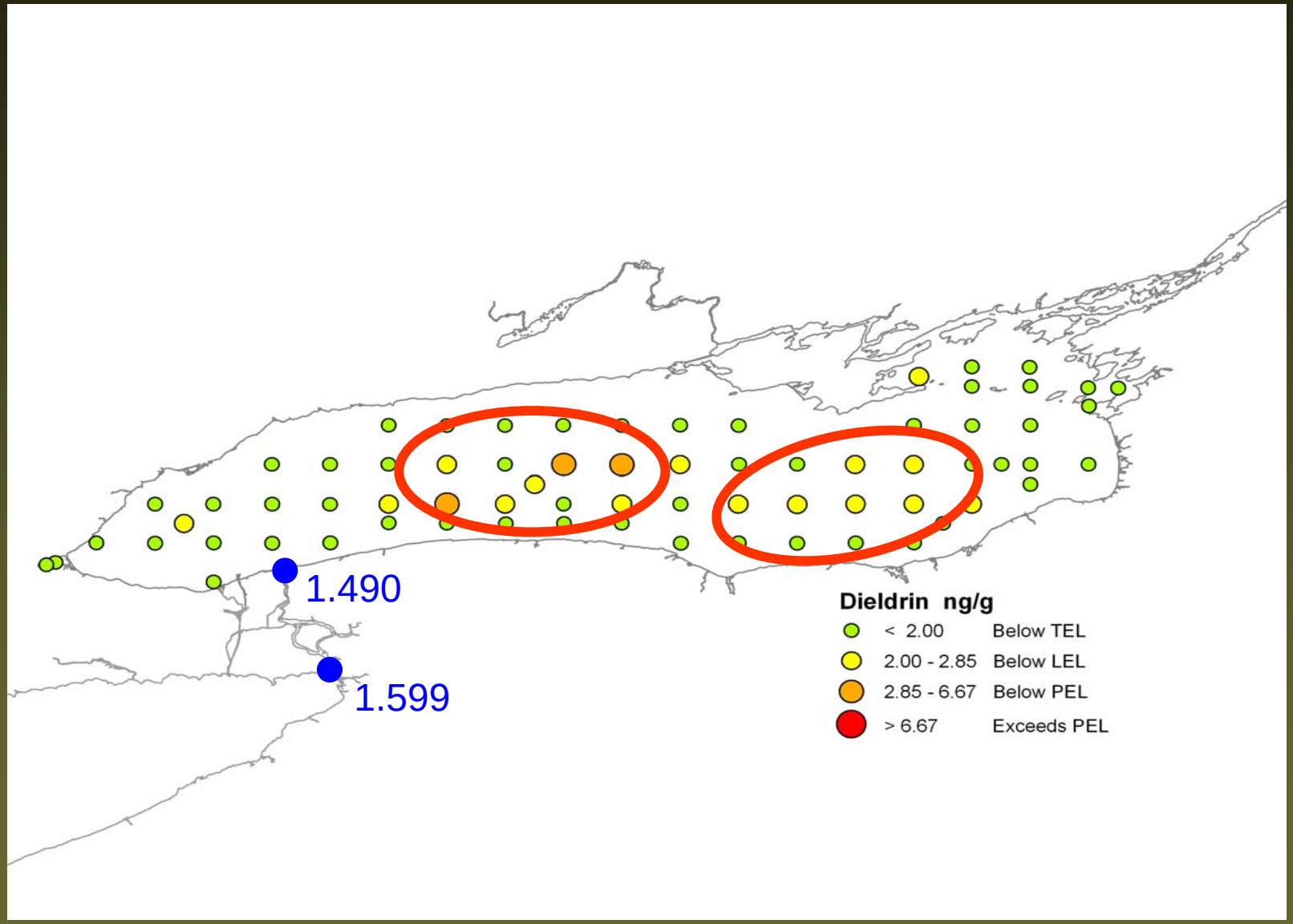
Metolachlor (ng/L)



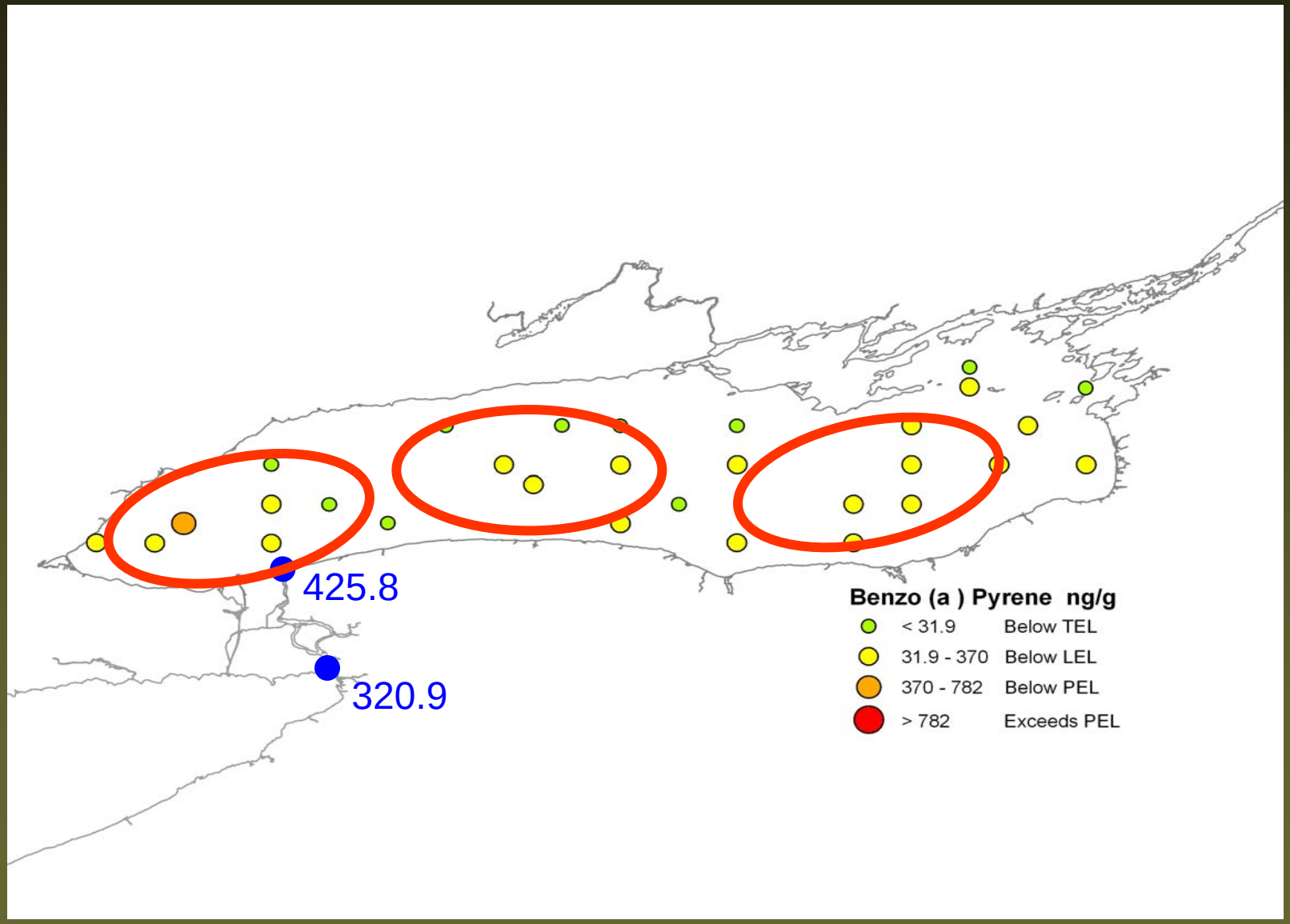
Dieldrin (ng/L)



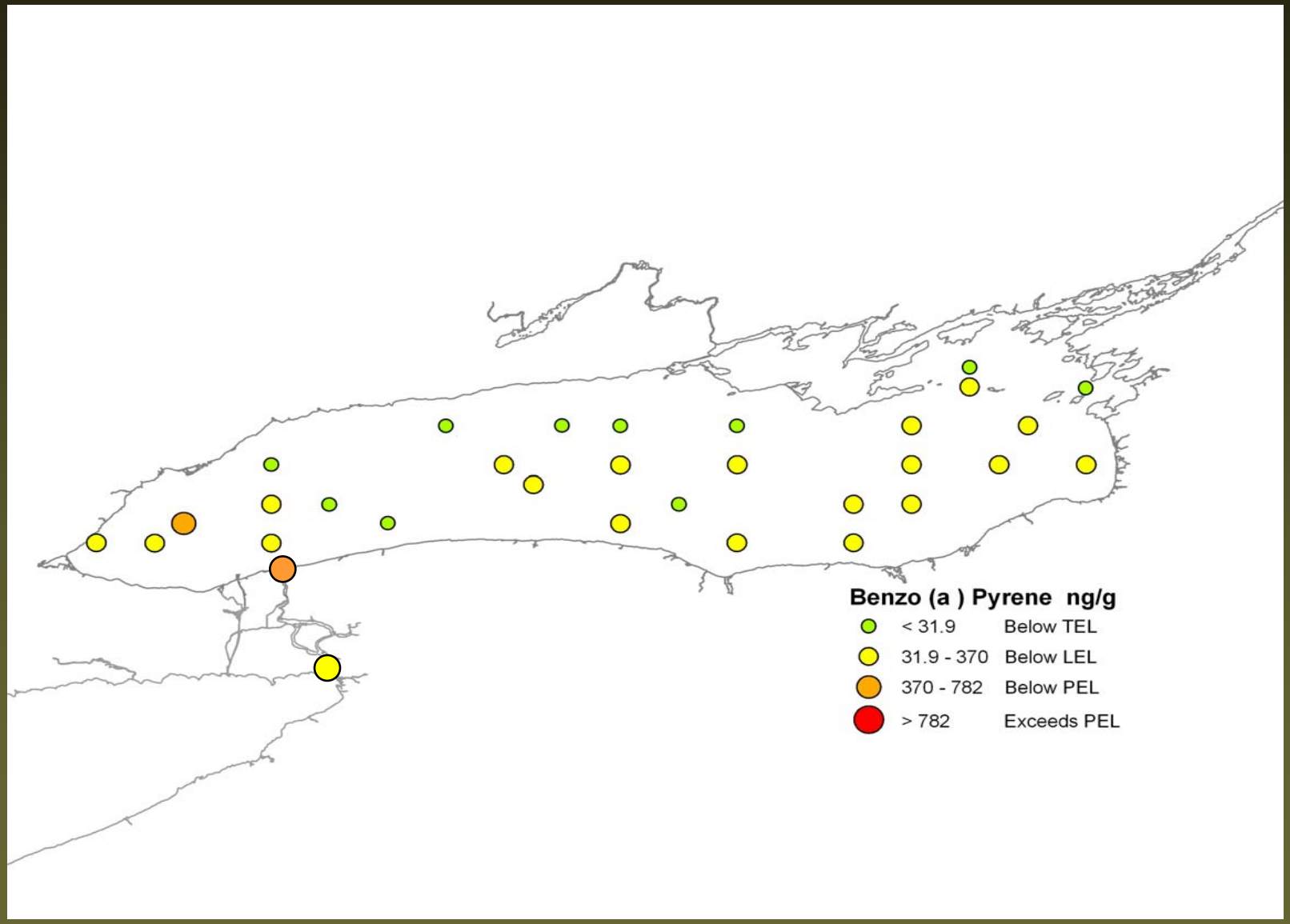
Dieldrin (ng/g)



Benzo(a)pyrene (ng/g)



Benzo(a)pyrene (ng/g)



Conclusions

- Niagara River is the primary source of water and a significant source of fine grain sediment for Lake Ontario
- Niagara River has been significantly impacted by contaminants
- Contamination levels in the Niagara River have been reduced over the past two decades
- There is insufficient data to establish a firm influence of the Niagara River on nearshore contaminant levels
- Dissolved phase contaminants appear to show higher concentrations in the nearshore zone
- Evidence suggests majority of sediment bound contaminants are found in offshore depositional areas

Future Directions

- More analysis with existing data sources
- Nearshore monitoring
- Current suite of compounds
- New & emerging compounds
- Future of the NRTMP

Acknowledgements

- Water Quality Monitoring & Surveillance
- EC, OMOE, NYSDEC, USEPA, DFO
- Niagara River Secretariat
- River Monitoring Committee