

# Temporal and spatial trends in Herring Gull eggs from Lake Ontario, 1974-2005.



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***Chemical Component for the Lower Foodweb  
and Fish and Wildlife Assessment :2008  
Lake Ontario Monitoring Plan  
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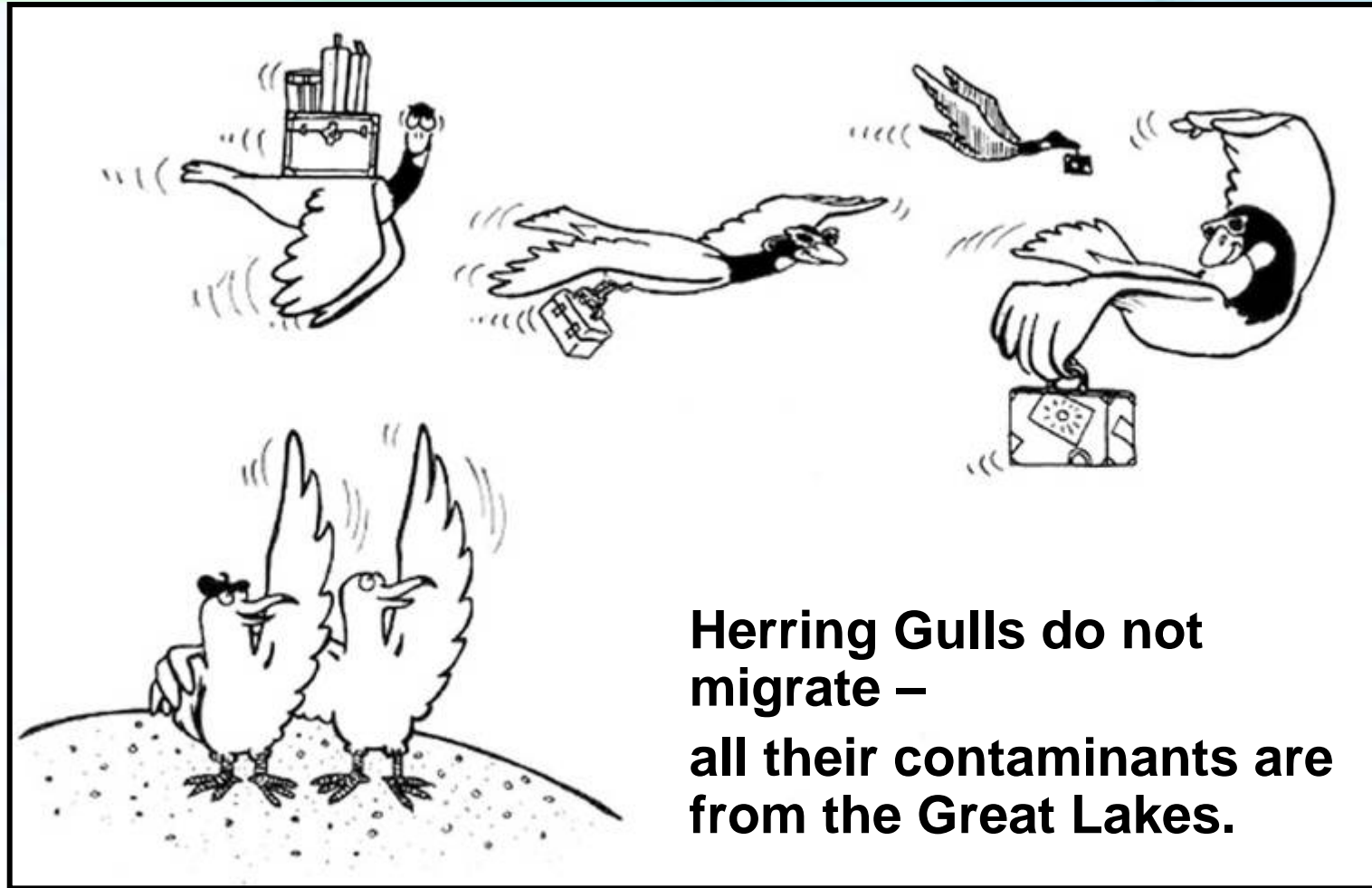
# The Herring Gull (*Larus argentatus*)

## Why is it a good indicator species?

- Breeds on all five Great Lakes
- Fish eater at top of food chain
- High egg lipid content
- Accumulates contaminants and is relatively insensitive
- Well studied and visible to the public



# But most importantly...



**Herring Gulls do not migrate –  
all their contaminants are from the Great Lakes.**



# Herring Gull colony



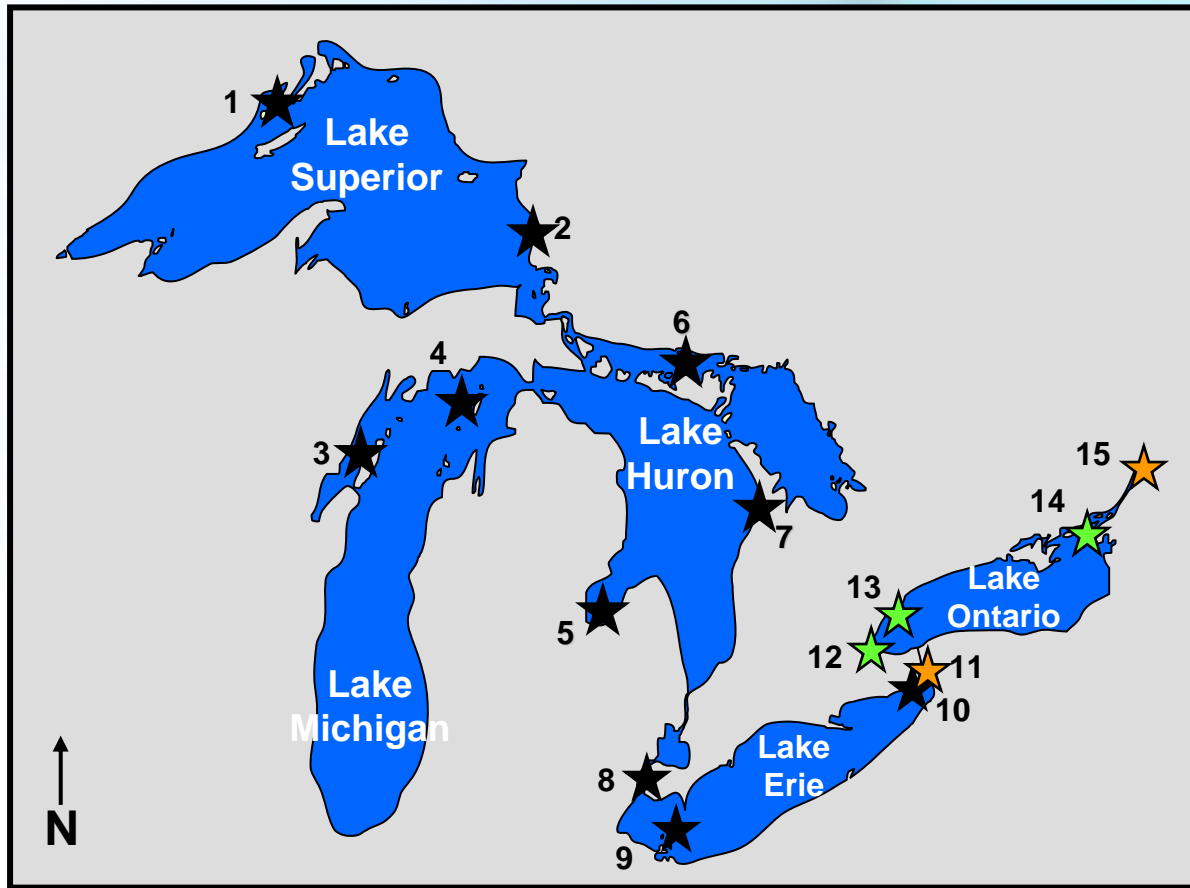
*Leslie St. Spit, Toronto Harbour*



*Scotch Bonnet Island*



# Annually Monitored Colonies



1. Granite I.
2. Agawa Rks.
3. Big Sister I.
4. Gull I.
5. Channel-Shelter I.
6. Double I.
7. Chantry I.
8. Fighting I.
9. Middle I.
10. Port Colborne
11. Niagara R.
12. Hamilton Hrbr.
13. Toronto Hrbr.
14. Snake I.
15. Strachan I.

# Egg collections

13 eggs (1 per complete clutch) from each site are collected in late April/early May



# Contaminant analysis

**1974 – 1986:** eggs analyzed individually (n=150/yr)

**1987 – present:** eggs analyzed as site pools (n=15/yr)

## Over 75 compounds and congeners measured:

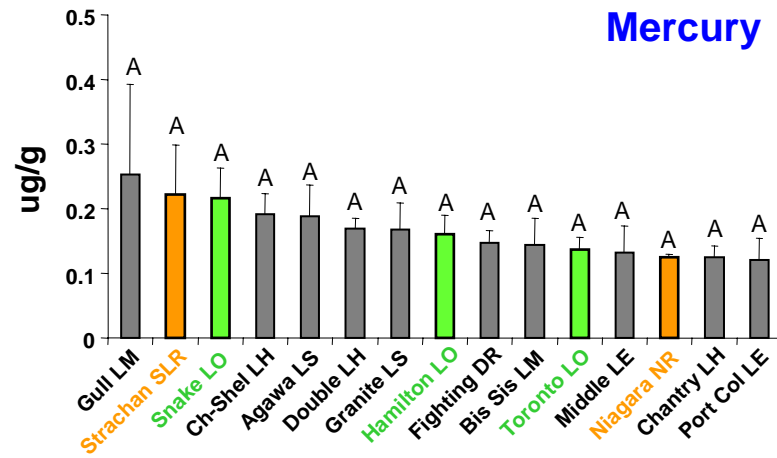
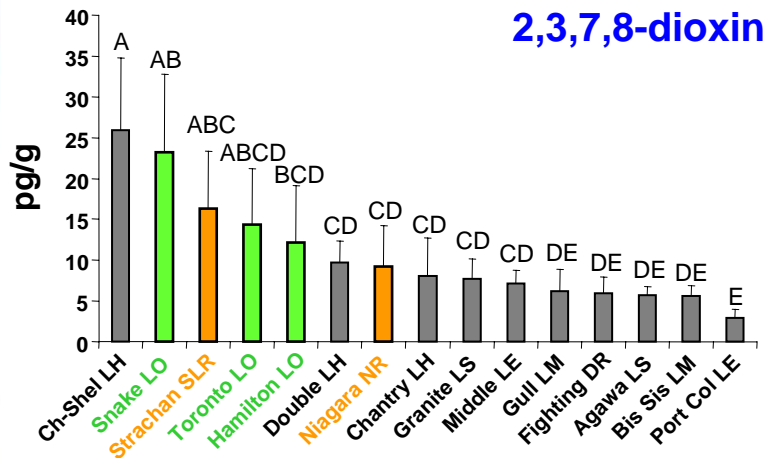
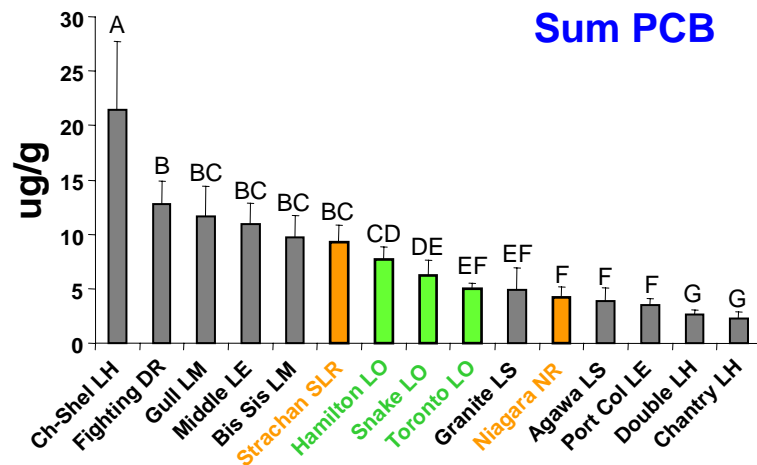
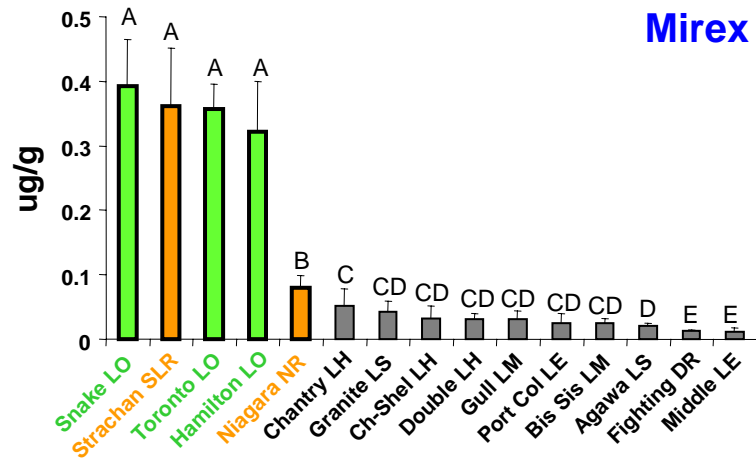
- organochlorines
- PCBs
- dioxins and furans
- PBDEs
- mercury



# Spatial analysis, 1998-2002

- mean contaminant concentrations calculated for the five year period, 1998-2002.
- means ranked from **1 (most)** to **15 (least)** contaminated).
- ranks were weighted with a measure of contaminant toxicity using fish flesh contaminant guidelines for the protection of piscivorous wildlife (*Newell et al. 1987*).
- ANOVA, with Student-Neuman-Keuls (SNK) multiple means test to assess differences among colonies.

# Contaminant spatial patterns, 1998-2002



\* Colonies with the same letter are not significantly different (SNK test,  $\alpha = 0.05$ )

# Overall spatial rankings, 1998-2002

Weseloh et. al, 2006 Environ. Monitor. Assess. 113: 265-84

colony	water body	rank			grouping*
		mean (weighted)	range	relative	
5. Ch-Shelter I.	L. Huron	1.2	1-8	high	A
15. Strachan I.	St. Lawrence R.	5.2	2-15	medium	B
4. Gull I.	L. Michigan	5.3	1-11	↓	B
8. Fighting I.	Detroit R.	5.8	2-14		B
14. Snake I.	L. Ontario	5.8	1-13		B
12. Hamilton	L. Ontario	6.2	4-12		B
9. Middle I.	L. Erie	6.6	4-15		BCD
13. Toronto	L. Ontario	7.4	3-14		BC
3. Big Sister I.	L. Michigan	7.5	2-14		BCD
1. Granite I.	L. Superior	9.3	3-10		BCDE
11. Niagara R.	Niagara R.	9.9	2-14		BCDE
6. Double I.	L. Huron	11.3	5-14		low
2. Agawa Rk.	L. Superior	12.0	4-13	↓	DE
7. Chantry I.	L. Huron	12.7	6-15	↓	E
10. Port Colborne	L. Erie	13.8	12-15	↓	E

ranking scale:

1 = most contaminated

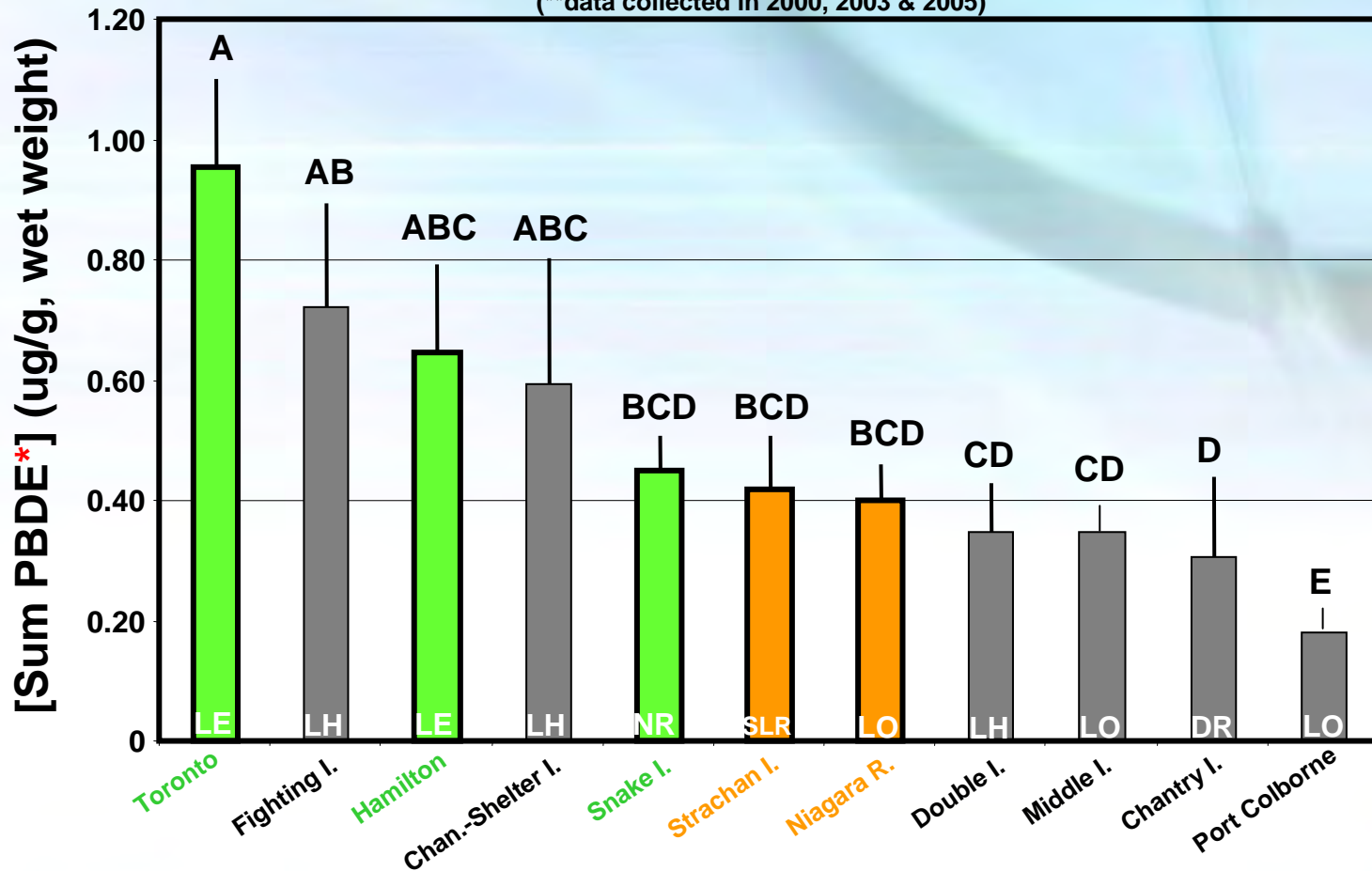
15 = least contaminated

\*colonies with the same letter are not significantly different (SNK test,  $\alpha = 0.05$ )

# Sum PBDE\* in Herring Gull eggs, 2000-2005\*\*

\* sum of 10 congeners: BDE-17, -28, -47, -66, -100, -99, -85, -153, -138, -183

\*\*data collected in 2000, 2003 & 2005



Colonies with the same letter are not significantly different (SNK test,  $\alpha = 0.05$ )

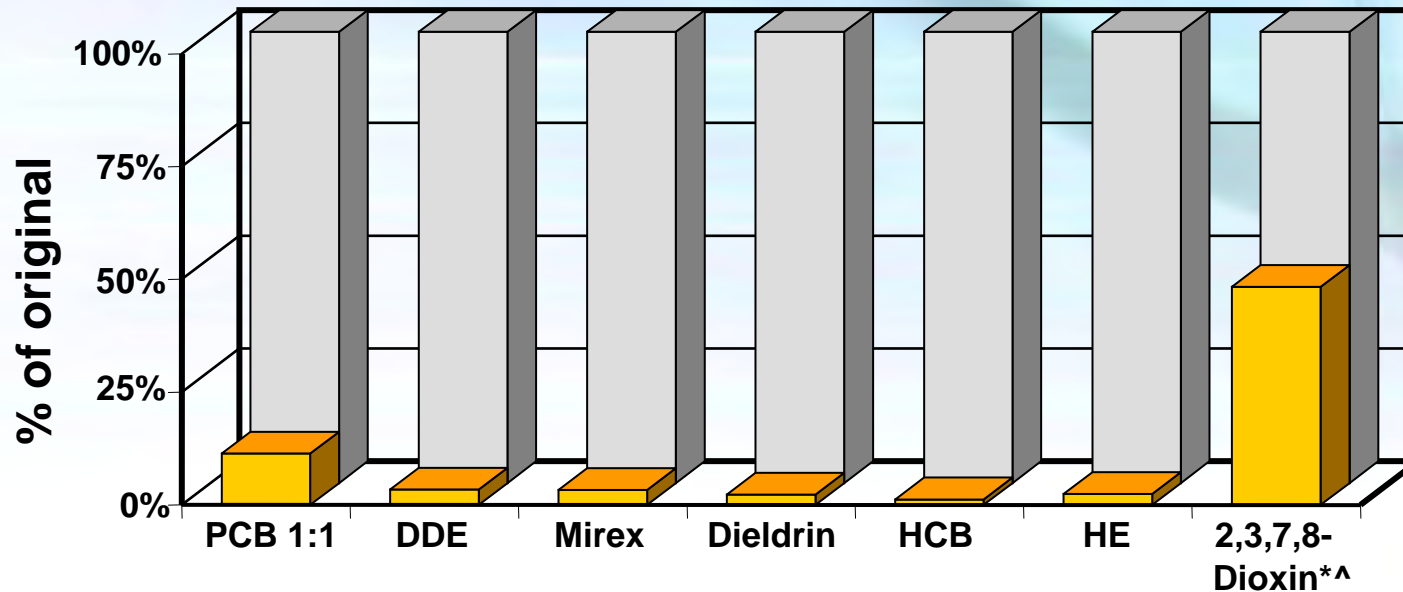


# Temporal trends



# % decline, 1981-2005\*, Hamilton Harbour

- Concentration ( $\mu\text{g/g}^\wedge$ , wet weight) measured in 1981\* set to 100%
- % of 1981\* concentration measured in 2005\* ( $\mu\text{g/g}^\wedge$ , wet weight)



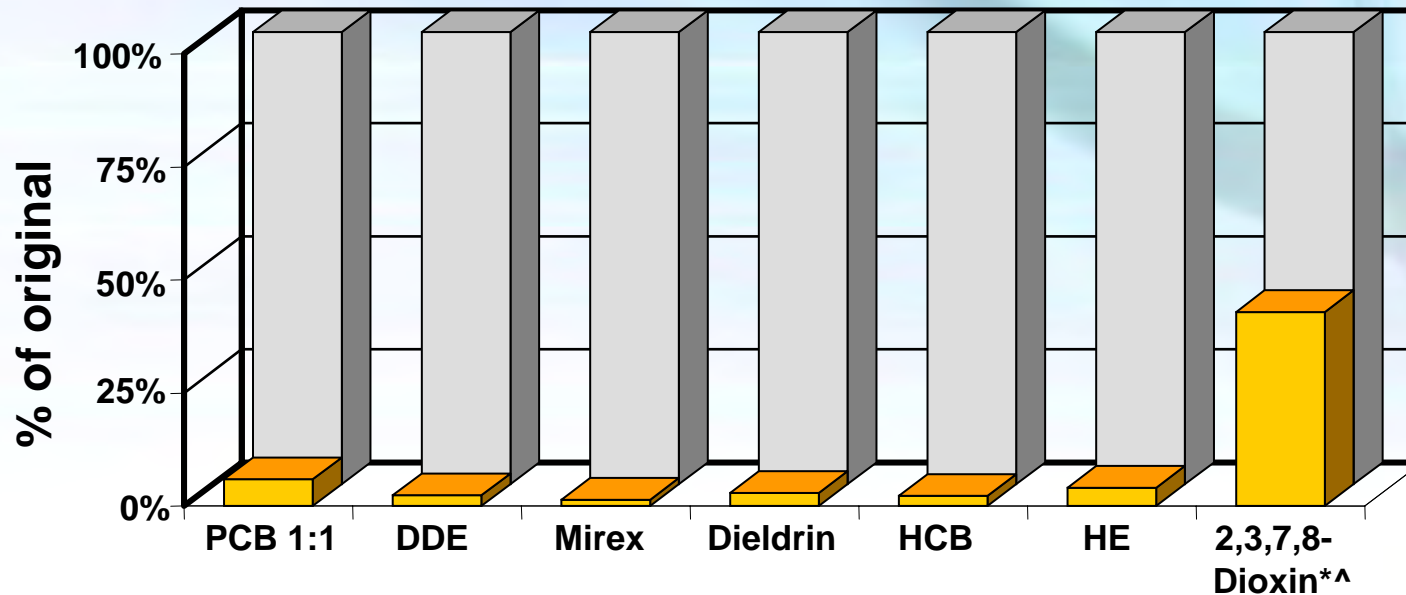
**% decline:**    89%    97%    97%    98%    99%    98%    52%    **mean = 89.7%**

\*dioxin first measured in 1984 and last measured in 2003

^dioxin measured in  $\text{pg/g}$ , wet weight

# % decline, 1974-2005\*, Toronto Harbour

- Concentration ( $\mu\text{g/g}^\wedge$ , wet weight) measured in 1974\* set to 100%
- % of 1974\* concentration measured in 2005\* ( $\mu\text{g/g}^\wedge$ , wet weight)



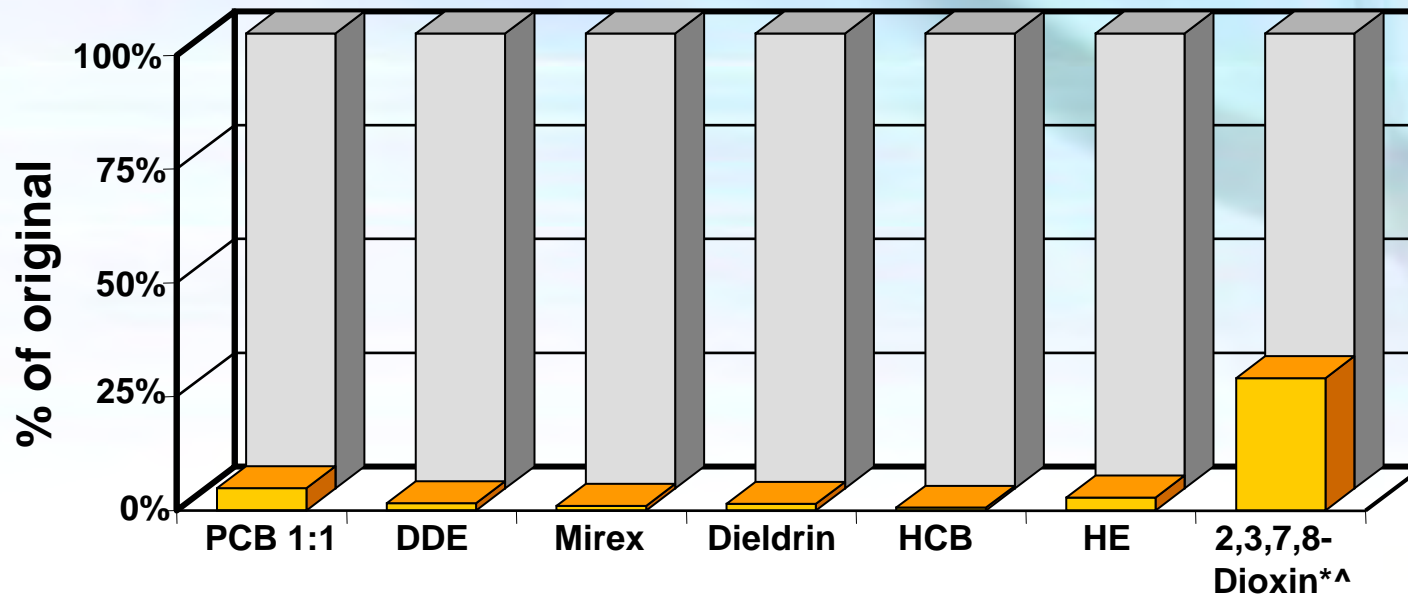
**% decline:**    94%    98%    99%    97%    98%    96%    57%    **mean = 91.2%**

\*dioxin first measured in 1984 and last measured in 2003

^dioxin measured in  $\text{pg/g}$ , wet weight

# % decline, 1974-2005\*, Snake Island

- Concentration ( $\mu\text{g/g}^\wedge$ , wet weight) measured in 1974\* set to 100%
- % of 1974\* concentration measured in 2005\* ( $\mu\text{g/g}^\wedge$ , wet weight)



**% decline:** 95% 98% 99% 99% 99% 97% 71% **mean = 94.1%**

\*dioxin first measured in 1984 and last measured in 2003

^dioxin measured in  $\text{pg/g}$ , wet weight



# Are contaminant levels still decreasing?

## Critics and skeptics say:

*“Most of the change in contaminant levels occurred in the 70s and 80s. Things have leveled off in the past decade.”*



# **To assess this, we use change-point regression:**

- 1. Determines if the rate of decline in contaminant concentrations has changed over time.**
- 2. A change-point year is detected when there is a significant change in contaminant concentrations and/or rate of decline.**

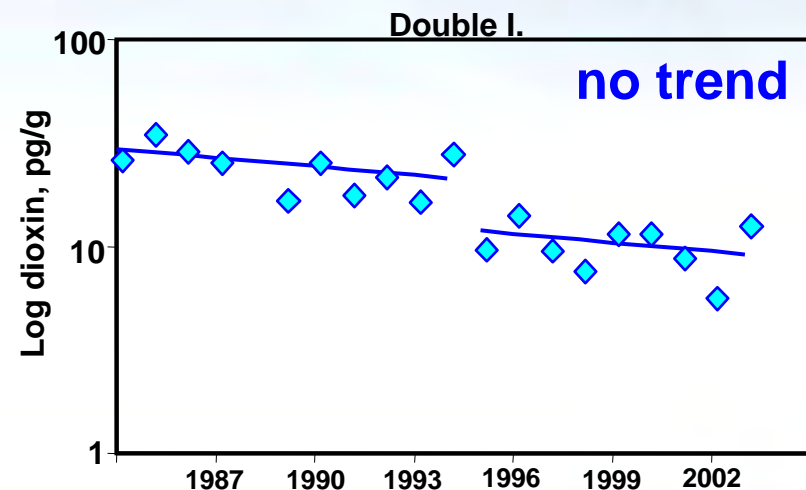
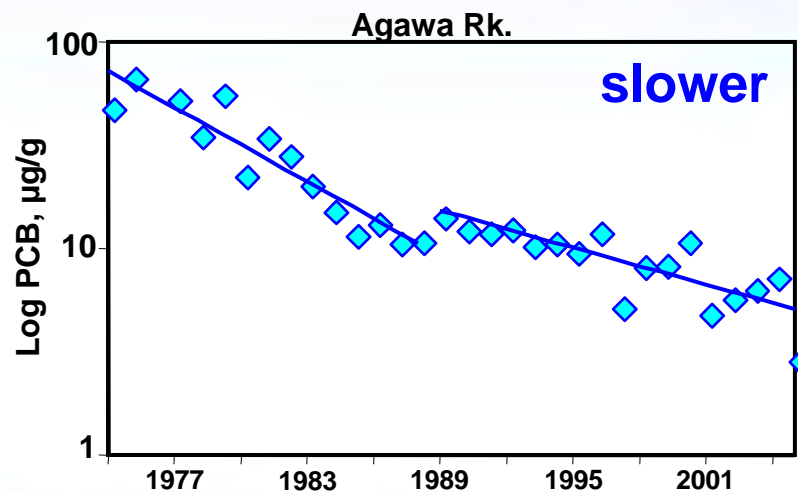
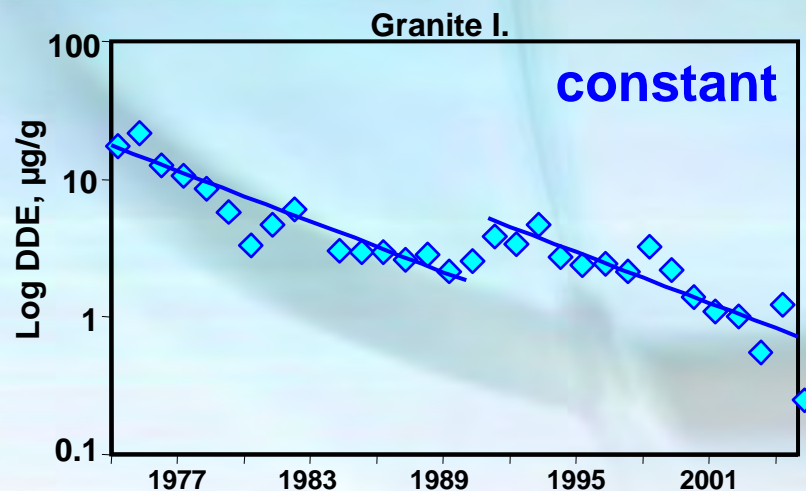
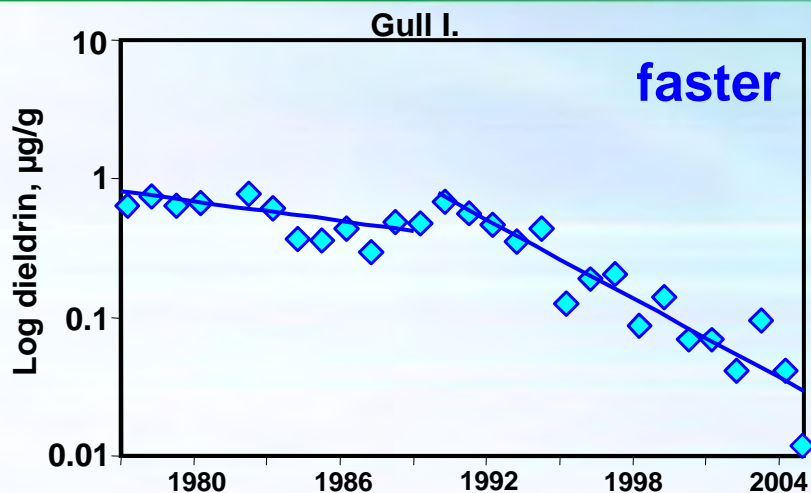


# Change-point regression analysis

7 compounds at 15 sites =  
105 contaminant-site comparisons

- PCBs
- DDE
- Mirex
- Hexachlorobenzene (HCB)
- Heptachlor epoxide (HE)
- Dieldrin
- 2,3,7,8-dioxin

# Change-point regression analyses - results fall into four categories:



year

# Change-point results summary to 2005

■ faster  
 ■ constant  
 ■ slower  
 ■ no trend

	DDE	Dieldrin	HE	HCB	Mirex	PCB	Dioxin*
Granite, L. Superior	constant	faster	faster	slower	slower	constant	no trend
Agawa, L. Superior	faster	constant	constant	constant	constant	slower	constant
Big Sis, L. Michigan	constant	constant	constant	constant	constant	constant	no trend
Gull, L. Michigan	constant	constant	constant	constant	constant	slower	faster
Ch-Shel, L. Huron	faster	constant	constant	constant	no trend	constant	constant
Double, L. Huron	constant	faster	constant	constant	faster	constant	no trend
Chantry, L. Huron	constant	no trend	constant	constant	constant	constant	constant
Fighting, Detroit R.	faster	constant	constant	constant	faster	constant	slower
Middle, L. Erie	constant	constant	constant	constant	constant	constant	no trend
Port Col, L. Erie	constant	constant	constant	constant	constant	faster	constant
Niagara R.	constant	constant	constant	constant	constant	slower	constant
Hamilton, L. Ontario	faster	constant	constant	constant	constant	slower	constant
Toronto, L. Ontario	constant	constant	constant	slower	constant	slower	constant
Snake, L. Ontario	faster	constant	constant	constant	constant	slower	no trend
Strachan, SLR	constant	constant	constant	constant	constant	faster	constant

\*2,3,7,8-dioxin last measured in 2003

Pekarik & Weseloh 1998, *Environ. Monitor. Asses.* / CWS unpubl.



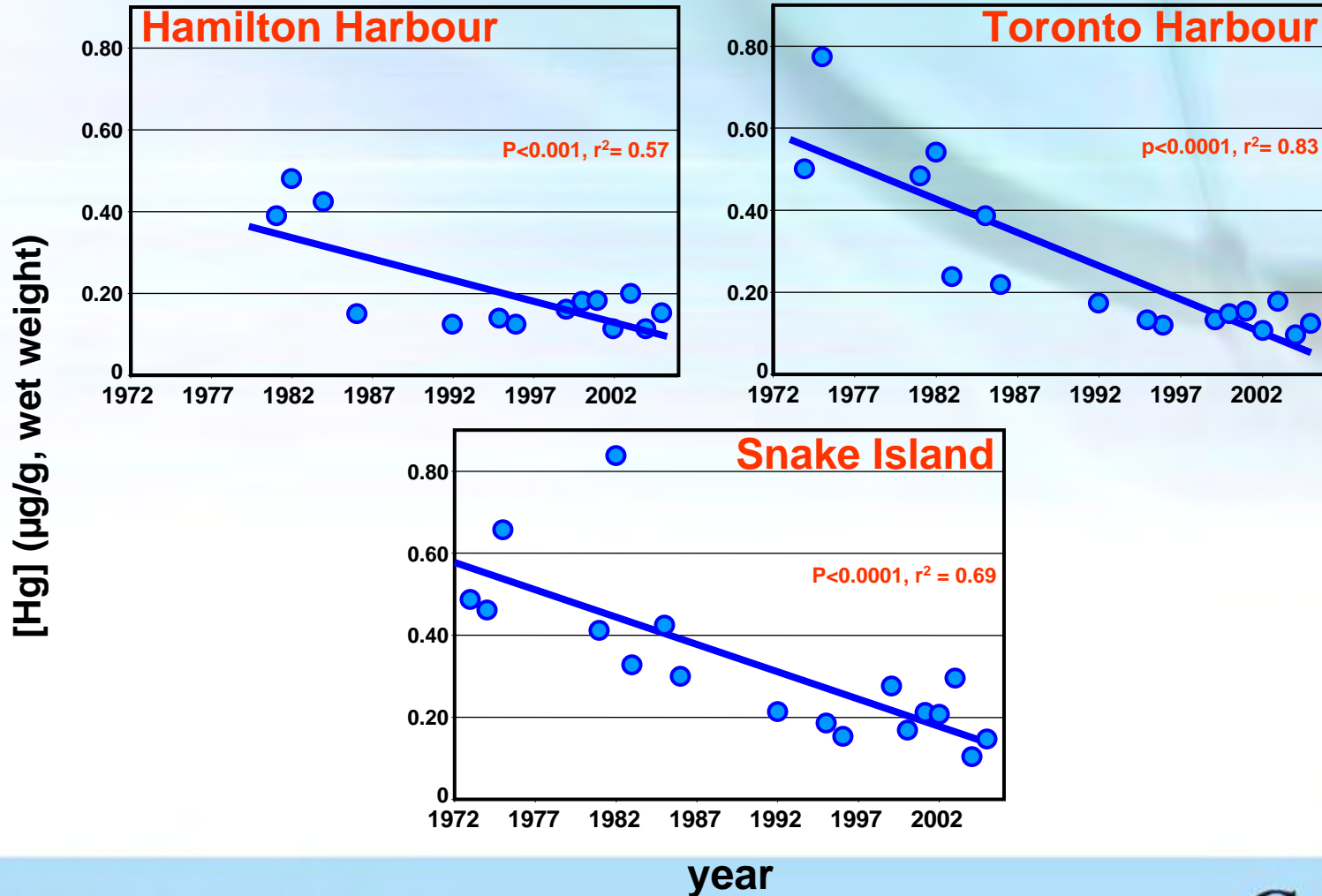
# Change-point summary:

Model	Lake Ontario
Faster	57.9%
Constant	26.3%
Slower	15.8%
No trend	5.3%
total	100%

84.2%

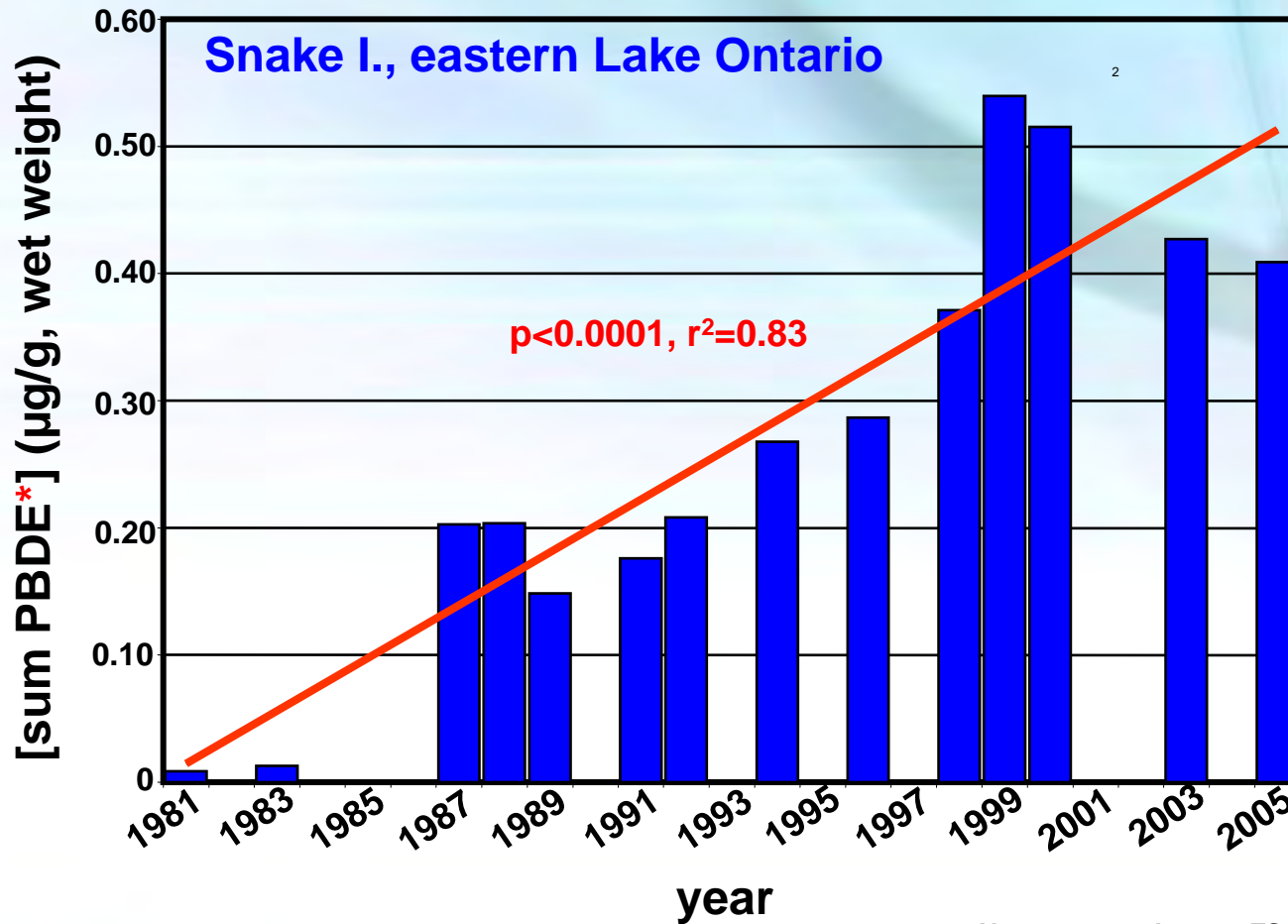


# Mercury in Lake Ontario Herring Gull eggs (1973-2005)



# Sum PBDE\* in Herring Gull eggs, 1981-2005

\* sum of 10 congeners: BDE-17, -28, -47, -66, -100, -99, -85, -153, -138, -183



Norstrom et al. 2002, ES & T / CWS unpubl.



# Summary

- there are 3 long-term HERG monitoring sites in LO: (1) Hamilton Harbour, (2) Toronto Harbour & (3) Snake Island (near Kingston).
- Of the 15 GL-wide sites monitored, HERG eggs from the 3 LO colonies ranked **4<sup>th</sup>** (Snake I.), **6<sup>th</sup>** (Hamilton) and **8<sup>th</sup>** (Toronto) in terms of overall contaminant load.
- with the exception 2,3,7,8-dioxin at all 3 LO sites, most contaminants in LO HERG eggs have declined  $\geq 94\%$  since 1974.
- Most (84%) major compounds have declined at a constant rate or have declined more quickly in recent years; PCBs are declining more slowly.
- PBDEs are the only measured contaminants showing a consistent increase in LO.



# Acknowledgements

**The following individuals/groups have assisted with egg collections, logistics or egg analyses over the years. We are grateful for their assistance.**

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# Thank you!

