Contaminants in Waterbirds
Formerly Indicator # 115

Overall Assessment
Status: Good
Trend: Decreasing and No Change
Rationale: The long term trends (1974 to present) of virtually all significant contaminants are declining. The short term trends, those over the last decade, are a mixture of some showing significant declines but others showing no significant change.

Lake-by-Lake Assessment
Lake Superior
Status: Good
Trend: Significant decline for most legacy contaminants in long term (1974-2009) and short term (2000-2009). Some legacy and some new contaminants show no significant change in the short term.
Rationale: The traditional legacy contaminants, DDE, SUM PCBs and TCDD, have declined significantly both since the 1970s and in the last decade. Hg has declined significantly in the long term but neither it, nor SUM BDE, has declined significantly in the short term.

Lake Michigan
Status: Good
Trend: Significant decline for most legacy contaminants in long term (1974-2009) and short term (2000-2009). Some legacy and some new contaminants show no significant change in the short term.
Rationale: The traditional legacy contaminants, DDE, SUM PCBs and TCDD, have declined significantly both since the 1970s and in the last decade. Hg has declined significantly in the long term but neither it, nor SUM BDE, has declined significantly in the short term.

Lake Huron
Status: Good
Trend: Significant decline for legacy contaminants in both the long term and the short term. No significant change for SUM BDE in the short term.
Rationale:

Lake Erie
Status: Fair
Trend: Decreasing in the long term; no significant change in the last decade.

Rationale: The legacy contaminants, DDE, SUM PCBs, TCDD and Hg, have all declined significantly since the 1970s. However, none of them, as well as SUM BDEs has declined significantly in the last decade.

Lake Ontario

Status: Fair

Trend: Decreasing in the long term; no significant change in the last decade.

Rationale: The legacy contaminants, DDE, SUM PCBs, TCDD and Hg, have all declined significantly since the 1970s. However, none of them, as well as SUM BDEs has declined significantly in the last decade.

Purpose

- To assess the current chemical concentrations and trends in representative colonial waterbirds (gulls, terns, cormorants and/or herons) on the Great Lakes.
- To infer and measure the impact of contaminants on the health, i.e. the physiology and breeding characteristics of the waterbird population.
- To assess ecological and physiological endpoints in representative colonial waterbirds on the Great Lakes.

Ecosystem Objective

Tracking progress of fish-eating colonial waterbirds on the Great Lakes toward an environmental condition in which there is no difference in contaminant levels and related biological endpoints between birds on and off the Great Lakes. As part of this indicator, contaminant levels are also measured in herring gull eggs to ensure that levels continue to decline.

Ecological Condition

Measure

- Annual concentrations of the DDT complex, PCBs/PCDFs/PCDDs and other organic contaminants, and Hg and other metals in Herring Gull eggs from 15 sites from throughout the Great Lakes (U.S. and Canada).
- Periodic measurement of biological features of gulls and other colonial waterbirds known to be directly or indirectly impacted by contaminants and other stressors. These include (but are not limited to): clutch size, eggshell thickness, hatching and fledging success, size and trends in breeding population, various physiological biomarkers including vitamin A, immune and thyroid function, stress (corticosterone) and growth hormone levels, liver enzyme induction, PAH levels in bile and porphyrins and genetic and chromsomal abnormalities. Additional monitoring considerations include: tracking porphyria, vitamin A deficiencies, and the evaluation of avian immune systems.

Endpoint

- Chemical levels and biological measures in colonial nesting waterbirds are not different from those from reference sites in Atlantic Canada or from the Prairies.

- Decreasing contaminant trends.

Additional Information

Although there are Great Lakes wildlife species that are more sensitive to contaminants than Herring Gulls, and colonial nesting waterbird species in general, there is no other species which has the historical dataset that the Herring Gull does. As contaminant levels continue to decline (if they do), the usefulness of the Herring Gull as a biological indicator species may lessen (due to its reduced sensitivity to low levels of contamination) but its value as a chemical indicator will remain and probably increase - as levels become harder and harder to measure in other media. It is an excellent accumulator tracker since many of the above biological measures are correlated with contaminant levels in their eggs. In other colonial waterbirds, there are similar correlations between contaminant levels in eggs and various biological measures. Contaminant levels in eggs of other colonial waterbirds are usually correlated with those in Herring Gulls. Adult Herring Gulls nest on all the Great Lakes and the connecting channels and remain on the Great Lakes year-round. Because their diet is usually made up primarily of fish, they are an excellent terrestrially nesting indicator of the aquatic community. The Herring Gull egg contaminants dataset is also the longest running continuous (annual) contaminants dataset for wildlife in the world.

Historical data on levels of chemical contamination in gull eggs are available, on an annual basis, for most sites in both the Canadian and U.S. Great Lakes dating back to the early 1970s. An immense database of chemical levels and biological measures from the Great Lakes, as well as many off-Lakes sites, is available from the Canadian Wildlife Service at Environment Canada. Data on temporal trends, portrayed as annual contaminant levels over time, for 1974-present in most instances, are available for each site and each compound. For example, DDE, from 1974-2008, is available for Toronto Harbour and could be displayed graphically. Geographical patterns in contaminant levels, showing all sites relative to one another, are also available for most years from 1974-present and for most compounds. For example, PCBs, 2008, at 15 Great Lakes sites from Lake Superior to the St. Lawrence River (including U.S. sites) and could be displayed on both maps and graphs.

The size and distribution of the waterbird population which breeds on the Great Lakes is also an indicator of ecosystem health. Declining waterbird populations (number of breeding pairs or nests) and vital rates (hatching success, fledging success, mortality rates, etc.) can be indicators of local environmental stress. The Great Lakes-wide population of colonial waterbirds has been censused jointly, by the Canadian Wildlife Service and the U.S. Fish and Wildlife Service since the 1970s, approximately every 10 years; four "decadal" censuses have been conducted to date: in the 1970s, 1980s, 1990s and 2000s. Briefly, and in the long-term (from the 1970s to the 2000s), these censuses have shown that the breeding numbers of six species have increased: Double-crested Cormorants, Black-crowned Night-Herons, Great Egrets, Ring-billed Gulls, Great Black-backed Gulls, and Caspian Terns. Unfortunately, the numbers of three species, Great Blue Heron, Herring Gull and Common Tern, have gone declined. In the short-term (from the 1990s to 2000s), numbers of night-herons, the three gull species and Common Terns have declined. For Common Terns, which have declined continuously since the first census, the trend is alarming; numbers have declined from approximately 8,600 pairs to just 5,000 pairs (42%). The reasons for this decline are unclear but it is partially due to competition for nest sites with Ring-billed Gulls and habitat loss. Although the Herring Gull population is much more numerous

(approximately 32,000 pairs), their decline should be monitored, especially in Lake Huron, where numbers have declined from approximately 33,500 pairs in the 1970s to 22,000 pairs in the 2000s (34%).

Data Limitations

Herring Gulls are highly tolerant of persistent contamination and may underestimate biological effects occurring in other less monitored, more sensitive species. Also, some adult Herring Gulls from the upper Lakes, especially Lake Superior, move to the lower Lakes, especially Lake Michigan, during harsh winters. This has the potential to confound the contaminant profile of a bird from the upper Lakes. Most of the gull's time is still spent on its home lake and this has not been noted as a serious limitation up to this point. Using contaminant accumulation by young, flightless gulls would eliminate this problem but their contaminant levels and effects would be less due to the much reduced contaminant exposure/intake.

It is difficult to show consistent differences in biological effects among colony sites within the Great Lakes. This is probably due to the great overall reduction in contaminant levels as well as the lessening in differences among Great Lakes sites. The comparisons which show the greatest differences for biological effects of contaminants are between sites on and off the Great Lakes.

Also, contaminant concentrations in most colonially-nesting, fish-eating birds are at levels where gross ecological effects, such as eggshell thinning, reduced hatching and fledging success, and population declines, are no longer apparent. Greater reliance for detecting biological effects of contaminants is being put upon physiological and genetic biomarkers. These are not as well characterized, nor are they understood as easily by the public. Other complementary species include: Double-crested Cormorant (Phalacrocorax auritus), Common Tern (Sterna hirundo), Caspian Tern (Hydroprogne caspia) and Black-crowned Night-Heron (Nycticorax nycticorax).

Linkages

There are many linkages between the contaminant levels in fish-eating waterbirds indicator and many other indicators within the SOLEC reporting suite. There is a link between Contaminants in fish-eating waterbirds and Contaminants in Whole Fish as well as with Top Predator Fish and Preyfish. Trends seen in fish-eating colonial waterbirds are also likely linked to those seen in Bald Eagles. A link has also been shown by Dr. Craig Hebert between contaminant levels in Herring Gull eggs and Ice Duration. There is a direct link between Herring Gull contaminants and Endocrine Disruption and, in terms of the health of Great Lakes fish-eating birds, between Herring Gulls and both Botulism Outbreaks and the Occurrence of Fish Diseases.

Assessing Data Quality

Insert "x" under the statement that best corresponds with each data characteristic

Data Characteristics	Strongly Agree	Agree	Neutral or Unknown	Disagree	Strongly Disagree	Not Applicable
1. Data are documented, validated, or quality-assured by a recognized agency or organization	x					
2. Data are traceable to original sources	x					

3. The source of the data is a known, reliable and respected generator of data	x					
4. Geographic coverage and scale of data are appropriate to the Great Lakes basin	x					
5. Data obtained from sources within the U.S. are comparable to those from Canada	x					
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report	x					
Clarifying Notes:						

Acknowledgments

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Information Sources

Weseloh D.V.C., Pekarik C. and S.R. de Solla. 2006. Spatial patterns and rankings of contaminant concentrations in herring gull eggs from 15 sites in the Great Lakes and connecting channels, 1988-2002. Environ. Monitor. Assess. 113: 265-284.

DeSolla, S.R., D.V.C, Weseloh, C.E. Hebert and C. Pekarik. 2010. Impact of changes in analytical techniques for the measurement of polychlorinated biphenyls and organochlorine pesticides on temporal trends in Herring Gull eggs. Environ. Toxicol. Chem. 9999 (120: 1-8).

Weseloh, D.V.C., D.J. Moore, C.E. Hebert, S.R. DeSolla, B.M. Braune and D. McGoldrick. In press. Current concentrations and spatial and temporal trends in mercury in Great Lakes Herring Gull eggs, 1974-2009. Ecotoxicology.

Canadian Wildlife Service, unpublished data.

List of Figures

Figure 1. Change in concentration of DDE, sum PCBs, mercury (Hg) (ug/g, wet weight), 2,3,7,8-TCDD and sum BDEs (ug/g, wet weight) in Great Lakes Herring Gull eggs from year of first measurement (black bars) compared to most recent measurement (2009, yellow bars). Values in first year of measurement have been set to 100%. Years of first and most recent measurement are indicated below compound names on the x-axis. No eggs were available from Fighting in 2009, so the 2008 value has been used; similarly, 1973 DDE and Hg values were used for Lake Michigan. Values associated with each bar are the actual concentrations. Symbols above green bars indicate p-values from regressions on ln-transformed concentrations for the entire dataset (1st to last measured, red) and the period from 1999-2009 (black): **, p□0.0001; *, p□0.001; ^, p □0.01; #, p □0.05, ns, not significant.
Source: CWS – Burlington/Downsview.

Figure 2. Changes in the number of Common Tern nests (red) and breeding colonies (blue) in Canadian waters of the Great Lakes and connecting channels during four "decadal" survey periods (1976-80, 1989-90, 1997-2000 and 2007-2009). Not shown: Lake Superior had 25 nests at a single colony during the second census period.

Last Updated

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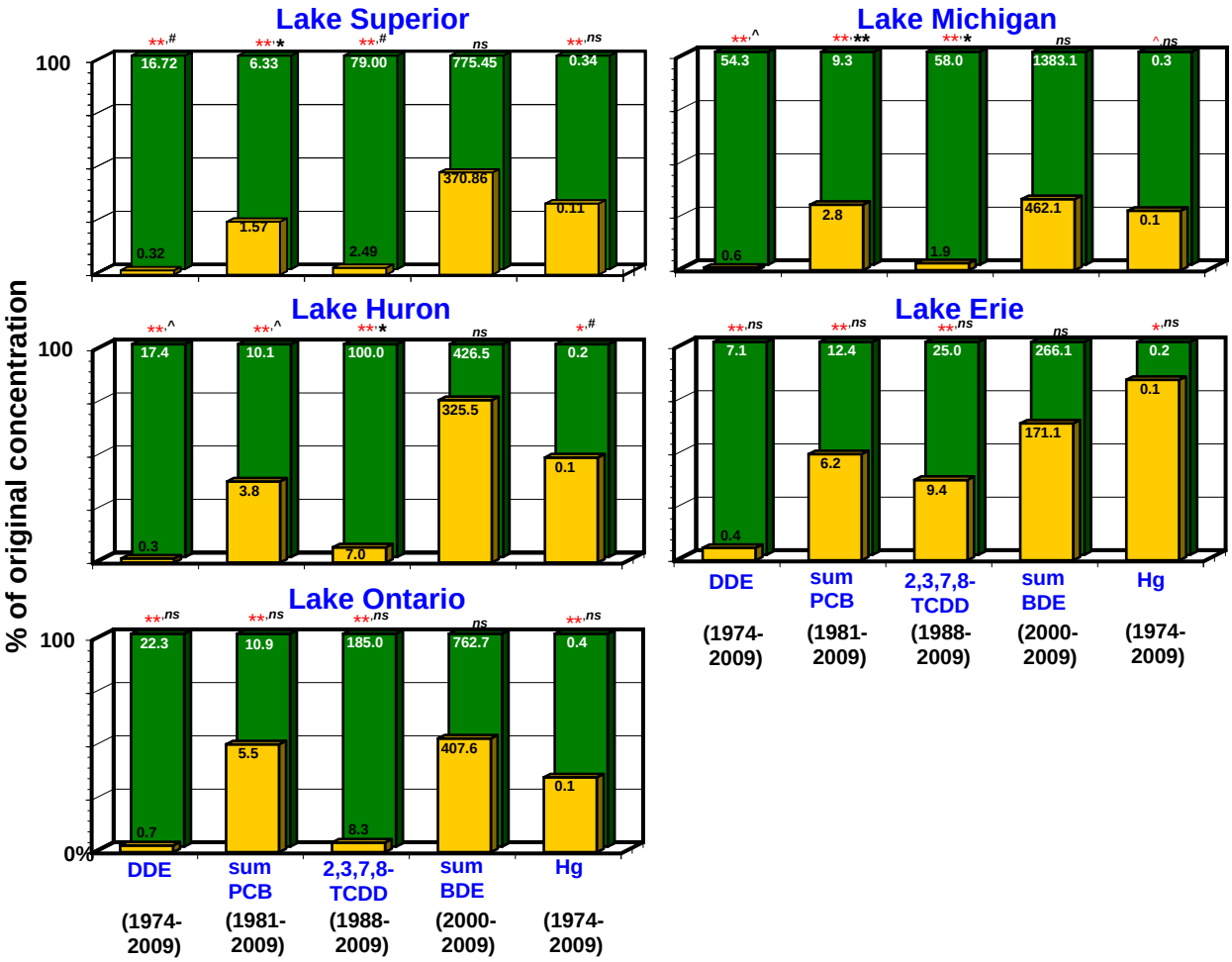

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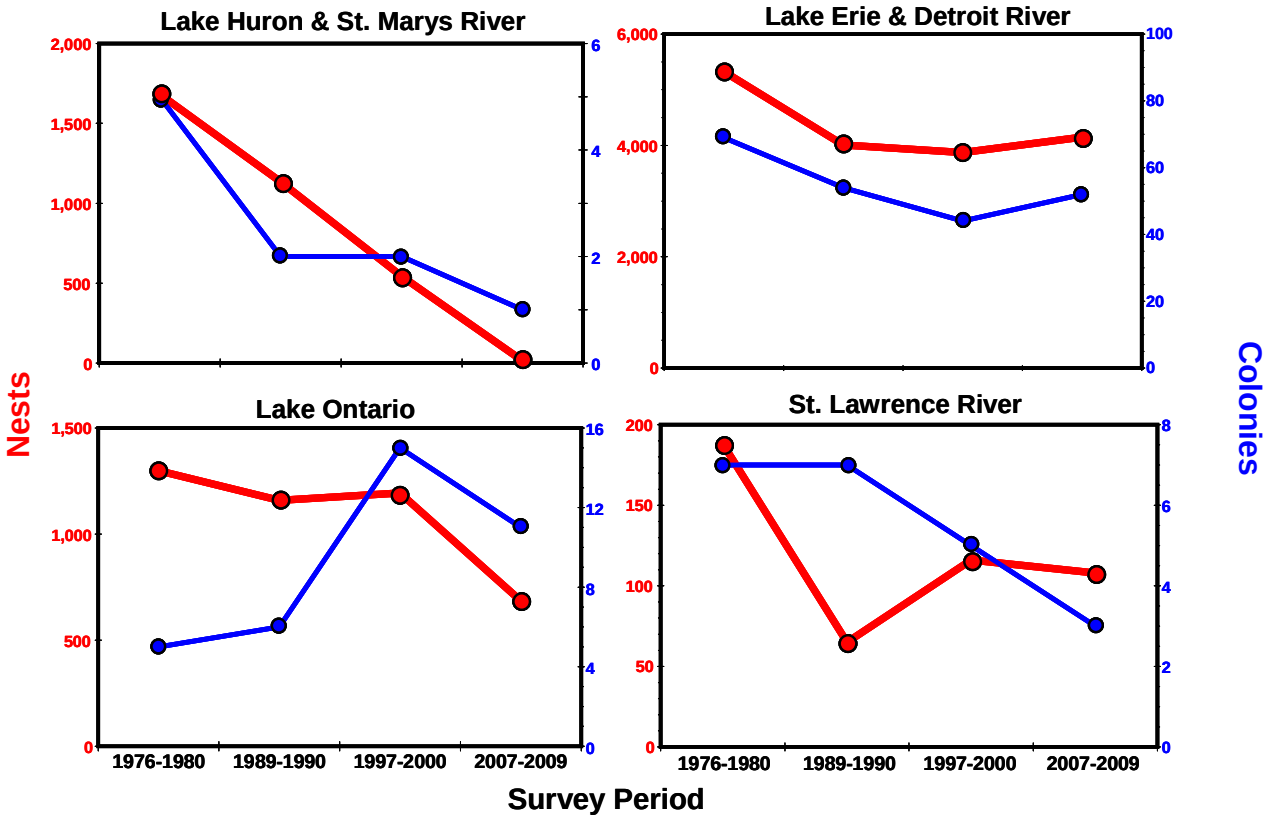

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