Colonial Waterbirds as Indicators of Environmental Change

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Aquatic birds are useful indicators of environmental change in both marine and freshwater environments (Elliott and Elliott 2013; Hebert et al. 1999). Fish-eating birds, such as gulls and terns, are top predators and integrate ecological processes occurring throughout the food web. Because they occupy high trophic levels these species also accumulate high levels of biomagnifying contaminants such as mercury and polybrominated diphenyl ethers. These aspects contribute to the utility of these species as environmental indicators; hence, colonial waterbirds are the focus of various monitoring programs located across Canada (Fig. 1). Eggs constitute the majority of samples collected as part of this work. Colonial waterbird eggs are formed primarily from resources obtained in the vicinity of the breeding colony; therefore, the chemical composition of eggs can reflect the local environment.

Figure 1. Location of waterbird egg collection sites.

Much of Environment Canada’s research on waterbirds has focused on the assessment of spatial and temporal trends in contaminant levels (Hebert et al. 2013), detection of emerging contaminants (Gebbink et al. 2011), and identification of ecosystem change through modification of food web structure (Hebert et al. 2008). Large-scale aquatic ecosystem change is often associated with alterations in the structure of biological communities. This in turn, affects how much and by what pathways energy, nutrients, contaminants, and disease agents flow through food webs. Top predators track changes in resource availability through their selection of prey and, in so doing, integrate food web processes over time. Temporal changes in food web interactions can thus be characterized through retrospective measurement of biochemical indicators of organism trophic position and energy/nutrient flow in archived tissue samples of high trophic level predators (Hebert et al. 2008).

The National Wildlife Specimen Bank (NWSB) in Ottawa is the largest repository of frozen wildlife tissues in Canada. The NWSB is an important source of specimens for retrospective “ecological tracer”
analysis. Examples of such ecological tracers are nitrogen and carbon stable isotopes and fatty acids. Stable nitrogen isotopes are useful in defining an organism’s trophic position as the heavier isotope, $^{15}$N, is progressively enriched through the food web leading to greater $^{15}$N values in organisms occupying higher trophic positions. Carbon isotopes provide information regarding the flow of carbon to consumers in that they can be used to differentiate between aquatic and terrestrial food sources. Fatty acid profiles in archived tissues such as eggs can provide additional insights into wildlife diets. Thus, retrospective ecological tracer analysis provides an historical perspective on food web tropho-dynamics allowing an evaluation of the extent and significance of food web change over time.

This presentation will demonstrate how data from colonial waterbirds are being used to improve our understanding of contaminant dynamics and trends in the Canadian environment. We will also examine how endpoints measured in waterbirds are providing insights into large-scale ecosystem change that is being manifested as alterations in the availability of resources for high trophic level predators as well as changing disease dynamics, e.g. emergence of botulism type E as a major factor causing wildlife mortality in the Great Lakes. Integration of data generated from the study of colonial waterbirds can provide a more holistic perspective on how changes in individual monitoring species may be reflecting larger, ecosystem-scale change (Fig. 2).

Figure 2. Integrated ecological tracer approach provides a holistic view of how alterations in endpoints measured in a biomonitoring species reflect larger ecosystem-scale change.

REFERENCES


