Mercury trends in cormorant and great blue heron eggs from Pacific Canada: a question of local and global sources

Tanya Brown
*Simon Fraser Univ., Canada*, tanya_brown@sfu.ca

John E. (John Edward) Elliott
*Environment and Climate Change Canada, Canada*, john.elliott@canada.ca

Kyle Elliott
*McGill Univ., Canada*, kyle.elliott@mcgill.ca

Sandi Lee
*Environment and Climate Change Canada, Canada*, sandi.lee@canada.ca

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Mercury trends in cormorant and great blue heron eggs from the NE Pacific

Tanya M. Brown, John E. Elliott, Kyle Elliott, Sandi Lee
Anthropogenic Hg in the NE Pacific Ocean: long-range transport vs local sources
Hg in the marine environment

- Airborne Hg deposits into the marine environment via rain;
- Sulfate-reducing bacteria in anaerobic regions (e.g., sediments and the water column (oxygen minimum zone) transforms inorganic Hg to MeHg;
- Bioaccumulates in invertebrates, fish, seabirds, and marine mammals;
- Biomagnifies through the food web, reaching high levels in fish-eating marine birds.
Hg trends in the North Pacific Ocean

• Hg deposition rates have increased 3-5 fold since the Industrial Revolution (Laurier et al. 2004).

• Hg in seabirds has increased by less than 2-fold over that period (Vo et al. 2011).

• Hg in water has increased and is expected to double by 2050 relative to 1995 levels (Sunderland et al. 2010).

• Hg in fish have been stable over the past 50 years (Kraepiel et al. 2003).
Study design – seabird monitoring

- Petrel, Auklet, Cormorant, Heron

- Collect eggs every 4 years

- 15 eggs per site

Gilbertson et al. 1987 IUCN Tech Pub 6:231
What are the recent trends in seabird eggs?

- No change with time in petrels or auklets;
- Hg levels declined with year in murrelets;
- $\delta^{13}C$ declined with year in murrelets.

Elliott & Elliott 2016, ES&T
Hg concentrations in pelagic cormorant eggs in the Salish Sea have decreased over time.

$r^2 = 0.74$

$P < 0.001$
However, changes in three isotopic signatures over time appear to suggest an influence of diet on Hg trends.

\[ r^2 = 0.44 \]
\[ P = 0.03 \]

\[ \delta^{15}N \]
\[ \delta^{13}C \text{ increased over time after 1990} \]
$\delta^{34}\text{S}$ decreased over time with increasing Hg

$r^2=0.41$

$P=0.01$
When adjusted for diet, Hg concentrations in pelagic cormorant eggs in the Salish Sea have decreased over time.
Hg concentrations in great blue heron eggs in the NE Pacific have also decreased over time.

\[ r^2 = 0.39 \]
\[ P = 0.03 \]
What are the recent trends in seabird eggs in the Canadian Arctic and Atlantic?

- After accounting for diet, Hg levels in seabird eggs:
  - increased with year in the Arctic;
  - showed no clear trend in the Atlantic.

Braune et al. 2014; Burgess et al. 2013
• Hg levels have declined over time in the open ocean pelagic environment (e.g., murrelets), but remain stable in auklets and petrels (Elliott & Elliott 2016);

• Hg levels have declined over time in nearshore Salish Sea pelagic cormorants and great blue herons;

• Diet has shifted over time in pelagic cormorants, possibly because of feeding:
  – lower in the food web;
  – more benthically; and
  – In more sulfate-depleted environments
Summary

- Regulations and source control appear to have reduced the release of Hg from point sources (e.g., forestry-related industry) over recent decades.
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Lab: Henry Won, Abde Idrissez, Peggy Dunlop, Francois Cyr, Suzanne Trudeau
Why is Hg declining in pelagic cormorants in the NE Pacific

• 1) Change in food web structure
• 2) Change in diet
• 3) Reduced emissions in North America because of regulations and source control