Mercury in Blood of Molting and Wintering Harlequin Ducks from Alaska

Lucas Savoy, Research Biologist
BioDiversity Research Institute
19 Flaggy Meadow Road
Gorham, Maine 04038
(207) 839-7600
lucas.savoy@briloon.org

Biodiversity Research Institute

1.0 Purpose of Study

Very little information exists on concentrations of certain contaminants available to sea ducks, particularly mercury (Hg). Mercury is a persistent contaminant, and readily available to most fish and wildlife through atmospheric deposition and localized industrial point sources (Evers et al. 2005). Levels of methylmercury (MeHg), the organic and highly toxic form of Hg, is bio-magnified through marine and freshwater food chains and at certain levels can be harmful to wildlife. The adverse effect levels of Hg for sea ducks are unknown. Exposure to dietary Hg can be highly variable among species of sea ducks due to prey selection, foraging strategies, and the proximity of wintering and breeding locations to contaminated areas.

Whole blood is the best tissue to determine recent intake of contaminants through daily foraging and can be sampled nonlethally. Mercury levels in the whole blood of birds often reflect an individual's Hg exposure through diet over the past several days (Evers et al. 2005). Mecury in the blood of birds is primarily MeHg (>95%) (Fournier et al. 2002, Rimmer et al. 2005). Blood sampling allows non-lethal capture options to conduct follow up studies (i.e., behavioral, survival, reproductive). Feathers can also be collected from live sampling and provide a more long-term accumulation of Hg, ultimately representing excess body burdens of Hg flushed into growing feathers at the time and location of an individual's molt (Bearhop et al. 2000).

Harlequin Ducks (*Histrionicus histrionicus*) were chosen because; 1) to the best of my knowledge, Hg data are not available for the Harlequin Duck, 2) Harlequins consume animal prey items known to accumulate contaminants, 3) Harlequins express strong winter philopatry and are susceptible Hg exposure from contaminated sites, and 4) extensive Harlequin research has been conducted in Alaska and the opportunity for utilizing archived blood samples from various locations existed.

2.0 Study Area

Archived Harlequin Duck blood samples were obtained from researchers conducting live capture and sampling studies from summer molting sites at Kodiak Island and wintering birds from multiple sites of western Unalaska Island, Alaska (Appendix 1).

3.0 Sample Analysis

Samples were split among three laboratories for Hg analysis; 1) Trace Element Research Laboratory (TERL) at Texas A&M University, 2) Center for Environmental Sciences and Engineering, University of Connecticut, and 3) Savannah River Ecology Laboratory, University of Georgia.

Results were reported as total mercury (THg) and on a parts per million (ppm) wet weight (ww) basis.

4.0 Results and Discussion

Kodiak Island

During August 2005, whole blood was collected from molting Harlequin Ducks at five locations in three bays around Kodiak Island (Appendix 1). Blood sampling was part of a previous Harlequin capture and sampling study conducted by Denny Zwiefelhofer from Kodiak Island National Wildlife Refuge. Frozen archived blood was provided to BioDiversity Research Institute (BRI) for mercury analysis. The blood remained frozen and later shipped to laboratories for total mercury analysis.

Blood Hg levels from 20 Harlequins sampled from three bays on Kodiak Island ranged between 0.02 – 0.09 (ppm,ww) and had a mean concentration of 0.04 ± 0.02 (ppm, ww) (Table 1, Appendix 2). Mercury levels varied slightly among sampling locations, but were not significantly different ($p>0.05$) (Table 1).

Table 1. Mean whole blood Hg concentrations (ppm,ww) in Harlequins among three sites around Kodiak Island, Alaska.

Site	n	Range	Mean ± SD
Bluefox Bay	3	0.02 – 0.04	0.03 ± 0.01
Terror/Viekoda Bay	9	0.03 – 0.06	0.04 ± 0.01
Uyak Bay	8	0.02 – 0.09	0.05 ± 0.02
Totals	**20**	**0.02 – 0.09**	**0.04 ± 0.02**

Although not statistically significant, age ($p=0.37$) and gender ($p=0.07$) appear to influence blood Hg levels. Males contained a slightly higher mean blood Hg concentration than females, 0.05 ± 0.02 and 0.04 ± 0.02, respectively. Mean levels were the same for after third year (ATY) 0.05 ± 0.02 and third year (TY) birds 0.05 ± 0.01, and were higher than second year (SY) birds, 0.02 ± 0.01.

Unalaska Island

During February 2006, wintering Harlequin Ducks were live trapped and blood samples collected by USGS Alaska Science Center biologists. Frozen archived blood was shipped to BioDiversity Research Institute and later sent to laboratories for THg analysis.

Blood Hg levels from 27 Harlequins sampled from four locations within western Unalaska Island (Appendix 1) ranged from 0.11 – 0.92 (ppm,ww) and had a mean Hg concentration of 0.30 ± 0.22 (ppm, ww) (Table 2, Appendix 2).

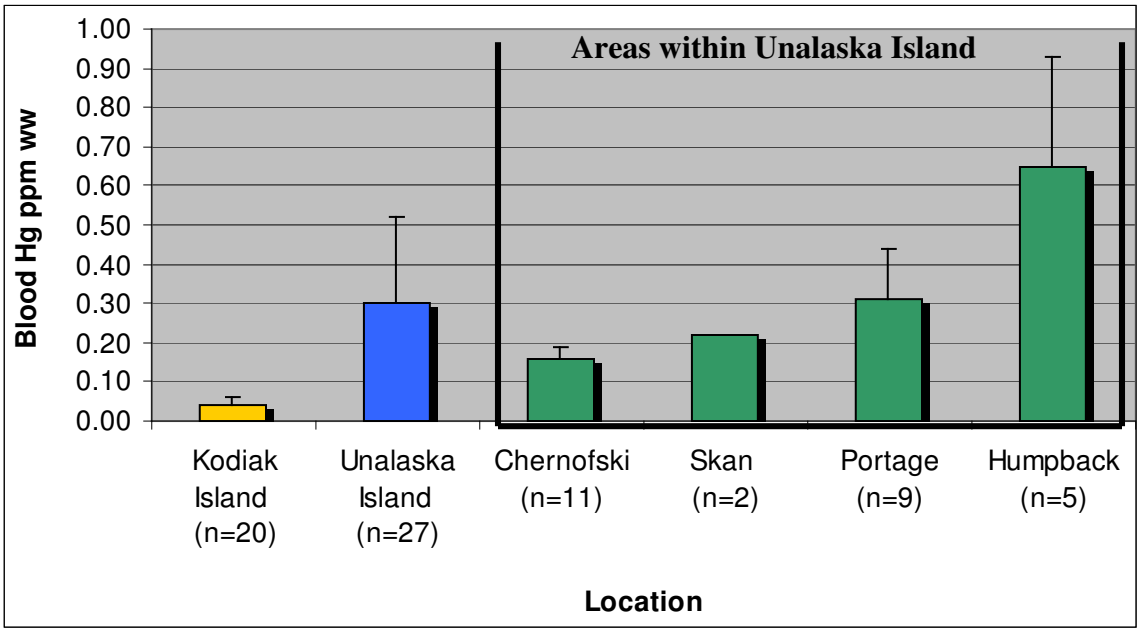
When combining all sampling locations within Unalaska Island, males tended to have higher Hg levels than females, 0.32 ± 0.24 and 0.27 ± 0.18, but were not significantly different ($p=0.62$). After second year (ASY) birds contained a slightly higher mean blood Hg concentration than second year (SY) birds, 0.31 ± 0.26 and 0.28 ± 0.09, respectively but were also not significantly different ($p=0.70$).

Table 2. Mean whole blood Hg concentrations (ppm,ww) in Harlequins at four sites within Unalaska Island, Alaska.

Site	n	Range	Mean ± SD
Humpback	5	0.31 – 0.92	0.65 ± 0.28
Portage	9	0.16 – 0.52	0.31 ± 0.13
Skan	2	0.18 – 0.25	0.22
Chernofski	11	0.11 – 0.22	0.16 ± 0.03
Totals	**27**	**0.11 – 0.92**	**0.30 ± 22**

Mercury levels varied among specific sampling locations (Table 2, Figure 1). Harlequins from Humpback had the highest Hg levels and were four times higher than ducks from Chernofski. Harlequins from Humpback were significantly higher ($p<0.05$) in Hg than ducks from the other three Unalaska Island sites, as well as ducks from the sites at Kodiak Island ($p<0.05$). Variation in blood Hg levels among Harlequins from the four Unalaska Island sites may be attributed to localized industrial effluent, or perhaps a variation in prey availability.

Figure 1. Comparison of mean blood Hg levels in Harlequin Ducks from Kodiak Island and four sites within western Unalaska Island, Alaska.



Variation in Hg Concentrations Between Age and Gender

For each sampling location, male Harlequins had a higher mean blood Hg levels than females.

As mentioned above, age and sex of the birds influenced blood Hg levels In Harlequins from Kodiak Island and Unalaska Island sites. When combining all SY and ASY birds from Unalaska Island and Kodiak Island, mean blood Hg levels tended to be higher in older birds. ASY Harlequins had a mean blood Hg level of 0.31 ± 0.26

(ppm,ww), while SY birds had mean Hg level of 0.20 ± 0.14 (ppm,ww). Statistically, ASY birds were not significantly higher than SY birds (p=0.20).

The reason for these increasing trends with age and by sex of Harlequins is unclear. Mercury levels in the blood represent contaminants accumulated through the Harlequin's recent diet. Perhaps body mass and bill size enable older (mature) and male Harlequins to eat larger or different prey items, containing more Hg, than smaller female and younger (immature) birds. It has been established that male Harlequins are larger in body mass than females (Robertson and Goudie 1999). Bill size appears to be larger in males than females, and in most studies, mature birds have larger bills than immature birds (Robertson and Goudie 1999).

Winter feeding studies have found female Harlequins spend more time foraging than males (Fischer 1998). This may be a result of females consuming smaller prey items and therefore requiring to forage more frequently than larger males to sustain energy requirements, or to maintain fat reserves for later egg production.

Comparison Among Sea Duck Species

There is little existing information available in the literature on blood Hg levels in sea ducks, and none for the Harlequin Duck or wintering sea ducks. A few studies have looked at Hg using blood from Common Eider (*Somateria mollissima*) (Franson et al. 2004, Wayland et al. 2001), King Eider (*Somateria spectabilis*) (Wilson et al. 2004), Spectacled Eider (*Somateria fischeri*) (Wilson et al. 2004), Long-tailed Duck (*Clangula hyemalis*) (Franson et al. 2004), and the Surf Scoter (*Melanitta perspicillata*) (BRI unpubl. Data) from their breeding or summer molting areas.

Wilson et al. 2004 found mean blood Hg levels in King eiders and Spectacled Eiders ranging from 0.12 – 0.31 (ppm,ww). Wayland et al. 2001 found a mean blood Hg concentration of 0.23 (ppm,ww) in Common Eiders. Means from these breeding ground studies were higher than Harlequin levels found at Kodiak Island and similar to those found at three of the four sites within Unalaska Island. Mean blood Hg concentrations in Harlequins from the Humpback site were higher than in all previously reported sea duck studies.

Acknowledgements

Many thanks to Denny Zwiefelhofer (USFWS Kodiak Island National Wildlife Refuge), Paul Flint (USGS-Alaska Science Center), Jason Schamber (USGS-Alaska Science Center), and Kim Trust (USFWS-Anchorage) for coordinating and providing samples for this study.

5.0 Literature Cited

Bearhop, S., S. Waldron, D. Thompson, and R. Furness. 2000. Bioamplification of mercury in great skua (Catharacta skua chicks: The influence of trophic status as determined by stable isotope signatures of blood and feathers. Marine Pollut. Bull. 40:181-185.

Evers, D.C., L. Champoux, N.M. Burgess, B. Hoskins, A. Major, W. Goodale, R. Taylor, R. Poppenga, and T. Daigle. 2005. Patterns of mercury exposure in freshwater avian communities in northeastern North America. Ecotoxicology 14: 193-221.

Fischer J.B. 1998. Feeding behaviour, body condition, and oil contamination of wintering Harlequin Ducks (Histrionicus histrionicus) at Shemya Island, Alaska. Master's Thesis, Univ. Massachusetts, Amherst.

Fournier, F., W.H. Karasov, K.P. Kenow, M.W. Meyer, and R.K. Hines. 2002. The oral bioavailability and toxicokinetics of methylmercury in common loon (*Gavia immer*) chicks. Comp. Biochem. Physiol. Part A. 133:703-714.

Franson, C.J., T.E. Hollmen, P.L. Flint, J.B. Grand, and R.B. Lanctot. 2004. Contaminants in molting long-tailed ducks and nesting common eiders in the Beaufort Sea. Marine Pollut. Bull. 48:504-513.

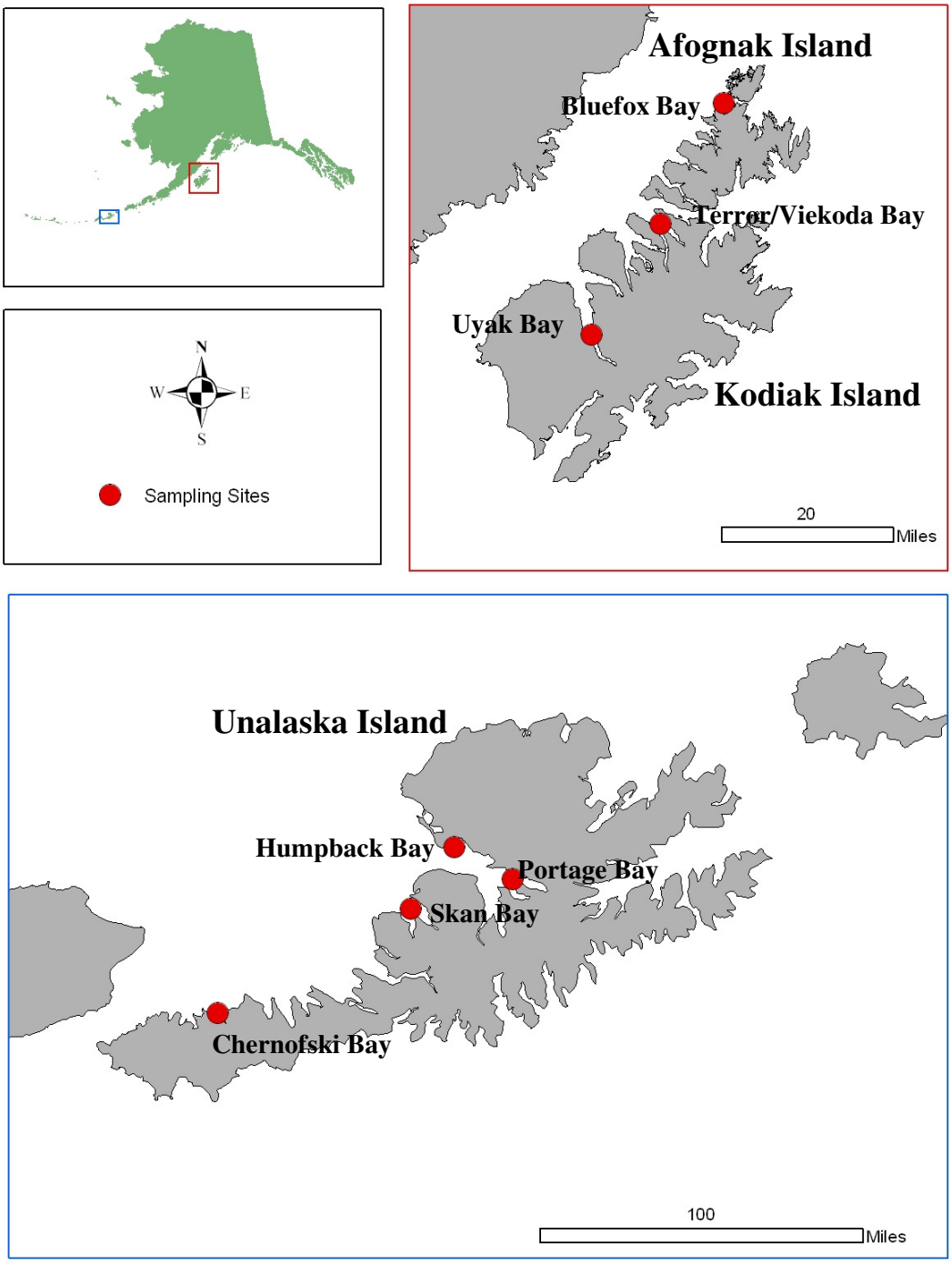
Rimmer, C.C., K.P. McFarland, D.C. Evers, E.K. Miller, Y. Aubry, D. Busby, and R.J. Taylor. 2005. Mercury levels in Bicknell's thrush and other insectivorous passerine birds in montane forests of the northeastern United States and Canada. Ecotoxicology 14:223-240.

Robertson, G.J. and R.I. Goudie. 1999. Harlequin Duck (*Histrionicus histrionicus*). *In* The Birds of North America, No. 466 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Wayland, M., A.J. Garcia-Fernandez, E. Neugebauer, and H.G. Gilchrist. 2001. Concentrations of cadmium, mercury, and selenium in blood, liver and kidney of Common Eider ducks from the Canadian Arctic. Environ. Monit. and Assess. 71:255-267.

Wilson, H.M., M.R. Petersen, and D. Troy. 2004. Concentrations of metals and trace elements in blood of Spectacled and King Eiders in northern Alaska, USA. Environ. Toxicol. and Chem. 23(2): 408-414.

Appendix 1. Harlequin Duck sampling locations.



Appendix 2. Blood Hg results in molting and wintering harlequins from Alaska.