HEALTH CONSULTATION

An Evaluation of Mercury Concentrations in Waterfowl from the Great Salt Lake, Utah for 2004 and 2005

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Prepared by

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Background and Statement of Issues

The Utah Division of Wildlife Resources (UDWR) began a preliminary study during the summer of 2005 to determine if ducks around Great Salt Lake contained mercury. This concern was based upon research findings from the United States Geological Survey (USGS) and United States Fish & Wildlife Service (USF&WS) that demonstrated the lake had elevated levels of methyl mercury. Archived tissue samples from three waterfowl species were taken from ducks collected in 2004 in an unrelated study being conducted by The Great Salt Lake Ecosystem Project at UDWR and Utah State University (USU). Results of that analysis promulgated a more expansive collection of seven waterfowl species for further testing. All of these data were provided to the Environmental Epidemiology Program (EEP) for review . This health consultation is an evaluation of mercury in waterfowl from areas near the Great Salt Lake covering the period 2004 and 2005.

Results

Waterfowl Analysis for 2004

All contaminant concentrations are reported as a wet weight concentration in milligrams of contaminant per kilogram waterfowl muscle tissue (mg/kg). Waterfowl muscle tissue was analyzed as samples from individuals of each species.

Three different waterfowl species were collected from four locations within the South Arm of the Great Salt Lake during November-December 2004. Muscle samples from the breast muscle of each bird were submitted for toxicological analysis. Ten Common Goldeneye were collected. Mercury levels ranged from 0.213 mg/kg to 4.721 mg/kg with an average mercury concentration of 2.012 mg/kg (Appendix A, Table 1). Ten Northern Shoveler were collected with mercury levels ranging from 0.262 mg/kg to 1.408 mg/kg with an average mercury concentration of 0.759 mg/kg (Appendix A, Table 2). Ten Green Wing Teal were collected with mercury levels ranging from 0.146 mg/kg to 0.329 mg/kg with an average mercury concentration of 0.232 mg/kg (Appendix A, Table 3).

Waterfowl Analysis for 2005

Seven different waterfowl species were collected in 2005 and muscle samples from individual birds of each species were analyzed for mercury. Ten Mallards were collected with mercury levels ranging from 0.039 mg/kg to 0.662 mg/kg with an average mercury concentration of 0.282 mg/kg (Appendix A, Table 4). Ten Northern Shovelers were collected with mercury levels ranging from 0.645 mg/kg to 11.708 mg/kg with an average mercury concentration of 3.220 mg/kg (Appendix A, Table 5). Three Northern Pintail were collected with mercury levels ranging from 0.007 mg/kg to 0.095 mg/kg with an average mercury concentration of 0.064 mg/kg (Appendix A, Table 6). Two Cinnamon Teal were collected with mercury levels of 0.228 mg/kg and 0.605 mg/kg with an average mercury concentration of 0.417 mg/kg (Appendix A, Table 7). One Redhead duck sample was collected and analyzed for mercury; the mercury concentration was 0.089 mg/kg (Appendix A, Table 8). Ten Green Wing Teal were collected

with mercury levels ranging from 0.064 mg/kg to 0.390 mg/kg with an average mercury concentration of 0.180 mg/kg (Appendix A, Table 9). Eleven Gadwall were collected with mercury levels ranging from 0.019 mg/kg to 0.205 mg/kg with an average mercury concentration of 0.057 mg/kg (Appendix A, Table 10).

Discussion

Screening values (SVs) were developed by the U.S. Environmental Protection Agency (EPA) and are used as standards by which levels of contamination can be compared. Screening values are defined as the concentrations of target analytes that can trigger further investigation and/or consideration of consumption advisories for the species where such concentrations occur [EPA 2000b].

In waterfowl tissue, the majority of mercury is methylmercury. Methylmercury is rapidly absorbed from the gastrointestinal tract. The body absorbs about 90 to 100 percent of ingested methylmercury. Methylmercury can be changed by your body to inorganic mercury. When this happens in the brain, the mercury can remain there for a long time. When methylmercury does leave your body after you have been exposed, it leaves slowly over a period of several months, mostly as inorganic mercury in the feces. The biological half-life of methylmercury in humans is roughly 50 to 65 days. The half-life is a measure of rate for the time required to eliminate one half of a quantity of a chemical from the body. As with inorganic mercury, some of the methylmercury in a nursing woman's body will pass into her breast milk [ATSDR 1999].

Results of the 2004 and 2005 mercury concentrations in waterfowl were compared to the SV. The SV for mercury is 0.3 milligrams mercury per kilogram fresh muscle tissue weight (mg/kg) [EPA 2000a].

The average concentration of mercury exceeded the SV for mercury of 0.3 mg/kg for Common Goldeneye and Northern Shoveler from 2004 and for Northern Shoveler and Cinnamon Teal collected in 2005. However, only two samples of Cinnamon Teal were collected and one sample was above the SV of 0.3 mg/kg.

Toxicological Evaluation

The nervous system is very sensitive to all forms of mercury. In poisoning incidents that occurred in other countries, some people who ate fish contaminated with large amounts of methylmercury or seed grains treated with methylmercury or other organic mercury compounds developed permanent damage to the brain and kidneys. Animals exposed orally to long-term, high levels of methylmercury or phenylmercury in laboratory studies experienced damage to the kidneys, stomach, and large intestine; changes in blood pressure and heart rate; adverse effects on the developing fetus, sperm, and male reproductive organs; and increases in abortions and stillbirths [ATSDR 1999].

Consumption Limits

When SVs are exceeded, consumption limits can be estimated to determine how many meals of waterfowl can be safely consumed each month [EPA 2000b]. Calculations are based on an adult body weight of 70 kg with a meal size of 227 g waterfowl and a child body weight of 16 kg with a meal size of 113 g of waterfowl (Appendix B).

Based on an average mercury concentration of 3.220 mg/kg in Northern Shoveler collected in 2005 and an average mercury concentration is 2.012 mg/kg in Common Goldeneye, people should refrain from eating Northern Shoveler and Common Goldeneye from the Great Salt Lake marshes. The average mercury concentration in Cinnamon Teal from 2005 exceeded the SV for mercury, however, with a sample size of only two waterfowl, there is not currently enough data on this species to warrant a consumption advisory.

Green Wing Teal were collected in 2004 and 2005. Only three Green Wing Teal of a total of twenty exceeded the mercury screening value. Three of ten Mallards from 2005 exceeded the SV. None of the samples from Northern Pintail, Gadwall, or Redhead ducks exceeded the screening value for mercury. Since the mean mercury levels for Green Wing Teal, Mallards, Northern Pintail, Gadwall, and Redhead ducks did not exceed the SV for mercury, consumption limits were not calculated for these species.

Children's Health Considerations

Infants and children have unique vulnerabilities to environmental contaminants. Children are less developed and may have developmental harm from exposure that would not be experienced by a completely developed adult. The developing body systems of children may sustain permanent damage if toxic exposures occur during critical growth stages. Children's health was considered as a part of this health consultation.

Very young children may be more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also pass to a nursing infant through breast milk. However, the benefits of breast-feeding may be greater than the possible adverse effects of mercury in breast milk. Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage [ATSDR 1999]. Due to the possible health effects from chemical contaminants on the fetus, pregnant women should follow the consumption limits assigned to children.

Conclusions

Northern Shoveler and Common Goldeneye from the Great Salt Lake have levels of mercury that may result in a risk of adverse health effects. Northern Shoveler and Common Goldeneye from the Great Salt Lake marshes should not be consumed.

The average mercury level in Mallard was just below the screening value. Additional sampling of this species is needed to further characterize the mercury levels in Mallards to determine if a consumption advisory is warranted.

Although the average mercury level in Cinnamon Teal exceeded the screening value, only two ducks were analyzed. The small sample size was insufficient to support a consumption advisory for this species. Additional sampling of the Cinnamon Teal is needed to further characterize the mercury levels in this species to determine if a consumption advisory is warranted.

The average mercury concentrations in Green Wing Teal, Northern Pintail, Gadwall, and Redhead ducks were well below the screening value for mercury.

Recommendations

The Environmental Epidemiology Program recommends a consumption advisory for waterfowl harvested from the Great Salt Lake marshes because of elevated levels of mercury detected in Common Goldeneye and Northern Shoveler. People should not consume meat from Common Goldeneye and Northern Shoveler harvested from this region.

The EEP recommends that concentrations of mercury and other chemicals continue to be monitored in waterfowl from the Great Salt Lake marshes.

Public Health Action Plan

The Environmental Epidemiology Program of the Utah Department of Health will continue to work with the Utah Department of Environmental Quality, the Utah Division of Wildlife Resources and local health departments on the development of waterfowl sampling and monitoring plans for Utah. A copy of this Health Consultation and waterfowl consumption advisories will be posted on the EEP web site.

The EEP will continue to work with all applicable agencies to perform additional research on mercury and other chemical contaminants in waterfowl in Utah. The EEP will adjust recommendations as new information becomes available.

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Appendices

Appendix A - Tables

Table 1. Mercury results for individual Common Goldeneye muscle samples from the Great Salt Lake, Utah (2004).

Sample	Mercury concentration (mg/kg)*
CG 92	**4.067**
CG 105	**2.054**
CG 119	**1.043**
CG 134	**4.721**
CG 135	**0.476**
CG 136	**0.617**
CG 137	**2.811**
CG 138	**1.006**
CG 139	**3.112**
CG 142	0.213
Average =	**2.012**

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 2. Mercury results for individual Northern Shoveler muscle samples from the Great Salt Lake, Utah (2004).

Sample	Mercury concentration (mg/kg)*
NS 4	**0.950**
NS 6	**0.889**
NS 7	**0.706**
NS 8	**0.469**
NS 9	0.262
NS 10	**1.408**
NS 11	**0.925**
NS 12	**0.551**
NS 13	**0.718**
NS 15	**0.714**
Average =	**0.759**

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 3. Mercury results for individual Green Wing Teal muscle samples from the Great Salt Lake, Utah (2004).

Sample	Mercury concentration (mg/kg)*
GWT 3	0.170
GWT 4	0.177
GWT 11	**0.319**
GWT 12	0.243
GWT 13	**0.329**
GWT 14	0.243
GWT 15	0.146
GWT 18	0.294
GWT 19	0.178
GWT 20	0.222
Average =	0.232

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 4. Mercury results for individual Mallard muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
MAL 1	0.160
MAL 2	**0.506**
MAL 3	0.096
MAL 4	**0.488**
MAL 5	**0.662**
MAL 6	0.258
MAL 7	0.039
MAL 8	0.240
MAL 9	0.188
MAL 10	0.182
Average =	0.282

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 5. Mercury results for individual Northern Shoveler muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
SHOV 1	**7.075**
SHOV 2	**3.789**
SHOV 3	**3.405**
SHOV 4	**2.380**
SHOV 5	**0.722**
SHOV 6	**0.847**
SHOV 7	**0.888**
SHOV 8	**0.645**
SHOV 9	**0.738**
SHOV 10	**11.708**
Average =	**3.220**

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 6. Mercury results for individual Northern Pintail muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
PIN 1	0.089
PIN 2	0.007
PIN 3	0.095
Average =	0.064

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 7. Mercury results for individual Cinnamon Teal muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
CT 1	**0.605**
CT 2	0.228
Average =	**0.417**

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 8. Mercury results for individual Redhead muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
RED 1	0.089

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 9. Mercury results for individual Green Wing Teal muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
GWT 1	0.109
GWT 2	0.064
GWT 3	0.142
GWT 4	0.099
GWT 5	0.169
GWT 6	0.153
GWT 7	0.136
GWT 8	0.249
GWT 9	**0.390**
GWT 10	0.292
Average =	0.180

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Table 10. Mercury results for individual Gadwall muscle samples from the Great Salt Lake, Utah (2005).

Sample	Mercury concentration (mg/kg)*
GAD 1	0.027
GAD 2	0.019
GAD 3	0.024
GAD 4	0.031
GAD 5	0.025
GAD 6	0.078
GAD 7	0.065
GAD 8	0.205
GAD 9	0.045
GAD 10	0.088
GAD 11	0.024
Average =	0.089

Waterfowl samples collected by Utah Division of Wildlife Resources.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

Appendix B – Screening Value and Consumption Limit Calculations

Screening Value and Consumption Limit Calculations

For Noncarcinogenic Health Effects

$SV = [(MRL)(BW)]/CR$

SV = Screening value for a contaminant (in mg/kg or ppm)
MRL = Minimal risk level (in mg/kg/day)
BW = Mean body weight of the general population or subpopulation of concern (kg)
CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

Consumption Rate Calculations for Non-Carcinogenic Health Effects

To calculate the maximum allowable waterfowl consumption rate for a non-carcinogen:

$CR_{lim} = [(RfD)(BW)]/C_m$

Northern Shoveler	RfD	BW	C_m	CR_{lim}
Adult	0.0001	70	3.220	0.0022
Child	0.0001	16	3.220	0.0005

Where:
CR_{lim} = maximum allowable waterfowl consumption rate (kg/day)
RfD = reference dose (EPA) or minimal risk level (ATSDR)
BW = mean body weight of the general population or sub-population of concern (kg)
C_m = measured concentration of chemical contaminant in a given species of waterfowl (mg/kg)

$CR_{mm} = [(CR_{lim})(T_{ap})]/MS$

Northern Shoveler	CR_{lim}	T_{ap}	MS	CR_{mm}
Adult	0.0022	30.44	0.227	0.3
Child	0.0005	30.44	0.113	0.1

Where:
CR_{mm} = maximum allowable waterfowl consumption rate (meals/month)

CR_{lim} = as calculated above

T_{ap} = time averaging period (365.25 days/12 months = 30.44 days per month)

MS = meal size (0.227 kg waterfowl/meal for adults, 0.113 kg waterfowl/meal for children)

Assumptions for Consumption Rate Calculations are as follows:

An average adult weighs 70 kg and eats 227 g of waterfowl per meal.

An average child weighs 16 kg and eats 113 g of waterfowl per meal.