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Introduction

Mercury (Hg) concentrations in mallard duck (*Anas platyrhynchos*) tissue are being monitored as part of the Long-term Monitoring (LTM) program for a mercury-impacted riverine system in the Shenandoah Valley, Virginia. The primary objective of the LTM is to evaluate potential post-remediation changes in human exposure to site-related Hg through consumption of mallard ducks (*Anas platyrhynchos*) harvested from the watershed, in response to remediation. Reliably assessing migratory waterfowl Hg exposure from a site is confounded by life history, habitat preferences and migratory habits of the selected waterfowl species. Baseline data collected to date suggest that despite these challenges, the monitoring program design may be capable of reliably evaluating changes in human exposure to Hg in response to remediation.

Background

- Study area spans a contamination gradient over 160 river miles, with aquatic habitats influenced by urban, agricultural and national forest land use (Figure 1).
- Robust monitoring program includes human, aquatic and terrestrial exposure receptors to monitor environmental response to remediation.
- Historical study area data on mercury in blood, feathers, edible tissue, and organs of mallard ducks.
- Mean total mercury (THG) concentrations in muscle and liver tissue 0.53 and 2.3 mg/kg ww, respectively (2009, VDEQ)
- Interagency task team evaluated baseline human exposure to mercury through consumption of mallard ducks and other wildlife (Figure 2).

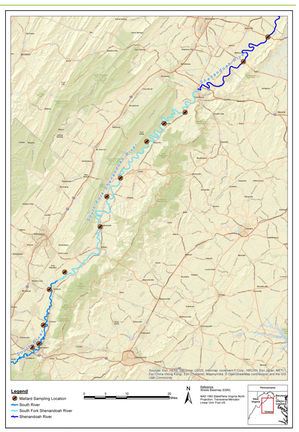

Figure 1: Site Location Map

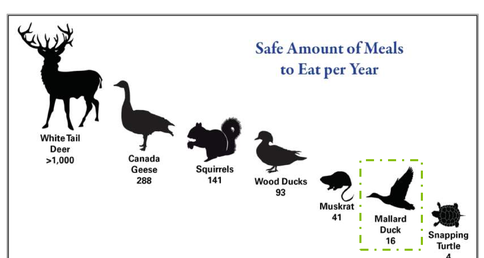

Figure 2: Safe amount of meals to eat per year for wildlife taken from the South River

Station ID	Description
SR-2.7	Ridgeview Park
SR0.1	Constitution Park / Basic Park (Waynesboro Reach)
SR11.8	Dooms to Crimora Reach
SR23.5	Harriston to Port Republic Reach
SF26.6	South Fork Shenandoah @ Lynnwood
SF48	South Fork Shenandoah @ Shenandoah Reservoir
SF63	Newport Landing
SF72	Hamburg, VA near Rt. 211 Bridge
SF89.4	Foster's Landing, near Rt. 694 Bridge
SF106	Bentonville Landing, near Rt. 613 Bridge
SF115	Karo Landing
SH143	Rt. 17/50 Bridge
SH158	Berryville, VA near Rt. 7 Bridge

Table 1: Station Locations

Approach

- Three mallards (*Anas platyrhynchos*) targeted for collection at each study location (Figure 1, Table 1).
- Traditional hunting techniques and hand held net guns used at some locations due to local ordinances and public parks (Figure 3, Figure 4 and Figure 5).
- Wing chord length, body weight, sex, and reproductive status data collected.
- Breast muscle tissue analyzed for THg and methylmercury (MeHg) by EPA Methods 1631 (THg) and 1630 (MeHg), respectively.

Figure 3: Constitution Park within the City of Waynesboro

Figure 6: Riverine habitats of the South River (A & B) and South Fork Shenandoah River (C)

Figure 4: Handheld net gun used to collect waterfowl where firearm use was not permitted

Figure 5: Hunter with waterfowl harvested from the South River

Results

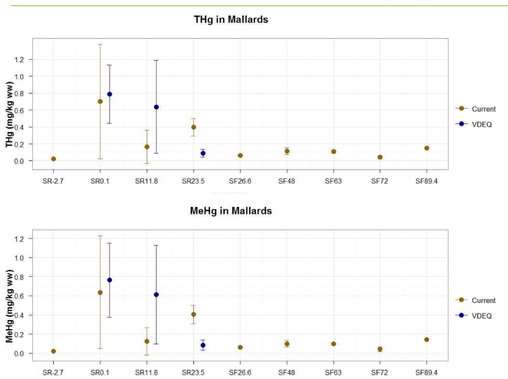

Figure 7: THg and MeHg concentrations in mallard (*Anas platyrhynchos*) breast muscle tissue

- THg and MeHg concentrations follow established spatial patterns for the system; increasing with distance from the historical point source, and declining approximately 12 river miles downstream (Figure 7)
- Within station variability is greater at stations with higher Hg concentrations (Figure 7)
- MeHg accounts for approximately 94% of THg in mallard (*Anas platyrhynchos*) breast tissue

Results *(Continued)*

- Distinct mercury signature documented in mallard ducks (*Anas platyrhynchos*) collected at Hg impacted stations (Figure 7).
- Dietary habits of resident mallards (*Anas platyrhynchos*) collected at public parks did not appear to influence Hg concentrations compared to non-park stations.
- Baseline mallard (*Anas platyrhynchos*) data follows similar spatial patterns as other human exposure endpoints [i.e. snapping turtles and smallmouth (*Micropterus dolomieu*)/largemouth (*Micropterus salmoides*] bass. Greater within station variability is also observed for these endpoints as well as at stations with higher mercury concentrations (Figure 8).
- Poor habitat availability led to limited mallard (*Anas platyrhynchos*) collection at stations furthest downstream (Figure 8).

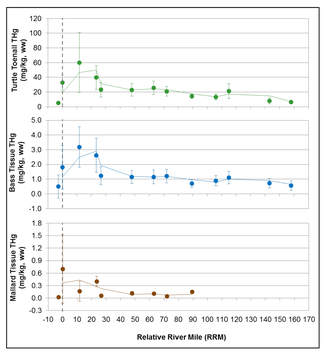

Figure 8: Comparison of baseline THg data for human exposure endpoints. Individual points represent location-specific mean THg concentrations based on multiple replicate samples collected from 2014 to 2016; moving average (rolling mean; 2 points) trendline represents the average trend of data on a downstream spatial scale.

Findings

Assessment of contaminant exposure in migratory species is difficult due to:

- Inter-annual climatic variability: effects migratory patterns and site exposure time (Figure 9 & 10).
- Differences in dietary habits of resident vs. migratory ducks effects contaminant exposure.

The monitoring program design was able to document increased Hg concentrations in mallard ducks (*Anas platyrhynchos*) at impacted sites. The comparison of historical data and multiple supporting lines of evidence (e.g. fish, turtles) will aid in the evaluation of human Hg exposure through waterfowl consumption in response to remediation.

Figure 9: Biological Flyways, Credit: Michael A Johnson, North Dakota Game and Fish Accessed at: http://flyways.us/flyways/info

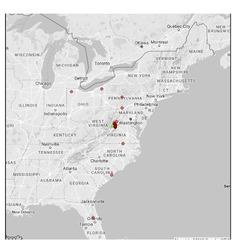

Figure 10: Waterfowl band returns for birds banded along the South River

The work described in this poster has been performed in conjunction with the South River Science Team (SRST), a multi-stakeholder group including representatives from local, state and federal governments, academia, environmental groups and DuPont. The SRST is a collaborative team created to provide input into the watershed-level, risk-based assessment framework to address mercury in the system.
For more information visit the South River Science Team website! → http://southriverscienceteam.org/