Saltmarsh and Nelson's (left) Sharp-tailed Sparrows, Scarborough Marsh, Maine. (Photo by K. O'Brien)

Developing a Geographic Exposure Profile of Methylmercury Availability in Salt Marshes of New England using Saltmarsh Sharp-tailed Sparrows.

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Abstract

We sampled blood and addled eggs from Saltmarsh Sharp-tailed Sparrows (*Ammodramus caudacutus*) nesting in 14 salt marshes in New England (Maine, Massachusetts, Rhode Island, and Connecticut) to assess methylmercury (MeHg) availability to insectivorous estuarine birds. We sampled blood and eggs of Tree Swallows (*Tachycineta bicolor*) concurrently at three of the sites to relate MeHg levels in sparrows to swallows. Sparrow mean blood mercury (Hg) levels ranged from 0.23 +/- 0.06 ug/g wet weight (ww) (n=6) in Connecticut, to 1.2 +/- 0.38 ug/g (n=25) in Massachusetts. Thirteen percent of the sparrows had Hg concentrations exceeding the lowest observed adverse effect level (LOAEL) of 1.0 ug/g (ww) as based on sublethal end points in tree swallows dosed with methylmercury. Egg Hg levels were similar between species suggesting eggs may not be the best indicator of mercury exposure in estuaries. Mercury exposure is site related and differed among marshes within a state and among states. Blood Hg levels in sparrows from Massachusetts were significantly higher than all other sites. Plausible explanations include: (1) higher levels of Hg input, (2) increased methylation rate and (3) variation in diet composition.

The blood Hg concentrations in Tree Swallows sampled from the the same three sites as Saltmarsh Sparrows were significantly lower than in Saltmarsh Sharp-tailed Sparrows, however, egg Hg levels in these species were similar and low (sample size of sparrow eggs was small, n=6).

1. Introduction

Exposure to mercury can impact bird behavior, physiology, and reproductive success (Thompson 1996, Wolfe and Norman 1998). Extensive studies with Common Loons have documented these impacts in Maine (Evers et al. 2004). It is well known that freshwater wetlands generally serve as areas of high Hg methylation, thus making obligate wetland wildlife especially vulnerable to high levels of Hg contamination (Evers et al. 2005). The role of saltmarsh habitats in methylating Hg and enhancing its bioavailability, however, is less well documented, but is of increasing concern especially in urban areas. *Saltmarsh Sharp-tailed Sparrows are obligate saltmarsh Passerines with ≈95% of their global population breeding in the northeast. Saltmarsh Sharp-tailed Sparrow is "watch list species with multiple causes for concern across its range" and according to Partners in Flight, one of the highest conservation priorities, and considered a "Bird of Conservation Concern" by USFWS Region 5. These designations result from their near endemic status in our region, lack of population trend data, and threats on their breeding and wintering grounds.*

Mercury levels in the blood reflect current dietary exposure. Spending their entire annual cycle in saltmarsh habitats should make Saltmarsh Sparrows excellent indicators of Hg contamination in estuaries of the Northeast.

Studies in Maine and Massachusetts have shown that Tree Swallows are appropriate indicators of Hg exposure in wetlands. We included swallows in the study to compare Hg levels in Saltmarsh Sharp-tailed Sparrows with established risk concentrations from other studies conducted with Tree Swallows (Heinz, pers. comm). Because recent dosing studies have now identified lethal effects at 0.8 ppm (wet weight=ww) in eggs, and lowest observed adverse effect levels (LOAEL) for Tree Swallow eggs at as low as 0.4 ppm (ww), we relate Hg exposure levels in Swallows with those in Sharp-tailed Sparrows. Tree Swallows nest in artificial boxes and are easily attracted to breed on the study area. *The purpose of this study was to determine Hg exposure and assess risk to passerines breeding in New England estuaries.*

6. Acknowledgments

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2. Methods

All capture and blood sampling occurred during June –August 2004 and 2005 using 12 m mist nets with 36 mm mesh size. An umbrella was used for shade to prevent birds from overheating. Sex, age and breeding status were determined for each bird. Venipuncture of the cuteneous ulnar vein with a 26 gauge sterile disposable needle allowed collection of 1-2 capillary tubes of blood into heparinized tubes for Hg analysis. The capillary tubes were sealed with Critocaps[R] and placed in 10 cc plastic vacutainer. All birds were released unharmed within 20-30 minutes of capture.

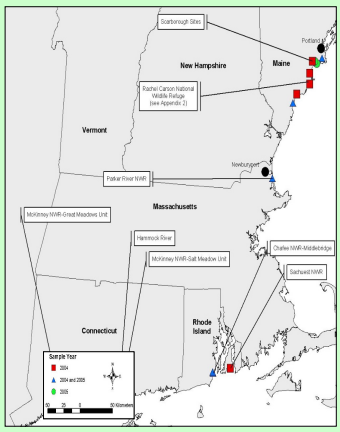
At two sites in Maine: Scarborough SWMA in Scarborough and Furbish Marsh, Rachel Carson NWR in Wells, and one site in Massachusetts, Parker river NWR in Newburyport (Figure 1), we placed nest boxes to attract Tree Swallows. We collected one egg from each box (unless the nest failed then we collected all eggs in the nest) and blood samples from nesting adult swallows for Hg analysis.

We opportunistically collected sparrow eggs from nests flooded during the high tide floods. Blood and egg samples were analyzed for total Hg at Texas A&M University, Trace Element Research Lab.

Statistical analyses

All statistical analyses were conducted using JMP 4.0 software with alpha=0.05. We used one-way Analysis of Variance (ANOVA) and Tukey-Kramer HSD pairwise comparisons tests to determine significant differences among sites and between species. When conditions of normal distribution of data were not met and/or variances were unequal a non-parametric Welch ANOVA test was used.

Figure 1. Saltmarsh Sharp-tailed Sparrow sampling locations in New England, 2004-2005.



3. Results and Discussion

Blood Mercury concentrations in Saltmarsh Sharp-tailed Sparrows

Sparrows from P*arker River NWR in Massachusetts had significantly higher blood Hg levels than birds from other sites sampled in 2004-2005 (P<0.05).* Sparrows from Sachuest site in Rhode Island and Little River in Wells, Maine had significantly higher Hg concentrations than Hammock River in Connecticut, Scarborough SWMA and Spurwink Marsh in Maine (P<0.05) (Figure 2).

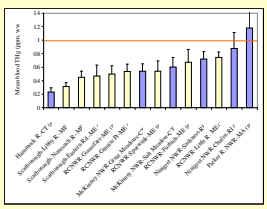


Figure 2. Mean blood Hg concentrations in adult Saltmarsh Sharp-tailed Sparrows, sampled across several NWR systems in New England, 2004-2005 (n=# of birds) (red line indicates 1.0 ppm Hg- the level for cause of concern in the blood of insectivorous birds).

3. Results and Discussion (cont.)

Comparisons between Tree Swallows and Saltmarsh Sharp-tailed Sparrows

Blood mercury

Mercury levels in Saltmarsh Sparrow blood were significantly higher than in Tree Swallows from all three sites (one-way ANOVA: Furbish Marsh: df=59, F=87, p<0.0001; Scarborough SWMA: df=35, F=44, p<0.0001 and Parker River NWR: df=35, F=66, p<0.0001 (Figure 3).

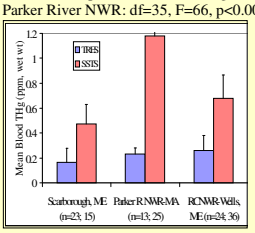


Figure 3. Blood mercury concentrations in Tree Swallows (TRES) and Saltmarsh Sharp-tailed Sparrows (SSTS) from Maine and Massachusetts, 2004-05.

The mean blood Hg levels are approximately 60% higher in Saltmarsh Sparrows versus Tree Swallows in both Maine sites and 80% higher in Massachusetts.

The difference in blood mercury levels between the species is likely a reflection of their foraging habits. Tree Swallows are likely feeding on prey lower on the food chain, therefore have lower Hg concentrations. Based on previous studies we speculate that prey items in Tree Swallow diet likely contain less Hg than the prey consumed by Saltmarsh Sharp-tailed Sparrows. Tree Swallows' estimated foraging radius is approximately 400 m from the nest box (Quinney and Ankney 1985). Saltmarsh Sparrows forage entirely in the salt marsh (Greenlaw and Rising 1994, Merriam 1979). On Long Island, New York Merriam (1979) found that the two most common insect orders in Saltmarsh Sharp-tailed Sparrow's diet were Diptera, ranging between 13 % in June to 47% of all items in July (predominantly adults and larvae of Stratiomyidae) and Hemiptera, ranging between 4% in June to 37% in July) (nymphs and adults of Miridae).

3. Results and Discussion (cont.)

Egg mercury

A total of 31 Tree Swallow eggs and 17 Saltmarsh Sparrow eggs were analyzed for Hg. *Hg levels in the eggs were lower than expected*. Based on a Hg dosing study (Heinz pers. comm.) conducted on Tree Swallow eggs the lethal LOAEL in swallow egg =0.8 ppm (ww) and sublethal effects may start at as low of concentrations as 0.4 ppm (ww). All eggs tested in this study were below the LOAEL threshold levels. We found a positive correlation between female Tree Swallow blood and egg Hg levels.

Based on our small sample size of sparrow eggs collected from Rachel Carson NWR in Wells-Furbish Road, *there was no significant difference in Hg levels between Tree Swallow and Saltmarsh Sparrow eggs (*F=0.12; df=12, P=0.8). *We found significantly higher blood Hg levels in the Saltmarsh Sparrows than Tree Swallows but the egg Hg concentrations were not significantly different between the species*. Therefore, contaminant levels measured in eggs might underestimate the total Hg exposure to the species. Interpreting Sharp-tailed Sparrow egg contaminant levels should be done with caution and eggs might not be the best tissue to use in estuarine contaminant studies or our sample size may not have been large enough to reflect differences between Tree Swallow egg and Sparrow egg Hg levels.

It is possible that at the time of egg laying the females' body burden of Hg was not at high enough levels to be depurated into the eggs.

4. Saltmarsh Sharp-tailed Sparrow Management Implications

Alarmingly high blood mercury levels found at some sites suggest that Hg accumulations may be high enough in the blood of Saltmarsh Sparrows to cause potential harm to the species. In order to fully understand these implications, it is important not only to identify the pathways of Hg into Saltmarsh Sparrows, but also the pathways in which Hg enters estuarine systems. Limiting mercury exposure through the reduction of point and non-point pollution is vital for the health of estuarine wildlife. Salt marsh managers will need to identity sources of Hg and reduce them by implementing BMPs for stormwater management where it impacts the salt marsh, using vegetative buffers, removing sources of pollution such as landfills and supporting regulations to reduce the amount of Hg entering the waste stream.

5. Conclusions

1. Saltmarsh Sharp-tailed Sparrow is an excellent indicator species of contaminants in estuaries; and bird blood is an appropriate tissue to use to evaluate the Hg exposure to insectivorous birds in salt marshes.
2. Saltmarsh Sharp-tailed Sparrows have elevated blood Hg levels across the sampling sites and are at potential risk to the effects from the contaminant in Parker River NWR in MA and Ninigret NWR in RI.
3. It appears that sparrow/swallow eggs may not be the best indicator tissue to use in assessing Hg exposure in estuaries.
4. It also appears that Tree Swallows may not always be the best indicator species of contaminants.
5. It is critical to select an appropriate indicator species when assessing the exposure of contaminants to wildlife.