Mercury Contamination of Crayfish in the Susquehanna River

Joshua Stocker and Brian Mangan
King's College, Environmental Program, Wilkes-Barre, PA

Abstract

Like many rivers in the United States, the Susquehanna River has been contaminated with mercury and large sections of the river are under a fish consumption advisory for high mercury concentrations in gamefishes. Therefore, the study of mercury in the invertebrate food web is essential to understanding mercury dynamics within the Susquehanna. There has been no research to date to determine mercury concentrations among crayfish in the Susquehanna River. We analyzed preserved tail-muscle samples of crayfish (n=314) from 11 sites along the river for total mercury concentration. Our results indicate that total mercury concentrations of individual crayfish ranged from 0.08 to 4.38 ppm with an average of 0.38 ppm. However, average mercury levels varied consistently along the river such that the highest levels occurred at the upriver sites and then steadily decreased at downriver sites.

Introduction

Mercury contamination is a major health concern for humans and the environment. Mercury can bioaccumulate and biomagnify among trophic levels and crayfish are considered bioindicators of mercury contamination because they function as omnivores at multiple trophic levels. As a result, crayfish can form a significant mercury pathway to predators such as fish, birds and mammals, including humans. To better understand the role of crayfish in river mercury dynamics, we collected crayfish from along the Susquehanna River and analyzed preserved tail muscle for total mercury (THg).

Methods

Crayfish were collected using baited wire traps at 11 sampling sites along 410 km of the Susquehanna River during the summer of 2008 (Figure 1). At each of the sites, 100 crayfish traps designed specifically for trapping river crayfish were baited and placed in 10X10 grids (Figure 2, Mangan et al. 2009a, Mangan et al. 2009b). Two species of crayfish were captured, the invasive Rusty Crayfish, *Orconectes rusticus*, and the native Allegheny Crayfish, *Orconectes obscurus*. All crayfish captured were preserved in 70% ethanol and returned to the lab for identification. Tail-muscle samples were removed from 20-30 crayfish from each sampling site. Attempts were made to compare crayfish similar in size among the sites and to sample equal numbers of males and females when possible. Tissue samples were dried in a heating block for 1 hour at 60 C before analysis.

Mercury analysis was done with a direct mercury analyzer (Milestone DMA-80) that uses thermal digestion, gold amalgamation and atomic absorption spectrometry. Quality assurance included reference, standard, and blank samples. Because crayfish were preserved in 70% ethanol, our results are approximately 4-5 fold overestimates of mercury concentrations that would be measured in non-preserved crayfish tissues (unpublished data).

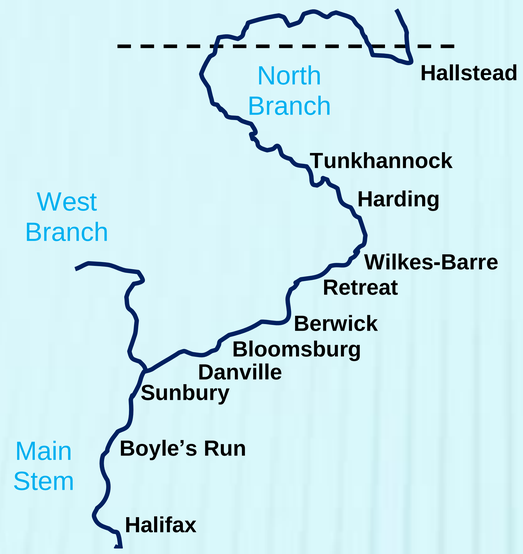

Figure 1. Map of the 11 sampling sites along the Susquehanna River.

Sampling Site	River Kilometer	THg Concentration ppm dry wt. (SD)	Crayfish Species
Hallstead	560	0.690 (0.269)	Rusty
Tunkhannock	354	0.697 (0.339)	Allegheny
Harding	327	0.554 (0.181)	Rusty
Wilkes-Barre	303	0.488 (0.250)	Allegheny
Retreat	278	0.256 (0.090)	Allegheny
Bell Bend	267	0.343 (0.109)	Allegheny
Bloomsburg	241	0.249 (0.124)	Allegheny
Danville	224	0.206 (0.054)	Allegheny
Sunbury	195	0.407 (0.770)	Rusty
Boyle's Run	185	0.282 (0.216)	Rusty
Halifax	150	0.160 (0.058)	Rusty

Table 1. Sampling sites, river kilometer, THg concentration, and crayfish species from the Susquehanna River.

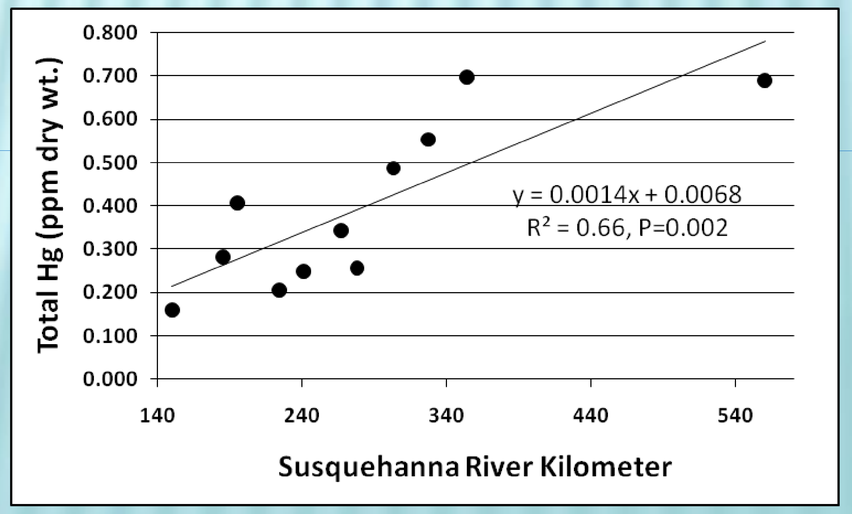

Figure 3. Plot of the average THg concentration of crayfish at each of the 11 sampling sites. Similar geographic patterns are observed among each species and sex of crayfish.

Results and Conclusions

Our data indicate that there is significant mercury contamination in crayfish from the Susquehanna River. In addition, these results suggest that crayfish can be a considerable pathway for mercury transfer between trophic levels in this ecosystem (Table 1).

Mercury concentrations in individual crayfish ranged from 0.08 to 4.38 ppm, with an overall average of 0.38 ppm. Thirteen crayfish from across the sites had THg concentrations ≥ 1.0 ppm. One of the crayfish at the Sunbury site had a mercury concentration in excess of 4 ppm, despite this site having the lowest average concentration of all the sites.

Levels of contamination varied along the river such that the lowest average levels occurred at the downriver sites and then steadily increased upriver (Figure 3). The average mercury concentration at Tunkhannock was over four times greater than the average concentration at Halifax, our southernmost site.

There were no significant relationships or differences observed between THg concentrations and crayfish size, sex, and species. With the invasion of the Rusty Crayfish throughout the watershed, and this species occurring at higher densities than the native Allegheny Crayfish (unpublished data), it seems possible that more mercury could be made available to crayfish predators within the Susquehanna.

Our results suggest that researchers and natural resource managers would be well advised to incorporate multiple sampling sites along rivers before attempting to characterize mercury contamination in crayfish if not other aquatic organisms. Further research is necessary to determine why THg concentrations in crayfish increased with distance from the mouth of the river.

Literature Cited

Mangan, B.P., A.D. Ciliberto, and M.T. Homewood. 2009a. A versatile and economical trap for capturing wild crayfish. J. Freshwater Ecol. 24(1):119-124.

Mangan, B.P., J.J. Savitski, and N.T. Fisher. 2009b. Comparison of two traps used for capturing wild crayfish. J. Freshwater Ecol. 24(3):445-450.

Figure 2. Trap used for the capture of crayfish from the Susquehanna River.

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