USGS
science for a changing world

Mercury in Biota of Sinclair Inlet, Puget Sound Washington

Kelly L. Scholting and Anthony J. Paulson — U.S. Geological Survey, Washington Water Science Center

Figure 1. Map showing Puget Sound with locations of sampling stations.

Abstract

In the Puget Sound Region, bioaccumulation of toxic chemicals in biota, particularly fish, has been a major concern. Past studies have shown that mercury concentrations in fish in Sinclair Inlet are higher than in other estuaries in Puget Sound. Because mercury concentrations in fish increase with increasing age, age and length must be considered in comparing mercury concentrations across geographical areas in Puget Sound. Historical (1996–2005) biota data were compiled from the Puget Sound Ambient Monitoring program over several years. Fish species of a higher trophic level, such as rockfish and ratfish, from Sinclair Inlet had higher mercury concentrations than fish from other locations in Puget Sound. Species of fish at a lower trophic level, such as Pacific staghorn sculpin and English sole, from Sinclair Inlet had mercury concentrations that were similar to other fish from locations in Puget Sound. Two benthic invertebrates, graceful crab and sea cucumber, had higher mercury concentrations in Sinclair Inlet than other locations in Puget Sound.

Introduction

In the Puget Sound region, bioaccumulation of toxic chemicals in biota, particularly fish, has long been a major concern. Fish contaminated with high amounts of toxic pollutants can become a potential health risk when fish are consumed by people. Studies have shown that mercury concentrations in water, sediment, and biota in Sinclair Inlet are higher than in other estuaries in Puget Sound (fig. 1). In addition, past studies by the Washington State Department of Fish and Wildlife (WDFW) in cooperation with the PSAMP (Johnston and others, 2007) have analyzed mercury in biological samples. As a result of information from these studies, Sinclair Inlet has become a location of particular concern for mercury bioaccumulation in biota, especially species at the higher trophic level that more likely to accumulate contaminants.

Approach

Historical biota data (table 1) was complied from the Puget Sound Ambient Monitoring program over several years (1996–2005). The resulting mercury concentrations in biota were compared between Sinclair Inlet and other locations in Puget Sound. Mercury concentrations in fish increase with increasing age, thus, the comparisons across Puget Sound were conducted with mercury data from individual biota samples to account for differences in length, age and/or weight among geographical areas.

Year	Sampling Location	Reference
Rockfish		
1996-1997	Sinclair Inlet	West and O'Neill, 1998
Spotted Ratfish		
2005	Hood Canal, Nisqually, Sinclair Inlet, Strait of Georgia	Johnston and others, 2007
Pacific Staghorn Sculpin		
2005	Sinclair, Vendovi	Johnston and others, 2007
English Sole		
1996	Sinclair Inlet	Jim West, Washington State Department of Fisheries and Wildlife, written commun., 2008
2003	Sinclair Inlet	Jill Brandenberger, Battelle Marine Sciences Laboratory, written commun., 2008
2005	Commencement Bay, Elliott Bay, Hood Canal,Nisqually,	Johnston and others, 2007
	Port Gardner, Strait of Georgia, Vendovi	
Graceful Crab		
2005	Hood Canal, Nisqually, Sincalir Inlet, Vendovi	Johnston and others, 2007
Sea Cucumber		
2005	Sinclair, Vendovi	Johnston and others, 2007

Table 1. Species, year, and location sampled.

Results

Rockfish,
(Sebastes spp.)

- Mercury concentrations in rockfish were positively correlated with age as shown in figure 2.
- Rockfish in Sinclair Inlet have significantly higher mercury concentrations relative to other populations in Puget Sound.
- Rockfish specimens from Sinclair Inlet were older (up to 33 years old) than other Rockfish collected from Puget Sound and hatched when mercury concentrations in Sinclair Inlet sediments were at their highest.

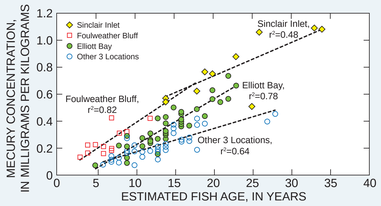

Figure 2. Rockfish age versus mercury concentration for several stations in Puget Sound with eight samples (diamonds) from Sinclair Inlet, which has the highest mercury concentrations and age. (Graph from West and O'Neill, 1998).

Pacific Staghorn Sculpin
(Leptocottus armatus)

- Based on limited samples, individual Pacific staghorn sculpin of similar length collected from Sinclair Inlet and Vendovi Inland have similar mercury concentrations as shown in figure 4.

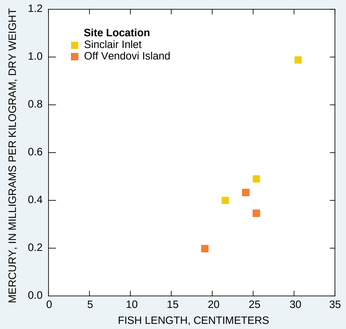

Figure 4. Pacific staghorn sculpin mercury concentration versus length for Sinclair Inlet and Vendovi Island.

Graceful Crab
(Cancer gracilis)

- Graceful crab with similar length from Sinclair Inlet have higher mercury concentrations than those collected from other areas of Puget Sound as shown in figure 6.

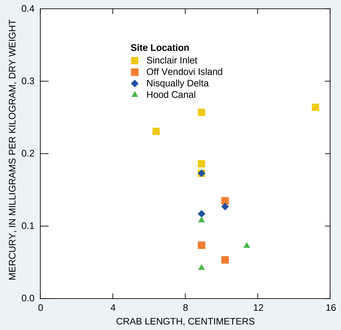

Figure 6. Graceful crab mercury concentrations versus length.

Spotted Ratfish
(Hydrolagus colliei)

- Spotted ratfish from Sinclair Inlet had higher mercury concentrations than individual specimens of similar length than other areas of Puget Sound (fig. 3).

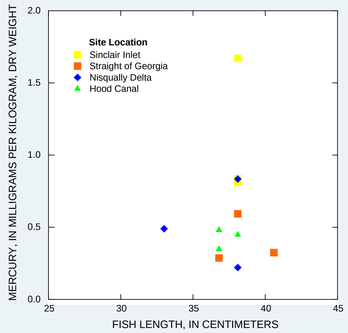

Figure 3. Spotted ratfish mercury concentrations versus length for four stations in Puget Sound.

English Sole
(Parophrys vetulus)

- Individual English sole collected from 1996 and 2003 had increasing concentrations of mercury as the length of the fish increased.
- English sole collected from Sinclair Inlet were larger than English sole collected from elsewhere in Puget Sound in 2005.
- When individuals of the same size are compared, mercury concentrations of English sole from Sinclair Inlet were similar to the mercury concentrations of English sole collected from other areas of Puget Sound (fig. 5).

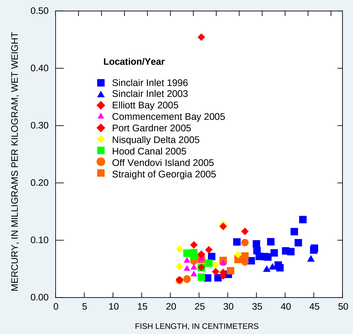

Figure 5. English sole mercury concentration versus length for several stations in Puget Sound.

Sea Cucumber
(Parastichopus californicus)

- Mercury concentrations in sea cucumber collected from Sinclair Inlet were at least 7-fold higher than those collected off of Vendovi Island north of Admiralty Inlet as shown in table 2.

Location	Hg (mg/kg) wet wt.	Weight (kg)
Sinclair Inlet	0.0245	0.44
Sinclair Inlet	0.0208	0.33
Sinclair Inlet	0.0168	0.71
Vendovi	0.00357	0.48
Vendovi	0.00384	0.75
Vendovi	0.0016	0.37

Table 2. Sea cucumber mercury results and sampling locations.

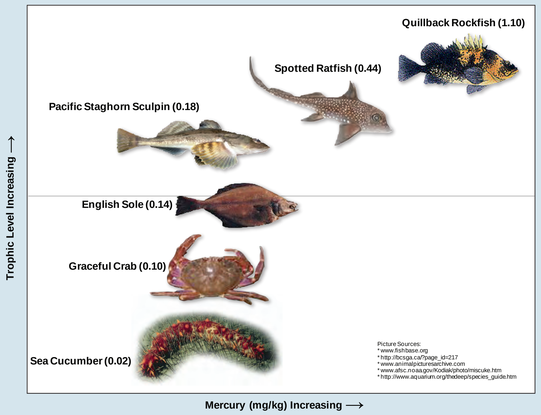

Figure 7. Trophic level versus mean mercury concentration (in parenthesis) in Sinclair Inlet.

Summary

- In Sinclair Inlet, mercury concentrations increase with the trophic level of species (fig. 7).
- Fish species at higher trophic levels, such as rockfish and ratfish, have higher mercury concentration in Sinclair Inlet than other locations in Puget Sound (figs. 2 and 3).
- Species of fish at a lower trophic level, such as Pacific staghorn sculpin and English sole, in Sinclair Inlet have mercury concentrations that are similar to other locations in Puget Sound (figs. 4 and 5) when individuals of similar size are compared.
- Two benthic invertebrates (graceful crab and sea cucumber) have higher mercury concentrations in specimens from Sinclair Inlet when compared to a limited number of other locations in Puget Sound (fig. 6 and table 2).
- For most species, there are an insufficient number of individual specimens to conduct statistically significant analyses.
- For ongoing sampling, it is recommended that programs assessing human health risk or for detecting differences among populations consider measuring mercury in individual specimens (as compared to composites) over a range of sizes in a subset of their measurements. These additional data are critical for the ability to detect geographical differences in contaminant burden in fish species.

References Cited

Johnston, R.K., Leisle, D.E., Brandenberger, J.M., Steinert, S.A., Salazar, Michael, and Salazar, Sandra, 2007, Contaminant residues in demersal fish, invetebrates, and deployed mussels in selected areas of the Puget Sound, Washington: Proceedings of the 2007 Georgia Basin Puget Sound Research Conference, Puget Sound Action Team and Environment Canada. (Data available at http://www.psmem.org/assets/PRIVATE/suppl_info.html)

West, J., and O'Neill, S., 1998, Persistent pollutants and factors affecting their accumulation in Rockfishes (*Sebastes* spp.) from Puget Sound, Washington: Puget Sound Research Conference.

Contacts:

Kelly Scholting **USGS Washington Water Science Center**
934 Broadway, Suite 300, Tacoma, WA 98402
Telephone (253) 552-1648 Fax (253) 552-1582
scholtin@usgs.gov http://wa.water.usgs.gov/

Anthony Paulson **USGS Washington Water Science Center**
934 Broadway, Suite 300, Tacoma, WA 98402
Telephone (253) 552-1681 Fax (253) 552-1582
apaulson@usgs.gov http://wa.water.usgs.gov/