# COPPER AND MERCURY IN AN OYSTER REEF SYSTEM, TEN THOUSAND ISLANDS, SOUTHWEST FLORIDA

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## INTRODUCTION

Oysters are often used as indicators of estuary health. Since oysters are suspension feeders that filter water, they can retain small particles within their bodies (Day, 1989). If these particles have heavy metals attached to them, this filtering would lead to a concentration of heavy metals within the oyster body. The Rookery Bay National Estuarine Research Reserve in the Ten Thousand Islands area in southwest Florida is currently focusing on restoring its estuary to pre-anthropogenic conditions. For these reasons, any information about oysters and oyster health in the area would be helpful to the reserve in determining estuary health.

Because the reserve is adjacent to agriculture and other development, heavy metal pollution is a potential threat. Heavy metals, especially copper and mercury, are a concern for both environmental and human health. In addition to being a carcinogen, mercury affects the nervous system and can permanently damage the brain. It can also harm unborn children if ingested by the mother (www.epa.gov/pbt/mercury.htm). Mercury biomagnifies though the environment, and causes death in fish, shellfish, and birds. This biomagnification can cause the mercury concentration in fish and shellfish to be tens of thousands of times greater than the concentration of mercury in the water (www.epa.gov/owow/oceans/airdep/air2.html). Copper is a necessary nutrient for humans, but excessive levels of it can be detrimental. Copper is recognized to cause gastrointestinal, cardiovascular and liver toxicity. Prenatal exposure can also be harmful (www.scorecard.org/chemicalprofiles/summary.tcl?edf_substance_id=7440-50-8).

Oysters live in clumps that combine to make up a larger oyster reef. A single reef with hundreds to thousands of oysters could potentially have significant filtering and accumulation effects. My research focused on answering the question of where in an oyster reef system the heavy metals that are filtered out accumulate. An oyster reef system includes sediment upstream, within, and downstream of the reefs, as well as oyster shell and tissue samples from within the reef. Generally, oysters accumulate heavy metals in their tissue. My hope is that this work will be significant in helping to understand more about oyster reefs in the Rookery Bay estuary, which will help resolve the larger problem of determining the estuary's health.

## PROJECT METHODS

Henderson Creek Bay was chosen as the study area because it is the waterway within Rookery Bay that is the most affected by agricultural development, and will likely have higher metal concentrations as a result. Reefs A and B are each about 2 meters long and are located along the margins of Henderson Creek, about a kilometer from the mouth of the creek. Reef C is a large circular reef, about 15 meters in diameter, and is located where Henderson Creek Bay opens into a larger bay system.

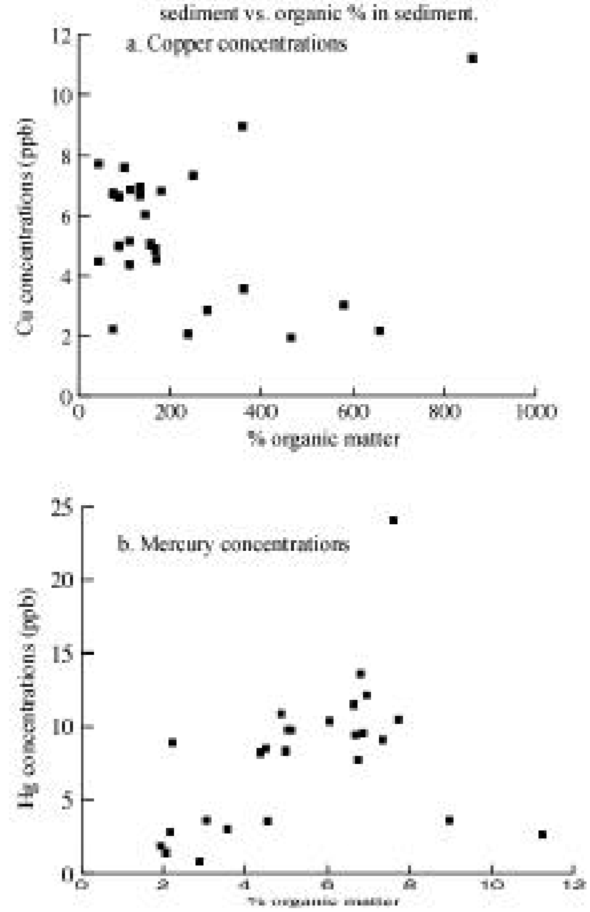
The sampling procedure was designed so that the filtering effects of the oyster reefs could be tested. Sediment from both upstream and downstream of the reefs was sampled to see if the oyster reefs had a significant impact on the water quality. Reef sediment, oyster tissue, and oyster shell were tested to see if oysters managed to concentrate the heavy metals in their shells or tissue, or if metals were passed through their system. Five components were tested at each of the three reefs: external sediments (upstream), internal sediment from the middle of the reef, shells and tissue from the middle of the reef, and external sediment downstream of the reef. Three samples were taken of each component to ensure a large enough sample size. Oyster samples were collected by hand, reef sediment was collected with a sanitary scoop, and coated cocktail shakers were used to collect external sediment. All sample devices were rated for trace metal analyses.

Samples were tested for mercury at the organic chemistry lab at Florida Gulf Coast University using their mercury analysis system. Testing the samples for copper was done at a chemistry lab at Whitman College using their atomic absorption instrument. Percentage of organic matter was found at Whitman College by ashing the sediment and then using 3% hydrogen peroxide.

## RESULTS AND DISCUSSION

There are two main factors that control mercury and copper concentrations in sediment. The first factor is distance from source area. For metal source areas located upstream of the test reef, metal concentration would likely decrease from reefs further upstream to reefs further downstream. Another factor that influences heavy metal concentration is the amount of organic matter within the sediment. Rickabaugh (1999), while working in the same estuarine system, observed that organic-rich sediment had increased capacity to concentrate heavy metals. Temminghoff and others (1997) also found that organic matter significantly absorbs heavy metals, especially copper. Organic matter content has been measured in all sediment samples to determine the role that organic matter had in absorbing and concentrating copper and mercury. Figure 1 shows the graphed correlation for heavy metals and organic content. No significant correlation was found.

Figure 1. Heavy metal concentrations in sediment vs. organic % in sediment.




### *Mercury Concentrations*

Table 1 lists the mean concentrations of mercury in sediment, oyster tissue, and oyster shell. Reefs A and B, the small reefs that are close together upstream in Henderson Creek show similar absolute concentrations, while reef C, the large reef downstream where Henderson Creek Bay opens into a larger bay system, has lower absolute concentrations. In all of the reefs, the concentration of mercury in oyster tissue is much higher than the concentration in the sediment. Reef C, which has the lowest absolute mercury concentrations in sediment, has the highest mercury concentration in tissue. For all the reefs, the mercury concentration in the oyster

**Table 1. Mercury (Hg) and copper (Cu) concentrations (ppb)** [reported concentrations are mean of the three samples measured at each position]

| | Upstream sediment | | Reef sediment | | Downstream sediment | | Oyster tissue | | Oyster shell | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hg | Cu | Hg | Cu | Hg | Cu | Hg | Cu | Hg | Cu |
| Reef A | 10.6 | 115 | 11.4 | 173 | 8.16 | 77 | 30 | 1374 | BDL | 162 |
| Reef B | 8.78 | 138 | 14.8 | 101 | 10.9 | 139 | 16 | 1299 | BDL | 242 |
| Reef C | 1.37 | 329 | 3.29 | 464 | 3.16 | 533 | 39 | 88 | BDL | 69 |

Reefs A,B = middle Henderson Creek Bay Reefs

Reef C = Hall Bay Reef (where Henderson Creek Bay opens into a larger bay system)

shells is below the detection limits of the instrument.

A reef filtering effect is not observed when sediment is compared between upstream and downstream sites on a reef. However, internal sediment from the inside of a reef has a higher mercury concentration than external sediment. This increased concentration is probably due to the high amount of oyster feces within a reef's interior.

Because higher mercury concentrations are found in the middle of Henderson Creek at reefs A and B as opposed to where Henderson Creek Bay opens into a larger Bay system at reef C, the source for mercury is probably freshwater runoff from higher up in the watershed.

### *Copper Concentrations*

Copper concentrations (Table 1) among reefs A, B, and C are opposite of what is observed for mercury concentrations. Copper concentrations in sediment from reef C are significantly higher than copper concentrations in sediment from reefs A and B. Previous research done in Galveston Bay, Texas shows a positive relationship between increased salinity and increased copper concentration (Tang, 2001). This is a possible explanation for the higher concentrations of copper at reef C, since reef C is further from the freshwater source, and is likely to have higher salinity concentrations than reefs A and B.

### *Levels of Concern*

Fortunately, none of the copper or mercury levels in the sediment, oyster tissue or oyster shell is at a level of concern. The EPA has set the minimum cleanup levels for copper in marine sediment at 390 ppm (parts per million), and for mercury in marine sediment at 0.59 ppm (590 parts per billion).

## COPPER AND MERCURY SOURCES

While mercury is found naturally in the environment, the Environmental Protection Agency estimates that human activities are responsible for 75% of worldwide mercury emissions. The initial source of mercury is difficult to determine because mercury can be deposited and re-emitted several times in the environment (www.epa.gov/owow/oceans/airdep/air3.html). However, there is strong evidence that the majority of the mercury found in southwest Florida comes from local sources. The majority of mercury (one model estimates 71$\pm$8%) comes from local sources such as municipal waste and medical waste incinerators and oil combustion in Broward and Dade Counties in southeastern Florida (Dvonch, 1999). Other sources of mercury are not as easily determined, and are probably in the atmosphere as a result of both global and regional sources. Mercury is transported through the atmosphere from eastern to western Florida by the trade winds that dominate during the stormy wet season, and is then deposited in the Everglades area by precipitation during the wet months (Guentzel, 2001).

The greatest outputs of copper contamination in the United States are from mining and smelting operations and municipal incinerators (www.epa.gov/safewater/dwh/c-ioc/copper.html). Copper is also a main ingredient in many pesticides and in marine paint, so likely sources in southwest Florida are from pesticides used in agriculture in the area, and from boats (www.scorecard.org/chemical-profiles/summary.tcl?edf_substance_id=7440-50-8).

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