Galveston Bay: Temporal Distributions of Organochlorine Contaminant Concentrations in Oysters

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Abstract

The temporal distributions of organochlorine contaminants (Chlordanes, DDTs, Dieldrin, PCBs and Dioxins) in oysters from six Galveston Bay sites from NOAA's NS&T Mussel Watch Program are discussed and compared with other NS&T sites from the Gulf of Mexico as well as the East and West Coast of the U.S. Decreases in the median for the Gulf-wide concentration of chlordanes, and dieldrin occurred during 1986-1992. The Gulf-wide median concentration of DDTs and PCBs, appears to be strongly influenced by a large-scale climatic factor, such as the El Nino/Southern Oscillation, exhibiting a cyclic concentration distribution that is also observed in the salinity at the Galveston Bay sites during the study. The dioxin concentrations tend to mirror the PCBs. The different temporal distributions would suggest that there are different mechanisms for uptake and depuration depending on the shape of the organochlorine contaminant.

Introduction

The Galveston Bay system is one of the important estuaries along the U.S. Gulf Coast. It receives contaminant inputs from the surrounding urban areas in the form of storm water runoff and waste discharge, which have shown an increase over the past 20 years.[1] Oyster samples (bivalves) have been collected from nearly 80 estuarine sites in the Gulf of Mexico since 1986, as part of the NS&T program. Oysters are utilized as sentinel organisms because they are economically important organisms, do not readily metabolize contaminants, provide an assessment of bioavailability, and are able to survive high pollutant loading.[2,3] Oysters, therefore, are considered to be excellent biomonitors of current contamination levels in estuarine areas. The contaminants in oysters reflect the time-integrated contaminant concentration available in solution, adsorbed onto particles and incorporated into food. The measured concentration of a particular contaminant in an oyster is the difference between uptake and depuration of that contaminant.[4,5] Using Galveston Bay NS&T sites as a small scale model, the temporal distribution of the concentration of selected trace organic contaminant analytes in oysters are compared with Gulf of Mexico sites and all NS&T sites.

Method

The American oyster (*Crassostrea virginica*) was collected at all Gulf of Mexico sites. Sampling started in January 1986.[6] Galveston Bay NS&T sampling sites include; Ship Channel (GBSC), located at the mouth of Goose Creek in Tabbs Bay, Yacht Club (GBYC), located near the judge's stand of the Houston Yacht Club, Todd's Dump (GBTD), located on a reef midway between Eagle Point and Red Fish Island, Hanna Reef (GBHR), a reef that separates East Bay from Galveston Bay, Offats Bayou (GBOB), near the 61st street bridge in Galveston, and Confederate Reef (GBCR), near Deer Island in West Bay. Details of the methods used to generate the present data have been reported previously.[7,8,9]

Results

Since the data for the contaminants is a log normal distribution, "high" concentrations have been defined as those that exceed the median plus one standard deviation for the log data.[10] Explaining the temporal variation in contaminant concentration is complicated because many biological and environmental factors may affect the measured concentration. Generally, it has been observed that populations with high contaminant concentrations are characterized as being less healthy.[9]

Chlordane

In the NS&T program, total chlordanes is defined as the sum of the components alpha-chlordane, trans-nonachlor, heptachlor and heptachlor epoxide. This definition is recognized as an under estimate of the complex mixture known as chlordane. The median concentration of total chlordanes for the Gulf of Mexico exhibits an overall decrease in concentration for the first seven years of NS&T, but the variation at each site within Galveston Bay is not covariant with the total Gulf-wide data, indicating strong local control for the source of chlordanes. The "high" concentration criterion relative to the Gulf-wide data was observed in 39 of the 102 samples for 1986-1992. GBOB was the site with the highest concentration of total chlordanes, which is probably due to its proximity to urban development where chlordane may have been used as a termiticide.

DDT and derivatives

DDT was once the most widely used insecticide in the world. The total DDTs is the sum of the p,p'- and o,p' isomers of DDT, DDD and DDE. The distribution of the concentration of DDTs for oysters from NS&T's Gulf of Mexico sites and all NS&T sites almost overlay. The Galveston Bay concentrations are distributed equally along the distribution curve. Bivalves appear to exhibit little biological effects attributable to DDT residues. Of the 102 Galveston Bay samples, 19 of the samples exceeded the criterion for "high" concentrations of having concentrations greater than the Gulf-wide median plus one standard deviation for each year. The general trend in the median total DDTs for all Gulf of Mexico sites is cyclic. The cyclic trend seems to fit the response a large-scale climatic control, such as the El Nino /Southern Oscillation, would impose on the contaminant concentration.[9] For the first seven years, GBSC was the site with the highest concentration of total DDTs.

Dieldrin

Dieldrin is synthesized by the oxidation of aldrin. It has generally been restricted to agricultural use.[11] The use of dieldrin and related aldrin were banned in the middle 1970's.[12] The "high" concentration criterion using Gulf-wide data was exceeded by 39 of

the 102 oyster samples from Galveston Bay. The trend in the median concentration of dieldrin exhibits an oscillation from year to year toward lower concentrations. GBSC and GBYC have the highest levels of dieldrin in Galveston Bay for the seven years of study. Site to site differences suggests local control for the source input of dieldrin.

Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are synthesized by chlorination of biphenyl, and may contain any of 209 discrete compounds, or congeners, containing one to ten chlorine atoms. The number of "high" concentration samples (greater than median plus one standard deviation) for Galveston Bay were thirty-seven of the 102 oysters. The median concentration for the Gulf of Mexico exhibits the cyclic distribution of concentrations that has been linked to large-scale climatic conditions exerting control over the concentration of contaminants. In Galveston Bay, GBSC was the site with the highest concentration of PCBs, and it is the site nearest industrial input. The PCB concentration for the Gulf-wide data is markedly lower in concentration than all NS&T sites. Particularily noteworthy is the lower percentage of high concentration samples from the Gulf of Mexico.

Dioxins

Dioxins are not currently measured as part of the NS&T program, but are interest because of the potential for causing environmental harm. The data suggests that there is a similarity in the distribution of dioxins to that observed for the PCBs.

Discussion

The percentage of "high" concentrations (i.e., concentration greater than the median plus one standard deviation) that should be expected for a log normal distribution are about 17%, since 83% of the data should be less than the median and plus one standard deviation. For DDTs the percentage of "high" samples in Galveston Bay were 19% compared to the Gulf-wide distribution. This suggests that Galveston Bay, the Gulf of Mexico, and all NS&T sites can be modeled using a single heterogeneous log normal distribution. The percentage of "high" concentration samples in Galveston Bay for PCBs, dieldrin, and chlordanes, are 36%, 38%, and 38%, respectively. This infers a higher contribution from local point sources of contamination in Galveston Bay when compared to the Gulf-wide NS&T data. The different temporal distributions for the various organoachlorine contaminants would suggest that there are different mechanisms for uptake and depuration depending on the shape of the organochlorine contaminant.

Acknowledgments

Funding for this research was supported by the National Oceanic and Atmospheric Administration, contract number 50-DGNC-5-00262 (National Status and Trends Mussel Watch Program), through the Texas A&M Research Foundation, Texas A&M University.

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