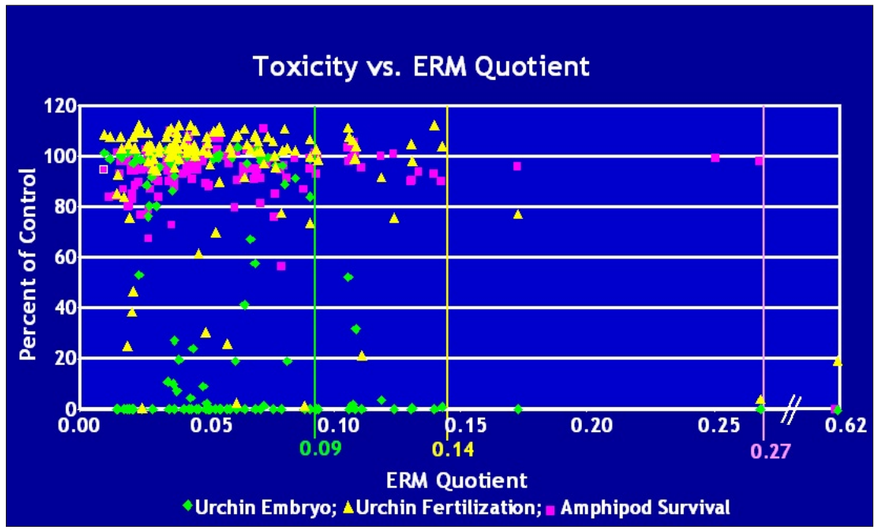
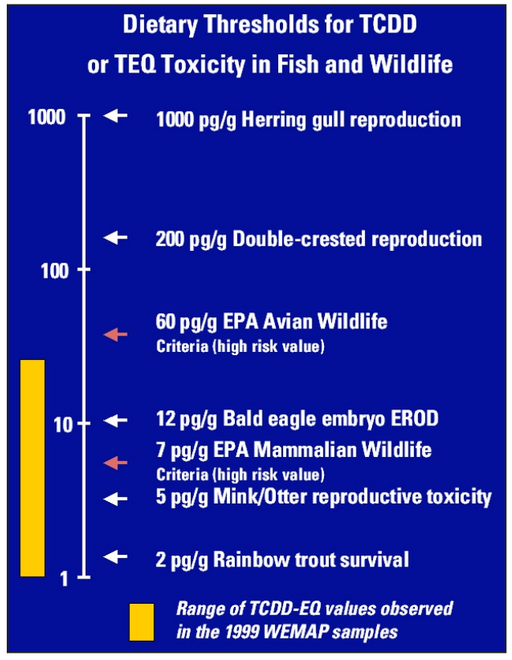
Relative Toxicity Threshold Comparisons for the Sea Urchin Tests and the H4IIE Bioassays

Toxicity vs. ERM Quotient. Threshold values for three different toxicity endpoints compared with ERM (Effect Range Median)* quotients (ERMQ) for data from the sea urchin toxicity tests. The ERMQ thresholds indicate the value at which all sediment pore water samples above which were significantly toxic for a particular test. The comparison among tests also provides a relative measure of sensitivity among the different endpoints.



* *Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments.* Environmental Management *19(1):81-97.*



Dietary toxicity thresholds for dioxin and dioxin-like chemicals in fish and wildlife species. A selection of toxicity thresholds for dietary amounts of dioxin and related chemicals are presented for some fish and wildlife species. The bar along the axis of the graph is the range of H4IIE bioassay-derived TCDD-EQ observed in fish from the small estuaries of the 1999 WEMAP collections. Concentrations of dioxins or dioxin-related potency greater than the toxicity values indicate elevated risk.

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BEST/EMAP-Western Small Estuary Monitoring

Introduction

The U.S. Geological Survey (USGS) Biomonitoring of Environmental Status and Trends Program (BEST) monitors, identifies, and assesses contaminants and their effects on biological resources, including biota and the habitats that support them.

BEST applies a suite of biomonitoring methods in large rivers as one approach for monitoring contaminants and effects, but it is not sufficient to address the wide array of issues concerning contaminant effects in the environment. Consequently, BEST is pursuing the development of additional monitoring options through collaborations with other national monitoring programs to complement the activities and results provided by those other programs.


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Small estuaries along the coastlines of Washington, Oregon, and California provide important habitat for a variety of fish and wildlife species.

The sediment porewater toxicity tests and the H4IIE bioassays are conducted in the laboratory under controlled conditions using samples collected from the small estuaries.

The Estuary Resource Group of the Environmental Monitoring and Assessment Program (EMAP) in 1999 sampled habitats along the Pacific coast. EMAP is a national program of the U.S. Environmental Protection Agency (EPA) that uses a probability-based sampling design to periodically characterize ecological conditions at regional and national spatial scales.

The core indicators of estuarine environments include measures of physiochemical attributes, water quality, sediment quality and habitat characteristics, as well as attributes of the fish and benthic communities. Many of these indicators are also BEST indicators.

The addition of porewater toxicity testing as an additional indicator of sediment quality provides a more comprehensive picture of contaminants and their effects in estuarine habitats.

The H4IIE bioassay is used in BEST to determine fish health and provides complementary information on the ecological metrics used in the EMAP program.

The first phase of this BEST/EMAP collaboration is an estuary monitoring study; a three-year joint effort to evaluate the ecological health of both small and large estuarine environments of California, Oregon, and Washington.

Visit the BEST web site at: http://www.best.usgs.gov/.

U.S. Department of the Interior
U.S. Geological Survey

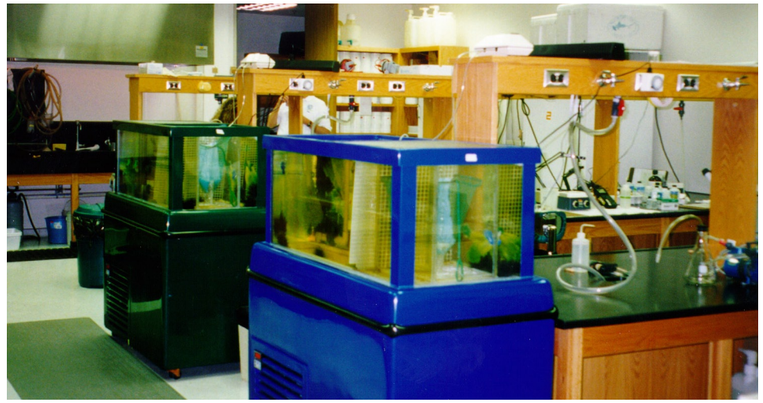
August 2003

Sediment Porewater Toxicity Tests

http://www.cerc.usgs.gov/pubs/pubs.htm#1

Toxicity assessments of sediment porewater from small estuaries in the states of Washington, Oregon, and California were conducted using the sea urchin (*Arbacia punctulata*) fertilization and embryological development tests.

Pore water resulted from an extraction process using a pressurized pneumatic device. Water quality characteristics and dissolved organic carbon measurements provided additional information to the toxicity assessment. Statistical comparisons between sediment test and reference sites demonstrated that some sediments in all three states exhibit toxicity; the most toxic were located in southern California.



Inside the Marine Ecotoxicology Research Station lab where sediment porewater tests are conducted.

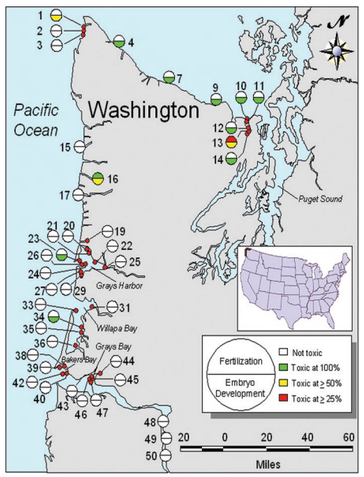
Sea Urchin Fertilization Toxicity Test

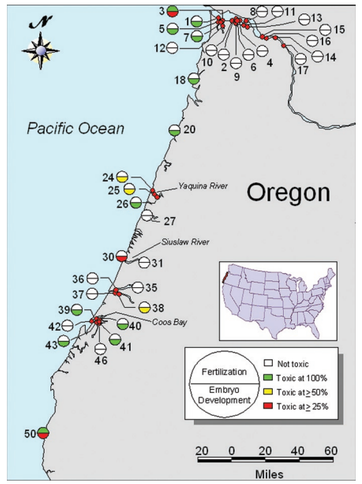
The purpose of the sea urchin fertilization toxicity test is to determine if the sediment pore water adversely effects fertilization. Sea urchin gametes collected and mixed with the sediment porewater were evaluated for fertilization. All tests were run in a dilution series.

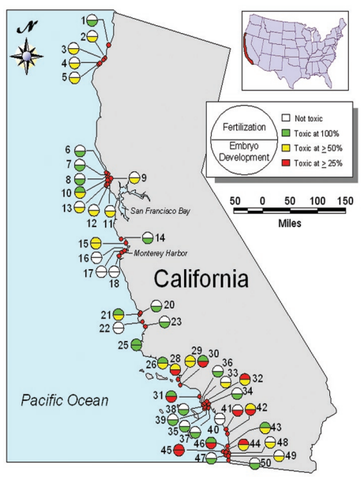
Sea Urchin Embryological Development Toxicity Test

The purpose of the embryological development toxicity test is to determine if the sediment porewater affects exposed sea urchin embryos, by arresting development or causing abnormalities. Gametes from the sea urchin are collected then mixed for egg fertilization. Resulting embryos are then used in the toxicity test, exposed to sediment porewater, and evaluated for development.

Sediment Toxicity Maps. Sea urchin toxicity test results for sediment pore water from sites along the Pacific coast of the United States. Color symbols indicate sites that are significantly different from the reference (Dunnett's t-test, α=0.05, detectable significance criteria applied).







H4IIE Bioassay

http://www.cerc.usgs.gov/pubs/pubs.htm#1

Small estuaries along the western coast of the U.S. were surveyed for dioxin-like contamination in fish. The relative potency of dioxin-like chemicals found in benthic fish was assessed with the H4IIE rat hepatoma cell line. The H4IIE bioassay measures all of the chemicals in an organic extract of the fish that bind to the dioxin receptor and cause dioxin-like toxicity.

The dioxin-like toxic potency of chemicals found is based on the ability of the fish extracts to increase 7-ethoxyresorufin-*O*-deethylase (EROD) activity in the H4IIE rat hepatoma cell line. The results of the induction caused by the extracts are evaluated relative to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD).

The H4IIE bioassay responds to chemicals that bind to the aryl hydrocarbon receptor (Ah-R). The chemicals included in this class are polychlorinated biphenyls (PCBs), polychlorinated dioxins (PCDDs), and dibenzofurans (PCDFs). The H4IIE bioassay integrates the overall potency of these chemicals. Response of the rat hepatoma cells to the environmental extract sample (fish) is calibrated against TCDD and the resultant potency is given as TCDD-EQs.

H4IIE Bioassay Maps

The H4IIE data are presented graphically on maps and represent results of the individual samples.

The H4IIE bioassay results were categorized into TCDD equivalents (TCDD-EQs) that were thought to be 1) no to low hazard, 2) potentially hazardous, or 3) likely to be hazardous. Sites with individual sample results that fell into more than one category are represented by multiple categories (semi-circles of two colors). No sites had samples in more than two categories. The maps represent all of the outcomes at a site and do not represent averages of the H4IIE results from the site. The categories are relative benchmarks for comparative purposes and should not be construed as definitive thresholds of toxicity.

Results of the H4IIE bioassay may be used to screen environments in which dioxins or dioxin-like chemicals may be of concern. The H4IIE bioassay can be used to discern those environments which need further attention or further chemical analysis.

The amount of dioxin-like potency in the fish from the small estuaries of the west coast was low in most cases. Fish from Washington estuaries had low to non-detectable (ND) concentrations of TCDD-EQs as measured by the H4IIE bioassay, except for some samples in the Columbia Rivers estuary which had ND to <5pg TCDD-EQ/g (wet wt).

H4IIE bioassay-derived TCDD-EQs in fish collected from Oregon Waters were greater, in general, than those observed in fish from Washington. The fish with the greatest TCDD-EQs were collected in the Columbia River estuary, Tillamook Bay, and the Yaquina River.

Fish collected in small estuaries from the California coastline had low to moderate amounts of TCDD-EQs as measured by the H4IIE bioassay.

H4IIE bioassay-derived TCDD-EQs for sites along the U.S. West coast. Color differentiation of symbols indicate categories of risk posed by quantities of dioxin-like chemicals in fish.