USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

(1) Project No:

(2) TITLE: Chemical Mixtures: Consequences for Water Quality

(3) Focus Categories: SED, TS, WQL

(4) Keywords: Ecosystems, Mixtures, Pesticides, Residues, Sediments, Toxic Substances, Water Quality

(5) Duration: September 1, 1998 to October 31, 2000

(6) Federal Funds: 27,120 (27,120)

(Total) Direct

(7) Non-Federal Funds: 54,349 (29,065) (25,284)

(Total) Direct Indirect

(8) Principal Investigator, University and City:

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(9) Congressional District No: District No.1

(10) Water Problem, Need for Research:

Non-polar organic pesticides and organic metals are released into the aquatic environment and partition from surface water into sediment due to their hydrophobic nature. These non-polar chemicals have the potential to bioaccumulate in aquatic organisms exposed by direct contact with the sediment or indirectly through food. Recently, the U.S. EPA has proposed to establish guidelines for assessing sediments based on the concentrations of bioaccumulative chemicals in benthic invertebrates. The toxicity threshold values for bioaccumulative chemicals have typically been based upon single chemical studies. However, it is rare that a chemical occurs alone in the aquatic environment, particularly sediment. At the present time, there is limited knowledge regarding the bioaccumulative nature and effects of chemical mixtures. Furthermore, the mechanisms by which mixtures of bioaccumulative pesticides and metals elicit adverse effects are poorly understood.

The overall goal of the proposed research is to evaluate the interactions of "real-world" bioaccumulative chemical mixtures having the potential for toxicological effects

not predicted from single chemical toxicity experiments. The model compounds, dieldrin, chlorpyrifos, and methyl mercury will be evaluated using the amphipod, *Hyallea azteca*. Bioconcentration data along with toxicological indices will be used to determine the critical body residue threshold concentrations at which toxicological effects occur. This proposal directly addresses Mississippi Water Research and South Atlantic-Gulf Region priorities related to water quality, particularly to needs addressing protection of water and sediment from environmental degradation.

(11) Expected Results, Benefits, Information:

he main goal of the proposed research is to evaluate the interaction of bioaccumulative chemical mixtures having the potential for toxicological effects not predicted from single chemical toxicity experiments. The compounds proposed for investigation, chlorpyrifos, dieldrin, and methyl mercury are persistent in the environment and occur as contaminants in sediments. They have been shown to bioaccumulate in aquatic organisms, reaching concentrations in the organism resulting in toxicity. In sediments, these chemicals often occur as mixtures, and not as single chemical contaminants. Therefore, assessments of contaminated sediments based upon single chemical toxicological and analytical data may not represent the "real world" toxicological effects of these chemicals. Most chemical interaction studies have evaluated mixtures of chemicals having identical or similar mechanisms of toxicity. From results of these previous studies, it was concluded that the toxicity of chemical mixtures is additive. That is, the toxicity of a mixture of chemicals is approximately equivalent to that expected from a simple summation of the known toxicities of the individual chemicals present in the mixture. Based upon basic pharmacological and toxicological assumptions, the toxicity of a mixture of chemicals having the same or similar mechanism of action would be additive. At the present time, the assessment of mixtures is typically based on the assumption of additivity, and does not consider chemical-chemical interactions of substances with dissimilar mechanisms of action. There is a paucitiy of knowledge concerning chemical mixtures that have similar toxicological effects, but act through different mechanisms. A review of insecticide mixture interactions by Calabrese (1991) addressed the specific lack of data for metal-insecticide interactions. Based upon the known mechanisms of the three bioaccumulative chemicals selected for investigation, it is hypothesized that a mixture of these chemicals will result in greater than or less than additive interactions resulting in toxicity that would not be predicted by the traditional model of additivity. The use of *H. azteca* as our model organism will enable a comprehensive evaluation of the chemical mixture interactions between the model compounds. Previous investigations examining the interactive effects of chemicals have been limited by the number of organisms used in testing. In these studies only a small number of concentrations and combinations of the chemical mixtures were evaluated. Therefore, limited data were

obtained to characterize the interactions. However, due to the abundance and ease of culturing *H. azteca*, there is a sufficient number of organisms to completely characterize the chemical mixture interactions. Additionally, *H. azteca* is physiologically similar to higher level organisms, having metabolic capabilities and organ systems by which whole organism effects can be evaluated, and thus represents an excellent model organism for use in this investigation.

In summary, the proposed research utilizes a novel approach to address the issue of chemical mixture toxicity. The model chemicals were selected due to their persistence in the environment and potential for occurrence as mixtures. Results of the proposed investigation will contribute to our currently limited understanding of chemical-chemical interactions. Accordingly, this project is directly applicable to Mississippi and the South Atlantic-Gulf because of the importance of accurately assessing ecological risk.