

Region V Dioxin Strategy

The Analytical Perspective: Blood, Sweat and Tiers

I. The Analysts

A. Troika

1. EPA - Environmental Research Laboratory, Duluth
2. EPA - Toxicant Analysis Center, Bay St. Louis
3. EPA - Research Triangle Park
4. Capacity

B. Contract Laboratory Program

1. IFB Awardees
2. Ongoing Lab Evaluation
3. Capacity

II. The Analytes

A. 2,3,7,8 - TCDD

1. Total Tetra Class
2. Isomer Specific

B. Penta - Octa Dioxin Classes

1. Isomer Specific

C. 2,3,7,8 - TCDF

1. Total Tetra Class
2. Isomer Specific

D. Penta-octa Furan Classes

1. Isomer Specific

E. Other organic priority pollutants, hazardous substance list compounds

III. The Analysis

- A. Dioxin Sample Control Centers
- B. Matrices and Detection Limits
- C. Extraction Techniques
- D. Clean-up methods
- E. Instrumental Analysis
 - 1. HRGC/LRMS
 - 2. HRGC/HRMS
- F. Quantitation and Identification

IV. The Assessment

- A. Regional Data Review
- B. Health Risk Assessment
- C. Auxiliary Data Auditors

Strategy for Integrated Assessment of a Multi-Media Study on
Regulatory Effectiveness in Protection of a Great Lakes Ecosystem

The large controls of the discharge of toxic wastes thru the various regulatory mechanisms within a basin will be evaluated for their combined ability to protect all segments of the ecosystem. Many regulatory mechanisms are available to water quality managers, however, the regulations are quite specific and do not provide a feedback mechanism that indicates how well the system is being protected. Traditionally, studies have been pollutant, trophic, organism, or industry specific, as opposed to an assessment of the system, as a whole. This includes abatement efforts as well as impacts on the ecosystem. There is a need to examine ecosystems which receive a large number of effluents to determine the extent to which systems are being protected by many individual regulatory avenues. Presently, there are two mechanisms used in the regulatory limitation of pollutants. These were established under the NPDES system in the 1972 Clean Water Act. The principal effort was to limit pollutants in effluents. These limitations were mainly technology based efforts. A second mechanism utilized water quality standards in the receiving of water. The evaluations placed on water quality standards have been hampered by the information available on the species to be protected. Generally, these have been limited to laboratory based numbers. In an integrated assessment, the limitation of the input of pollutants would be evaluated on the basis of ecosystem benefit in the receiving stream, as well as in the lake which receives the discharge. The proposed effort would be a multi-media study involving local and state planning and regulatory agencies, the EPA Regional Surveillance and Analysis ^{Division} Section, the Enforcement Division (permits), Great Lakes Nationwide Program Office,

and the Water Quality Division. In Region V, initiatives have already begun to examine a river-harbor system regarding the permit effectiveness in controlling the amount of pollutants being discharged to the system. The study is an assessment of the ecosystem, and is a mechanism to relate the environmental effects to regulatory actions.

The need for a total ecological assessment is becoming increasingly evident as we enter an era of evaluating the effectiveness of pollution control measurements in protecting all segments of the environment. Because the ecosystem is so closely integrated and interdependent, evaluations which span the total assemblage of organisms inhabiting the body of water must be carried out. With the emphasis on the control of pollution through effluent permits, the focus on the quality of the receiving water has been de-emphasized. It is evident that water bodies need to be examined in detail to determine the effects of various pollutants singly, and in combination, on the biotic communities of various aquatic ecosystems. The need for a comprehensive environmental initiative that relates pollutant input to transport, fate and ecological effects has been the subject of recent ORD/OEPER issue papers and multi-agency workshops.

It is proposed that a basin in the Great Lakes be used in evaluating regulatory efficacy based on an ecological assessment. Many agencies already contribute to the base of knowledge that would be required to support such an effort. The Fish and Wildlife Service of the Department of the Interior have extensive fish stock assessment programs. The Environmental Research Laboratory of National Oceanographic and Atmospheric Administration has extensive studies in water circulation. Various universities have studies in all phases of ecosystem assessment and

research. State and local agencies are active in the assessment of many nearshore ecosystems. The Large Lakes Research Station has conducted extensive studies on heavy metals and PCB's dealing with their transport, fate and effects in select ecosystems. Region V and the local and state regulatory agencies have information on discharges thru NPDES.

The overall objective of such a study is to coordinate a multi-media program which would examine the singular and combined impact of pollutants on the major, if not all, segments of a specified ecosystem. The regulations in place applicable to the system would then be evaluated and assessed for their effectiveness in protection of the system. Both effluent limitations and water quality standards would be evaluated. The approach would seek to examine transport within the aquatic system emphasizing the dissolved fraction and that portion associated with particulate matter, including inert biological materials. Both accumulation through the food chain (bioaccumulation) and direct uptake of pollutants (bioconcentration) would be measured or calculated. The major thrust in the approach of this study is to relate pollutant input to ecological effect in a quantifiable way. Historically, ecological studies have been used to describe pollutant effects in qualitative terms. The basic question of "how much must be removed" could never be answered by the biologist-ecologist. This inability to quantify a response results from the lack of numerical estimates which related pollutant dose to physical effects in natural systems. Through an effective linkage of laboratory test information and dose responses from pollutant transport models, ecological risk estimates can be developed. The ecological assessments can subsequently be verified through chemical measurements and field evaluations of the biological communities. The basic approach would be to

relate the duration of exposure of sessile communities and planktonic forms to pollutant inputs. In the latter case, the pollutant and biological communities would be transported together. It has been observed in studies of the Great Lakes zooplankton and phytoplankton that pollutant effects can be easily demonstrated in these communities. The effect of urban areas was well documented on the planktonic populations of Lake Ontario. Laboratory information on primary production, nutrient uptake, and organism growth as well as the pollutant response will be combined into a model framework for the evaluation of field and laboratory measurements. For many areas of the Great Lakes, pollutant transport models now exist. For limited segments of the Great Lakes ecosystem, models now exist that relate pollutant inputs to organism dose. The last step in relating field dose to effects on organism physiology and behavior have not been adequately applied to the Great Lakes; however, modeling frameworks presently exist. For some areas, transport would have to be incorporated by addressing source information of various pollutants. In other areas, simple transport mechanisms would be adequate. The incorporation of microcosm data is possible through the use of "bag" experiments. Both these, and other types of enclosures have been used in the Great Lakes to assess the impact of pollutants. The intent therefore is to develop dose/time or intensity/duration assessments for pollutants and organism assemblages.

The output for these studies would be used to quantitatively relate pollutant input to ecological effect. Specific water quality criteria have been developed for many pollutants entering the Great Lakes, however, these are based on the most sensitive impact and do not approach the overall ecosystem responses. Through a numerical coupling and calibration of field data, individual and combined pollutant inputs can be evaluated for the

impact on many different toxic levels. The modeling framework would provide guidance on the different types of additional field and laboratory information that would be required. The ultimate output would be to relate ecosystem responses to exposures of pollutant discharges. Individual populations are exposed to varying degrees depending upon pollutant burdens and the circulation within the water body. With the development of pollutant transport models for many of the areas of the Great Lakes, the application to a total ecosystem assessment should be greatly enhanced.

Specific sites within the Great Lakes appear to be well suited for the examination of ecosystem responses to pollutant inputs. The Saginaw Bay area has been studied in great detail for the past six years during the development of phytoplankton models to describe and develop nutrient loading limits. More recently, heavy metal and organic contaminants models have been developed. Each of these have related specific inputs to various components of the ecosystem. It would appear that with the addition of other data that is available on the Saginaw Bay system and nominal amounts of additional data that might be required, a comprehensive model could be developed and compared against field data. The model would provide an overall framework to evaluate exposure and to identify gaps in knowledge for a total assessment. Saginaw Bay appears to have severe ecosystem impacts that have not been totally evaluated. These include perturbations of primary production, large zooplankton mortalities and varying pollutant uptakes by portions of the ecosystem. The intermedia concept is important in Saginaw Bay since, to a large extent, heavy metals originate from the atmosphere. Fortunately, years of atmospheric and tributary input data are available for this area.

St. Louis Harbor-Lake Superior area appears to be well suited for a pollutant ecosystem assessment with the laboratory data which is available, or could be developed on the species inhabiting that embayment. Pollutant transport which is available for existing St. Louis Harbor models would provide exposure/dose evaluations. A detailed knowledge of the various toxic levels toxic materials within the harbor and the pollutant inputs would be required.

At the outset, a careful evaluation of the target species within the system and the anticipated pollutant impact would have to be undertaken. The development of a mathematical framework which relates pollutant input to organism response would be required for any site, since most frameworks are organism specific, and not generally designed for the evaluation of total ecosystems. Studies relating pollutant bioaccumulation are available, although, tolerance models are not. The size of the Saginaw Bay and St. Louis systems are such that studies will permit numerical analysis of pollutant transport and responses as well as ecosystem studies of the major biotic communities. Regulatory information is available for the Saginaw Basin from the Michigan Department of Natural Resources and the Central Michigan Planning and Development Region and Region V. Discharge information on the St. Louis River is available from the Minnesota Pollution Control Agency.

Other sites such as the Raisin River in Michigan and the Ashtabula River in Ohio will be evaluated by Region V. They are preparing a multi-media study on the regulations in place on these systems. ORD could add the assessment of the lake ecosystem and its response to the regulatory efforts.

During the first year, frameworks could be developed which would conceptualize the pollutant/ecosystem relationships. These would be built upon models that exist for Saginaw Bay and St. Louis Harbor. In the St. Louis Harbor, additional testing of pollutant inputs and biotic structure would need to be undertaken. During the second year (FY82), field sampling would be undertaken to measure the exposure of various types of pollutants to organisms within the system. Laboratory experiments would be implemented during the second and third year periods to verify the responses to the specific pollutants observed in the field year. The fourth and fifth years would be spent in data evaluation and ecosystem simulations of the pollutant responses.

The following information is currently available in support of this proposed effort:

Materials available on characterization of the physical and chemical components of Saginaw Bay.

Materials available on the biology of Saginaw Bay.

Models available for Saginaw Bay.

PCB data available for Saginaw Bay.

Materials available for the characterization of the physical and chemical components of St. Louis Harbor.

Materials available on the biology of St. Louis Harbor.

Models available on St. Louis Harbor.

Laboratory data available for organism - pollutant response from Saginaw Bay and St. Louis Harbor.