



EMAP Monitor

ENVIRONMENTAL • MONITORING • AND • ASSESSMENT • PROGRAM

An interagency program to monitor the condition of the nation's ecological resources

An Overview of the Environmental Monitoring and Assessment Program

Both the incidence and scale of reported environmental problems have increased over the past two decades. The public is increasingly concerned that the resources upon which they rely for recreation, quality of life, and economic livelihood remain sustainable. Scientists are increasingly concerned that the impact of pollutants now extends well beyond the local scale: global climate change, acidic deposition, ozone depletion, non-point source pollutant and sediment discharges to waterways, and habitat alteration threaten our ecosystems on regional and global scales. Years of scientific study have not only heightened our environmental awareness, but also have convinced us that the ecological processes that determine how our ecosystems respond to both natural and anthropogenic disturbances are extremely complex. Unfortunately, the current status of our environment is currently not well documented, making it impossible to assess quantitatively where and at what rate degradation may be occurring. While we believe that our policies and programs are protecting the quality of our environment, we cannot prove it with currently available data.

We cannot, for example, determine whether reported problems are increasing across extensive areas of the country, or simply reflect a more informed and vocal public or a locally visible pollution issue. Nor can we determine whether collective human impacts are a more plausible explanation for such problems than are natural causes such as drought. Finally, we are unable to determine whether the policies and programs we now have in place to restore our damaged resources, or to protect those perceived to be threatened, are effective. Clearly, we need a national baseline against which future changes in the condition of our resources can be measured and the overall effectiveness of our environmental policies can be evaluated with confidence.

In 1988, the U.S. Environmental Protection Agency's (EPA) Science Advisory Board recommended implementing a program to monitor ecological status and trends that would identify emerging environmental

problems before they reach crisis proportions. The next year, EPA refined the focus of its environmental protection efforts by calling for an active confirmation that its programs are truly maintaining or improving environmental quality. The Environmental Monitoring and Assessment Program (EMAP) is part of the Office of Research and Development's (ORD) response to both the Science Advisory Board's recommendation and the Agency's call for "managing for results." EMAP's goal is to monitor the condition of the nation's ecological resources. EMAP data will enable us to evaluate the success of current policies and programs and identify emerging problems before they become widespread or irreversible.

EMAP represents the foundation for ORD's Ecological Risk Assessment Program. When fully implemented in cooperation with other agencies that share resource monitoring responsibilities, this coordinated research and monitoring effort will provide the information needed to document the current condition of our ecological resources, understand why that condition exists, and predict what it may be in the future under various management alternatives. Such information will enable EPA to take proactive steps that will minimize future risk or to revise current efforts that fall short of their intended results.

The concept of EMAP was developed in 1987. Since then, several key questions have been formulated that will guide the Program toward meeting its goal: What is the current extent of our ecological resources, and how are they distributed geographically? What proportions of the resources are currently in acceptable ecological condition? What proportions are degrading or improving, in what regions, and at what rates? Are these changes correlated with patterns and trends in environmental stresses? And, finally, are adversely affected resources improving in response to control and mitigation programs?

These questions pose a challenge that cannot be met without a long-term commitment to environmental

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monitoring on national and regional scales. Furthermore, this challenge cannot be met efficiently without drawing on the experience and expertise within other federal agencies and organizations that share responsibility for maintaining environmental quality or sustaining our resources.

The EMAP approach to monitoring ensures broad geographic coverage; enables quantitative and unbiased estimates of ecological status and trends; facilitates analysis of associations among measurements of habitat condition, pollutant sources and exposure, and biological condition (indicators); and allows sufficient flexibility to accommodate sampling of multiple types of resources and identification of emerging environmental issues.

EMAP Objectives

- ❑ *Estimate the current status, extent, changes, and trends in indicators of the condition of the nation's ecological resources on a regional basis with known confidence.*
- ❑ *Monitor indicators of pollutant exposure and habitat condition and seek associations between human-induced stresses and ecological condition.*
- ❑ *Provide periodic statistical summaries and interpretive reports on ecological status and trends to resource managers and the public.*

To ensure efficient execution of this approach, EMAP planning and field demonstration projects have involved other organizations within EPA, including the Program and Regional Offices, as well as other federal agencies. Current collaborative efforts are described in the Current Activities section of this issue. As specific plans for implementation are formulated, EMAP will also need to enlist the assistance of state agencies located within the particular areas targeted for monitoring. The development of monitoring plans, which undergo rigorous technical review by national scientific organizations, is also occurring in concert with many university cooperators.

Several long-term, coordinated monitoring efforts will be implemented by EMAP over the next five years. These programs, which will operate on regional scales over periods of years to decades, will collect data from many resource categories: arid lands, agricultural systems, forests, lakes and streams, the Great Lakes, inland and coastal wetlands, estuaries, and coastal waters. Field crews will measure biological, chemical, and physical variables and processes on statistically selected sampling sites for resource classes, such as sagebrush-dominated shrubland, orchard cropland, oak-hickory forests, small lakes, emergent estuarine wetlands, or large estuaries. Some of these measurements

will also be made by using remote sensing techniques. Data on atmospheric deposition and exposure to other air pollutants will be obtained. Finally, maps, aerial photography, and satellite imagery will be used to describe broad regional patterns of the landscape in areas where sampling is being conducted.

Organizationally, EMAP has four major elements: Resource Monitoring, Coordination, Integration, and Developmental Research.

❑ **Resource Monitoring**

Resource monitoring focuses on collection and interpretation of field data on the ecological condition of the eight resource categories mentioned earlier. The activities of the Estuaries Resource Group are highlighted in the feature article of this first issue of the *Monitor*, and summaries of progress to date for the other active groups follow the feature article.

❑ **Integration**

Integration activities include several functions that facilitate the acquisition, management, and interpretation of monitoring data. The Air and Deposition and Landscape Characterization Groups provide data that assist all Resource Groups in interpreting observations on resource condition. EMAP-Information Management facilitates the storage of information and its dissemination to and from the Program as well as among the Resource Groups, Coordination Groups, and the other Integration Groups. The Integration and Assessment Group oversees the acquisition of data from other monitoring networks that cut across or are relevant to two or more Resource Groups. This Group also ensures that the scientific information collected during various EMAP field activities is translated into a form that can be used to answer management questions regarding regional-scale problems. Activities to date are provided in the Current Activities section.

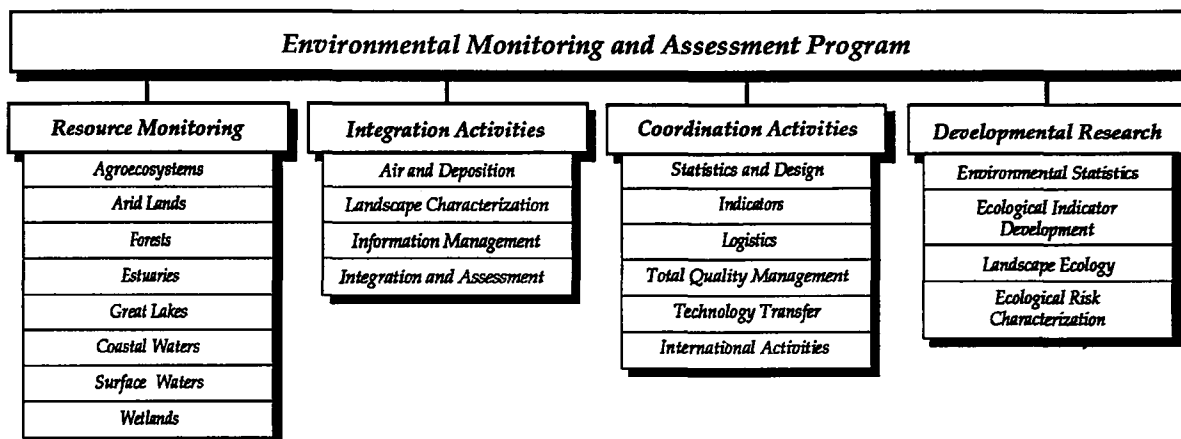
❑ **Coordination**

Several coordination activities support EMAP's resource monitoring efforts, including network design and statistical analysis; indicator selection, testing, and evaluation; logistics; and quality assurance. A principal function of the Coordination Groups is to ensure that data collection activities by the Resource Groups are conducted in standardized ways. For example, the Coordination Groups provide complementary network designs and statistical procedures for analyzing data, consistent field and laboratory methods, and quality assurance and quality control protocols. Activities to date for each of these Groups are summarized in the Current Activities section.

Other coordination functions include technology transfer activities and liaison with the international community, other agencies, states, and EPA Regions. These activities will be highlighted in future issues of the *Monitor*.

❑ **Developmental Research**

An active research program is essential to ensure that EMAP can respond and adapt to new issues;



capitalize on improved scientific understanding; and incorporate advances in methods development, data analysis, and reporting techniques, while simultaneously retaining continuity in the long-term data sets it develops. All major groups within EMAP conduct research that is relevant to their specific resource or coordination and integration responsibilities. Additionally, EMAP has identified four major areas of research that are cross-cutting and is currently establishing research programs for these areas: environmental statistics, ecological indicator development, landscape ecology, and ecological risk characterization. These programs are an integral part of ORD's Ecological Risk Assessment Program and will be discussed in further detail in future issues of the *Monitor* as their plans are refined.

Although the agenda for EMAP is ambitious, the Program represents the type of monitoring program that is needed for the 1990s and beyond. As a developing program, the ideas, approaches, and strategic plans must be subjected to critical review, evaluated using existing and new data, tested in regional demonstration projects, and periodically reevaluated before they are adopted as standard operating procedures. Periodic review and evaluation of performance of standard operating procedures will determine whether refinements are necessary. The Program will make maximum use of existing information to avoid duplication and will capitalize on the experience of past efforts, both the successes and failures. Above all, EMAP data, plans, and reports will be presented for critical review by the scientific community and representatives from government agencies whose missions complement EMAP's. Comment and input on EMAP's priorities will be actively solicited from business groups, citizen groups, and other public interest groups. Only through a broad-based, open forum can we ensure that the products from EMAP will have a significant influence on the setting of this nation's environmental policies.

EMAP managers currently are working with the National Academy of Sciences to define the scope and production schedule for an interim report on the Program by the Academy. EPA's Science Advisory Board, working closely with the Academy, will review the Program in the context of its ability to bring improved science to the EPA decision-making process. Additionally, all senior EMAP scientists who have responsibility for major program elements have been charged with ensuring the scientific merit of their approaches through active review by special technical panels, such as members of the American Statistical Association, the Ecological Society of America, the Estuarine Research Federation, and other scientific societies and scientists with specialty expertise.

The Estuaries Resource Group has completed a demonstration project in the Mid-Atlantic region (see the Feature Article in this issue), and plans are well under way for a similar project along the Gulf Coast to be conducted next summer. The Forests Resource Group has completed pilot projects for indicators in both the Northeast and the Southeast. The Surface Waters Resource Group is planning for a regional lake demonstration project in the Northeast next year, and the Wetlands Resource Group is planning to conduct a pilot study on selected coastal wetlands along the coast of Louisiana next summer.

In the upcoming year, all Resource Groups will have prepared plans that describe their proposed activities over the next five years. Strategic plans for network design, indicator development, and landscape characterization, and for the overall Program direction through 1995, are scheduled for completion in early 1991. A document that details the relationship of EMAP to the risk characterization process is also targeted for completion in the first half of 1991. Full implementation of monitoring in all resources is being targeted for 1995.

The 1990 Demonstration Project for Estuaries in the Mid-Atlantic

In 1990, EMAP initiated a demonstration project in the Mid-Atlantic region (from Cape Cod southward to the mouth of the Chesapeake Bay) to evaluate the utility of regional-scale monitoring data for assessing the ecological condition of the nation's estuaries. Elements of this demonstration project included (1) testing and evaluating the degree to which proposed indicators of ecological condition could help distinguish polluted from unpolluted environments, (2) constructing a data set that provides the information required to evaluate alternative sampling designs for assessing estuarine condition on regional scales, (3) identifying and resolving logistical problems associated with conducting a regional sampling program in estuaries, and (4) completing an interpretive assessment of the present status of the estuaries of the Mid-Atlantic region.

Why Study Estuaries?

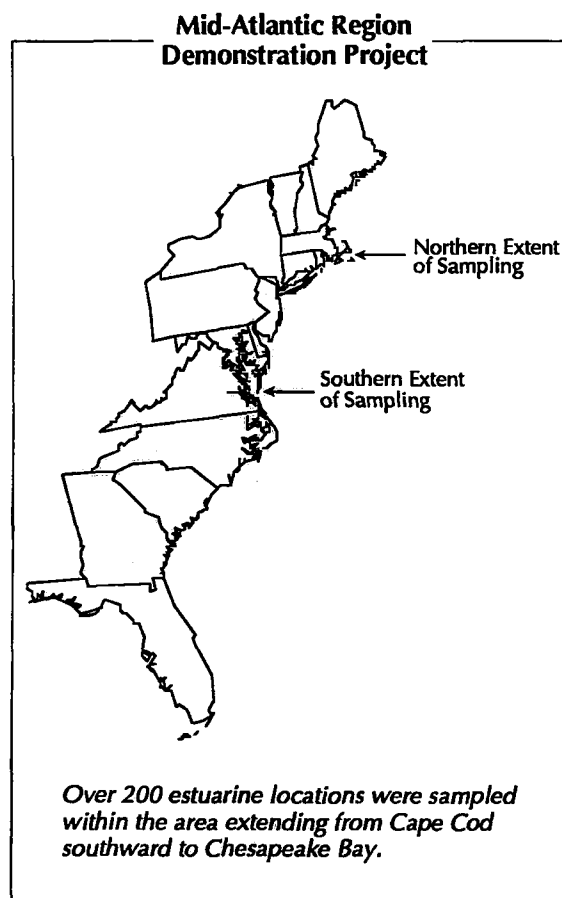
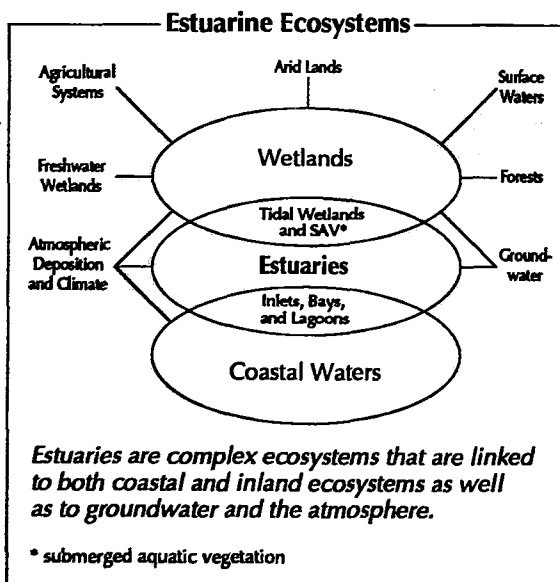
Estuaries include the many tidal wetlands, submerged aquatic vegetation communities, inlets, bays, and lagoons that connect the nation's rivers to the coastal waters of the continental shelf. These ecosystems provide critical spawning and nursery habitat for fishery resources, and the areas close to estuaries have become attractive to the U.S. population for settlement. Census experts predict that about 75% of the U.S. population will reside within 50 miles of estuaries by the year 2000. Much of the wastewater from homes, businesses, and industries in coastal areas is treated and then directly discharged into estuaries. Additionally, most discharges into the nation's rivers that drain watersheds far from the coastline eventually reach these systems.

Estuaries are not simple transport "pipelines," but rather are complex transition zones with physical and chemical features that concentrate and retain pollutants. Es-

tuaries tend to serve as repositories for the many pollutants released into the nation's waters and into the atmosphere. The ecological condition of estuaries is thus strongly influenced by human activities throughout the entire watershed, particularly land use and the release of pollutants to the environment. As a result, the overall environmental quality of the watersheds should be reflected by measurements of the ecological condition of estuaries.

Why Start with Estuaries in the Mid-Atlantic Region?

The Mid-Atlantic region was selected as the testing ground for EMAP's estuaries program because there is a general public perception that estuaries in this area are



rapidly deteriorating. Additionally, many of the estuaries in this region have been intensively investigated by scientists, and a considerable amount of information was available for use in designing the demonstration project. Finally, many management decisions for this region are forthcoming, including development of a restoration plan for the New York Harbor complex and development and evaluation of management plans and

actions for many large estuaries, including Delaware Bay, Chesapeake Bay, and Long Island Sound. Development of these plans presents an opportunity to demonstrate how EMAP data can assist in the formulation of environmental programs and policies.

What Is the Purpose of the 1990 Demonstration Project?

The demonstration project will provide data for use in evaluating the utility of the EMAP sampling design and approach for estuaries. It also provides the information we need to develop a technically credible and cost-effective sampling program that can be implemented across the nation over the long term. In particular, the project will demonstrate the value of regional-scale monitoring data collected in a standardized way for conducting assessments of the ecological condition of our estuaries.

Participants in the Demonstration Project

Scientific Community: Scientists from many marine research organizations provided guidance, expert opinion, and review comments on the design of the demonstration project. This past spring, a committee selected by the Estuarine Research Federation performed a scientific review of the Program Plan. This committee will continue to serve as technical advisors to EMAP-Estuaries this winter when data analysis and assessment activities begin.

Other Agencies: The National Oceanic and Atmospheric Administration (NOAA) worked closely with EPA to plan the demonstration project and to ensure it did not duplicate their activities. This cooperation has contributed in part to an agreement between NOAA's National Ocean Service and EPA's Office of Research and Development to coordinate their research and monitoring efforts aimed at assessing the impacts of human activities on marine and estuarine ecosystems. The combined results of both agencies' programs will serve the nation's interest more than either agencies' program alone. It is intended that this agreement will lead to the establishment of a joint NOAA/EPA program for monitoring the status and trends of near coastal environmental quality and ecological condition.

ORD Laboratories: Several ORD Laboratories have also played critical roles in the design and execution of the Project: the Environmental Research Laboratories in Narragansett, RI, and Gulf Breeze, FL; the Environmental Monitoring Support Laboratory in Cincinnati, OH; and the Environmental Monitoring Systems Laboratory in Las Vegas, NV.

How Were Sampling Sites Selected?

The estuaries in the Mid-Atlantic region were assigned to the following classes, which have similar physical features and are expected to respond to environmental stresses in a similar manner:

- ☐ large estuaries (e.g., the Chesapeake Bay and Long Island Sound);
- ☐ large tidal rivers (e.g., the Potomac and Delaware Rivers); and
- ☐ small estuaries, bays, and tidal creeks and rivers (e.g., Barnegat Bay and the Elizabeth River).

Sampling sites within each estuarine class were selected using a statistical procedure, which permits the proportion of the estuaries (or estuarine area) in poor ecological condition to be estimated quantitatively. This procedure also permits the uncertainty of these estimates to be calculated.

What Did We Measure?

Monitoring every aspect of estuarine condition of interest or concern to the public and scientists is prohibitively costly. Therefore, selected measurements of the condition of the estuaries were taken during mid-summer, when water temperatures are highest and pollution problems typically exert the greatest impact on estuarine organisms. These measurements, or indicators, included

- ☐ the kinds and abundance of fish,
- ☐ the incidence of fish gross pathology,
- ☐ the kinds and abundance of organisms living in the sediments (where pollutants concentrate),
- ☐ measures of water quality (such as the concentration of dissolved oxygen in the water),
- ☐ concentrations of contaminants in sediments, and
- ☐ the toxicity of sediments to sensitive organisms.

A qualitative description of the appearance of each estuary was also made. Additionally, data on environmental stresses, which will be used to evaluate associations between human activity and estuarine condition, are being obtained from the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey, the U.S. Department of Agriculture, and the U.S. Census Bureau. This information includes estimates of point and nonpoint source pollutant loadings, land use data, climate, and changes in population density and distribution in Mid-Atlantic coastal areas.

How Are We Assured of the Quality of the Data?

Many organizations and individuals collected and processed samples. To ensure consistency in sample collection and processing, field crews were intensively trained to use and maintain sampling equipment. In addition, quality control checks of both field and laboratory operations were performed. A joint NOAA/EPA quality assurance program was implemented to maximize comparability of collected data with that from the NOAA National Status & Trends Program.

How Will the Data Be Analyzed?

The measurements taken this summer will be examined in a variety of ways so that the current status of Mid-Atlantic estuaries with respect to (1) suitability for human use and (2) health of biological communities can be documented. Measurements taken next summer and in subsequent years will enable us to document whether these attributes are getting better or worse and, if they are changing, at what rates.

The analysis approach begins by examining the "big picture" (i.e., all of the data on the sampled estuaries throughout the Mid-Atlantic region). Then, subsets of the estuaries having unhealthy or deteriorating conditions will be evaluated to determine if their condition can be associated with exposure to pollution stress or other human disturbances. Estuaries having healthy or improving conditions will also be evaluated to determine if this improvement can be associated with pollution abatement programs or other management practices.

For many analyses, the data will be integrated to produce estuarine condition indices that will enable scientists to make statements about status and trends that are

understandable to non-scientists and useful to policy-makers. Such indices will be similar conceptually to the national air quality index or the Dow Jones stock market average.

What Are the Current Activities of the Demonstration Project?

Information from over 200 sampling sites that were visited this past summer is presently being analyzed. With assistance from the Estuarine Research Federation technical advisory committee, EMAP scientists are preparing an assessment that is scheduled to be available for review by the fall of 1991. The final assessment report is expected to be completed by the end of 1991.

What Are Our Future Plans?

In 1991, estuarine sampling will continue in the Mid-Atlantic region, and a demonstration project will begin in the estuaries of the Gulf of Mexico in an area extending from north of Tampa Bay to the Mexican border. Progress reports on these activities will be available in 1992. During the summer of 1992, we expect to begin sampling estuaries in the South Atlantic.

Current Activities

Agroecosystems

Plans are under way for a joint pilot study to be conducted in North Carolina in FY92 by the Agroecosystems Resource Group and the U.S. Department of Agriculture's (USDA) Agricultural Research Service and National Agricultural Statistical Survey (NASS). Data on five agroecosystem indicators (crop productivity, soil productivity, irrigation water quality and quantity, agricultural chemical usage, and land use) will be collected by NASS field samplers in conjunction with their routine, annual surveys. Data on temperature, total rainfall, rainfall during the growing season, and catastrophic events (hail, hurricanes, flooding) will be obtained from the National Weather Service. The pilot study serves two principal purposes: (1) to test and evaluate these indicators and several others that are in the developmental phase and (2) to compare the EMAP statistical approach for sample site selection with the approach used by NASS. Coupled with these pilot study evaluations is an ongoing analysis of existing data bases on agroecosystems, including the Soil Conservation Service's National Resources Inventory and SOILS-5 data.

Several indicator development projects are also under way in cooperation with scientists from North Carolina State University (NCSU) in Raleigh and various federal

agencies. Specialists in weed ecology and nematode ecology are assisting EMAP-Agroecosystems in the development of a pest density indicator. Other university scientists are cooperating on the development of an indicator that will be used to assess chemical and sediment exports from agroecosystems. This Group also hosted a workshop, led by a scientist from the U.S. Fish and Wildlife Service, on the habitat linear classification system. This field-based methodology for measuring horizontal distribution of vegetation shows promise as an indicator for wildlife habitat suitability. Finally, economists from the USDA Economic Research Service and the NCSU Department of Economics and Business have offered to provide guidance on the development of a productivity indicator that would be used to quantify net production in agricultural systems. This indicator would account for non-market factors, such as the environmental impacts of crop production.

The results of the pilot study and indicator development projects will be used to implement a long-term monitoring effort to determine the "health" of our nation's agroecosystems. A healthy agroecosystem is defined within EMAP as one that balances sustainable crop and livestock production with maintenance of air, water, and soil integrity, and assures wildlife and vegetation diversity in associated noncrop habitats. The approach for monitoring agroecosystems is scheduled for review by a scientific panel in 1991.

Arid Lands

The Arid Lands Resource Group is developing an integrated, long-term monitoring effort to assess the ecological condition of deserts, grasslands, chaparral woodlands, prairies, and pinyon-juniper communities. To facilitate designing this effort, this Group is laying the groundwork for a pilot study currently planned for FY92 in the West (Arizona, California, New Mexico, and Nevada). This study, which will focus on riparian ecosystems (those occurring in predominantly arid landscapes, but associated with a sustained source of water, such as a river), is being closely coordinated with the Bureau of Land Management, other federal agencies, EMAP-Surface Waters, and EMAP-Wetlands. The results of the study will be used to select the most efficient option from a number of trial approaches for site selection, field sampling, quality assurance, data management, indicator measurements, and others for full-scale national implementation of EMAP-Arid Lands by the latter 1990s.

A principal accomplishment of a planning workshop, held in mid-1990, was to produce a working definition of an "arid ecosystem." Arid ecosystems are those for which potential evaporation exceeds precipitation, annual precipitation ranges from approximately 5 cm (2 in) to 60 cm (24 in), and daily and seasonal temperatures vary from -40 °C (-40°F) to 50 °C (122°F); in addition to these physical factors, the definition also includes vegetation type and other biological factors. This workshop included representatives from the USDA Forest Service, the Bureau of Land Management, the Idaho National Engineering Laboratory, and EPA; four universities were also represented: Nevada-Las Vegas, Oregon State, Arizona State, and Utah State.

Two major issues of primary concern to the USDA Forest Service and the Bureau of Land Management, land use/grazing and the effects of global climate change, are being considered by this Group. The Natural Resource Ecology Laboratory of Colorado State University is providing data for modeling global climate change and its effects on grassland ecosystems; the National Park Service is also exchanging information on global change monitoring and research.

A spatial and temporal evaluation of the use of remote sensing data for regional assessment of arid lands is being conducted by the Commonwealth Scientific and Industrial Research Organization in Australia. Various applications of remote sensing technology will also be researched under a Memorandum of Understanding between the National Oceanic and Atmospheric Administration and the Desert Research Institute (the organization that has the technical lead for developing EMAP-Arid Lands). As part of the Memorandum of Understanding, the Cooperative Institute for Aerospace Science and Terrestrial Applications was established. This institute potentially affords a direct mechanism for joint research between the National Oceanic and Atmospheric Administration and EMAP-Arid Lands on applying remote sensing technology to facilitate research on terrestrial ecology.

Forests

The Forests Resource Group is working closely with the USDA Forest Service to implement a long-term interagency monitoring effort to assess the condition of U.S. forests. This joint effort resulted in the completion of two indicator evaluation projects – one on northeastern hardwoods in New England and one on southeastern loblolly pine in Virginia. For each project, data were collected at 20 forest sites for five indicators: growth efficiency, vertical vegetation structure (related to wildlife habitat), visual symptoms of air pollution on tree canopies, soil productivity, and nutrient concentrations in foliage. In addition to identifying logistical or design problems in data collection, these pilot studies served two purposes: (1) as feasibility studies, they helped evaluate whether multiple indicators can be sampled in a survey mode, and (2) the studies helped determine variability for each indicator. Some preliminary results are expected in early 1991.

In a second study in New England, the USDA Forest Service, New England state agencies, and EMAP-Forests jointly conducted a field survey to compare the EMAP approach for selecting sampling sites with the approach used by the Forest Service in its Forest Inventory Analysis Program. Preliminary results indicate that the percentages of major forest classes in New England were comparable using both site selection techniques. Precision of estimates for the visual symptoms indicator was also comparable at regional geographic scales.

Looking ahead to 1991, this Group has plans to continue providing support to the USDA Forest Service in the expansion of their monitoring network in the Northeast and to implement a demonstration project in the Southeast. Additional sampling sites in Maryland, Delaware, and New Jersey will be selected; visual symptoms, growth efficiency, and soil productivity will be measured at these sites as well as the sites sampled in 1990 in the New England states. Testing of other indicators is planned on a subset of sampling sites. EMAP-Forests plans to continue providing planning support (design, indicator development) and assistance with implementation (quality assurance, information management, and logistics) and reporting. Activities related to reporting will be coordinated closely with three EMAP Groups: Integration and Assessment, Air and Deposition, and Landscape Characterization.

The southeastern demonstration project would focus on measurements of a set of indicators (similar to those tested in the New England and Virginia studies) in one class of forests, loblolly pine. A second set of indicators related to wildlife, habitat structure, chemical contaminants, and microbial biomass would be measured on a subset of sampling sites to evaluate their feasibility for long-term forest monitoring in EMAP. Field efforts for this demonstration project would be conducted by the USDA Forest Service, the USDA Soil Conservation Service, and southeastern state forestry agencies.

Great Lakes

EMAP-Great Lakes is the most recently formed Resource Group. This Group is working closely with the Surveillance Branch of EPA's Great Lakes National Program Office to determine whether existing monitoring efforts for the Great Lakes can be integrated with EMAP. Elements that are essential for EMAP but are not being addressed in existing monitoring efforts will be identified, and plans for supplementing the existing networks will be formulated. A program plan that describes these activities and a phased approach for evaluating indicators and design options through pilot studies is expected to be available by late 1991. Pilot studies are being planned for one of the lower Great Lakes and one of the upper Great Lakes. Full implementation in all five lakes is targeted for the mid-1990s.

Preliminary discussions are under way regarding the use of the EMAP approach as a tool for monitoring the current distribution and ecological impact of the zebra mussel in the Great Lakes. This activity would be coordinated with the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the Great Lakes Fisheries Commission, the Canada Centre for Inland Waters, and the Ontario Ministry of the Environment.

Surface Waters

Several activities are under way in preparation for a summer 1991 EMAP-Surface Waters pilot study on lakes in the northeastern United States. During recent months, a principal activity has been the identification of lakes in EPA Region 1 (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut) and Region 2 (New York and New Jersey) for potential sampling during the pilot. Development of lake access information also has begun for approximately 300 lakes in these two regions.

Discussions are ongoing with EPA's Office of Water and the Office of Policy, Planning, and Evaluation, regarding the potential role of EMAP-Surface Waters in filling some of the informational needs of these Offices. The proposed application of biocriteria being developed by the Office of Water and the indicator strategy being developed by the Surface Waters Resource Group present compatible and complementary approaches for assessing surface water condition. Other organizations are also cooperating with EMAP-Surface Waters. As an example, in a Sierra Nevada survey, researchers from the California Air Resources Board are using sites selected using the EMAP grid for sampling of fish, macroinvertebrates, and amphibians.

Current indicator development activities include evaluating methods for relating EMAP-Surface Waters measurements with fishability, fish contamination, trophic status, species composition, physical and chemical habitat, sediment toxicity, and other issues of public concern. The effect of various sources of statistical sampling error in indicators is being analyzed using

existing lake data bases. Spatial and temporal variability of lake trophic status, the index of biotic integrity, and other indicators are being examined within and among lakes, among years, and among several alternative sampling periods (June through September); variability analyses include how analytical error and field measurement error might affect estimates of ecological condition or EMAP's ability to detect trends in lakes. Similar analyses using existing data sets for streams are also being conducted. Based on data from midwestern streams, results obtained using a macroinvertebrate index differed considerably from those obtained using an index of biotic integrity. Possible reasons for these differences include (1) water quality is assessed in different ways, (2) the indices respond differently to stressors, and (3) the indices differ in sensitivity and applicability.

The practical application of the EMAP design for selecting stream sampling sites was the subject of a stream design pilot project, conducted in Oregon by the Surface Waters Resource Group. The objectives of this investigation were to (1) produce a sample data set using simulated hexagonal areas around points of the EMAP sampling grid, (2) evaluate 1:250,000-scale topographic maps of the same areas in terms of the stream orders represented, (3) develop protocols for collecting geographic data, (4) estimate time requirements for this method, and (5) identify replicability issues for this site selection process. The results of this study are currently being reviewed in light of future efforts to develop sampling frames for streams in regions to be surveyed by EMAP.

Progress made to date on these indicator evaluations and design-related analyses, as well as the approach proposed by EMAP-Surface Waters to implement a national monitoring effort in lakes and streams, was recently presented to a peer review panel. Panel members included scientists from several universities (North Texas, Michigan, Wisconsin, Cornell, and Oklahoma State); the American Statistical Association; several federal agencies, including the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and EPA's Office of Water; the private sector; and Oak Ridge National Laboratory. The National Research Plan for EMAP-Surface Waters is currently being revised to incorporate the panel's comments and is expected to be available for public distribution in the first quarter of 1991. It is anticipated that some of the panel members will continue as long-term scientific advisors to this Group.

Wetlands

A principal focus of the Wetlands Resource Group has been the development of a National Research Plan for monitoring wetlands that will serve as the basis of full-scale implementation of a national-scale monitoring effort in wetlands, anticipated to begin first in the midwestern and southeastern United States with subsequent expansion to other U.S. regions. A peer review of this plan was conducted in late November 1990. Scientists with expertise in wetland ecology and statistical sampling served as panel members; six universities participated: Duke, Louisiana State, New Mexico State,

East Carolina, Ohio State, and Syracuse. As for EMAP-Surface Waters, the plan is currently undergoing revision and is anticipated to be available for distribution in early 1991.

EPA's Office of Water has expressed interest in the use of this Group's indicator information to evaluate the adequacy of current water quality criteria for protecting salt marsh wetland health in the Southeast and the Gulf. EMAP-Wetlands has also been interacting with EPA's Office of Wetlands Protection, which is interested in indicators of wetland health and integrity. EMAP's ability to provide information on three of this Office's principal objectives is being explored: (1) update the physical inventory of wetlands more frequently, (2) assess the functional integrity of wetlands, and (3) assess the landscape integrity of wetlands. This Group also recently provided information to the U.S. Fish and Wildlife Service on the need for assessing wetland functional integrity; the information included a statement of how a baseline (like that proposed for EMAP-Wetlands) could be used to measure the success of the "no net loss" policy and how establishment of long-term research sites could enhance our understanding of wetland processes, including how such processes are affected by environmental stresses.

The Wetlands Resource Group also is currently planning for an indicator evaluation pilot study in the coastal marshes of Louisiana and a design evaluation pilot using data from four states in 1991. The indicator evaluation project will compare hydrology, vegetation associations, composition and abundance of wetland species, and other indicators of ecological condition in 20 wetlands considered by coastal wetland experts to be in acceptable condition and 20 wetlands considered to be in unacceptable condition. The coast of Louisiana was selected for this evaluation because there is considerable public concern over the effect of ongoing management practices that are apparently resulting in coastline subsidence and, subsequently, alteration of wetland habitat. Planning for this pilot involves EMAP-Estuaries and experts on Louisiana wetlands; discussions have also begun with the U.S. Fish and Wildlife Service, the state of Louisiana, EPA Regions 4 and 6, and the EPA Gulf of Mexico Program Office.

This Group is also interacting extensively with staff of the U.S. Fish and Wildlife Service's National Wetland Inventory and EMAP-Landscape Characterization to conduct the design evaluation pilot. The design pilot will address EMAP-Wetlands classification and statistical sampling association rules. Data sources for the study include digitized wetland inventory data bases for the state of Illinois and portions of Washington, North Dakota, and South Dakota.

Air and Deposition

One goal of the Air and Deposition Group is to produce a framework for consolidating existing air quality and deposition monitoring networks and new EMAP monitoring programs into a cooperative network set that can respond efficiently to both EMAP needs for

information on levels of deposition and environmental effects information called for under the Clean Air Act Amendments (CAAA). To assist with this consolidation, this Group has been providing quality assurance support and partial funding to help maintain the National Acid Deposition Program's (NADP) National Trends Network. A principal function of this Group's current activities is the evaluation of existing network capabilities to provide air quality and deposition data for determining exposure levels to ecological resources located in nonurban environments. Data from the NADP networks, the Great Lakes Atmospheric Deposition Program, and other networks are being incorporated into a master data base to facilitate analyses on spatial and temporal trends that will lead to identification of where (1) additional monitoring sites are needed, (2) redundant sites occur, and (3) topographic features indicate a need for special network design. Ultimately, the goal is to enhance established nonurban air and precipitation quality networks for national trends assessments.

EMAP-Air and Deposition recently became part of a multiagency working group, which will plan for implementation of the combined, cooperative EMAP/CAAA network. Eight work groups have been organized, each of which is responsible for producing an activities plan that will enable field installation of the network to begin by September 1991. Several federal agencies, also slated to become permanent members of the work groups, participated in a November 1990 meeting that included the U.S. Geological Survey, the USDA Forest Service, the National Oceanic and Atmospheric Administration, the National Park Service, and EPA. State agencies from California, Wisconsin, Michigan, New York, and Vermont were also represented, and Canadian participants included representatives from Environment Canada and the Ontario Ministry of the Environment.

Landscape Characterization

The principal function of the Landscape Characterization Group is to provide spatial data on landscape patterns and composition that will aid in (1) the development of sampling frames for use by the EMAP Resource Groups in selecting sites for monitoring and (2) the interpretation of observed ecological condition of resources (e.g., forests, wetlands, lakes, and streams). To refine characterization methods and evaluate standard operating procedures, this Group has completed data collection efforts for a pilot study in Maryland. A data base has been developed that includes spatial information on land use, land cover, roads, hydrography (distribution of surface waters), contour, and soils. Field verification and accuracy assessment of the pilot data are ongoing.

This Group has worked closely with the Wetlands Resource Group and the U.S. Fish and Wildlife Service's National Wetlands Inventory in planning and coordinating interagency activities for EMAP. Technical issues that have been discussed include wetland classification, indicator development, statistical design, and sampling frame development. In cooperation with the

Agroecosystems Resource Group, EMAP-Landscape Characterization is providing aerial photographs from the Maryland pilot study to the National Agricultural Statistical Service (NASS) for use in evaluating how the NASS approach might be adapted to aid in the sampling efforts for agroecosystems. Cooperation with the U.S. Geological Survey's National Aerial Photography Program, which acquires new color-infrared aerial photography for most of the United States every five years, is currently being explored.

The proposed approach for landscape characterization was reviewed in June 1990 by scientists from the U.S. Geological Survey; the USDA Forest Service; the National Park Service; the National Aeronautics and Space Administration's Ames Research Center; EPA's Science Advisory Board, Office of Water, and Region 3; and several universities, including the University of North Carolina, Utah State University, Southern Illinois University, and the University of Wisconsin. In response to this review, the Landscape Characterization Group plans to design and implement several pilot studies in FY91 aimed at refining characterization methods and demonstrating the overall approach, especially through the use of historical remote sensing data. Study areas are being selected based on known ecological problems and in areas where coordination with EPA Regions and Program Offices and other federal, state, and local programs can be maximized. The primary pilot study is being designed for implementation within the Chesapeake Bay watershed. This area was selected for a two-year study (FY91 and FY92) because of concern over nonpoint-source pollution, apparently related to increased population growth along the coast, and because habitat alteration is reportedly widespread in the watershed.

Information Management

The Information Management Group was established to plan, develop, and implement a comprehensive, automated, information management system for EMAP and to ensure that the information management systems developed by the various EMAP Groups are compatible and are conducive to efficient data transfer. Initial work has included the preparation of (1) the Information Management Program Plan, which highlights strategies and activities for information management proposed for the next few years; (2) an Information Management Committee Charter, which describes the program organization and personnel responsibilities; (3) an EMAP Information Center concept paper and functional statement; and (4) a conceptual design for the Geographic Information System (GIS), which presents design objectives and approaches for the GIS component of the EMAP Information Management System. In addition, a document on data confidentiality has also been prepared, focusing on issues related to the transfer and use of environmental data originating within and outside EPA.

More recently, this Group has been working with EPA's Office of Administration and Resources Management

(OARM) and Office of Information Resources Management (OIRM) to ensure that EMAP information management plans are consistent with Agency policy. This Group is also coordinating efforts with the Resource Groups to develop their specific information management plans and ADP (automated data processing) plans. The focus of these coordination activities has been to assist EMAP-Estuaries and EMAP-Forests, both of which conducted field projects in 1990.

The Information Management Group has met with other agencies, including the U.S. Geological Survey and the National Aeronautics and Space Administration, to discuss potential exchange of data and collaboration on EMAP information management requirements. This Group is also interacting on GIS-based systems and data catalogs with the Gulf of Mexico Program (EPA Regions 4 and 6 and the states bordering the Gulf of Mexico). Personnel from Australia's Commonwealth Science and Industrial Research Organization briefed EMAP-Information Management on GIS, data base management for ecosystems, and remote sensing operations.

Integration and Assessment

The Integration and Assessment Group has two primary functions: to provide the means for (1) addressing scientific questions through the process of combining EMAP data collected by the various Resource Groups or combining these data with data from other sources and (2) addressing policy-relevant questions, which rely on synthesizing and translating the resultant scientific information. A multiyear operating plan, including the objectives, measures of success, and tasks needed to achieve integrated EMAP products, is being prepared. Principal activities for FY91 are to (1) identify critical clients and information needs, (2) examine existing and needed tools and procedures, and (3) develop conceptual approaches for feeding EMAP information into ecological risk characterization and risk assessment studies based on a recommendation by the EPA Science Advisory Board's Ecological Processes and Effects Committee.

This Group participated with the Estuaries Resource Group in preparing an Example Interpretive Assessment Report and provided guidance to several other Resource Groups for preparing Example Annual Statistical Summaries. The aim of the example assessment is to demonstrate to potential users of EMAP assessments how data can be displayed to show current status and trends in indicators of ecological condition, associations among indicators, and possible factors contributing to this condition for a specific ecological resource. The example summaries illustrate the types of data, analysis approaches, and presentation formats for reports currently planned to be published annually by each Resource Group. The Example Assessment for Estuaries was recently reviewed by scientists from the National Oceanic and Atmospheric Administration, EPA Region 3, and EPA's Office of Policy, Planning, and Evaluation; the document is expected to be com-

pleted in January 1991. Example statistical summaries for Agroecosystems, Forests, Surface Waters/Wetlands, and Arid Lands should be completed by early 1991.

Statistics and Design

The Statistics and Design Group provides the coordination and technical support required to ensure that sampling designs implemented by the Resource Groups are consistent with the overall EMAP design. This Group's initial emphasis has been on the preparation of an EMAP design document, which describes the overall EMAP sampling design, addresses the design's flexibility for application to particular resource categories, and discusses approaches for site selection. This Group assists the Resource Groups with the preparation of the design sections of the individual research plans, planning for pilot and demonstration field studies, and evaluation of these studies in order to refine their designs.

This Group is examining several issues regarding spatial statistics, including how to handle incomplete or inaccurate spatial data and how to incorporate statistical analysis into GIS. The practical application of statistics to enhance our ability to identify and quantitatively assess the urgency and magnitude of environmental problems is currently being explored by the Statistics and Design Group and Oregon State University.

Members of this Group are also interacting with a panel of the American Statistical Association to institute a comprehensive program for review of all statistics and design activities and establish a process for peer review of statistical components of the Resource Groups' research plans.

Indicators

Members of the Indicators Group have worked with all EMAP Resource Groups to produce two key EMAP documents: the Ecological Indicators Report for the Environmental Monitoring and Assessment Program and the Draft Indicators Development Strategy for EMAP. The first, published in September 1990, details the approach proposed for (1) describing ecological condition, (2) defining a common indicator selection strategy to facilitate integration among EMAP resource categories, and (3) seeking expert advice and identifying regional data to begin characterizing the spatial and temporal variability of proposed indicators.

The second document, scheduled for completion in February 1991, is a research strategy for the application of indicators in EMAP. This document includes (1) a vision of how a fully functional EMAP indicator development project would operate; (2) a framework for determining indicator development needs; (3) criteria and protocols for selecting, evaluating, and reevaluating indicators; (4) procedures for coordination of indicator-related activities among Resource Groups; and (5) an organization/ communication/coordination plan.

To obtain as much current information as possible on ecological indicators, an International Symposium on Ecological Indicators was held in Fort Lauderdale, FL, on October 16-19, 1990. This symposium was jointly sponsored by EPA's Office of Research and Development, the National Oceanic and Atmospheric Administration, the U.S. Department of Interior's Minerals Management Service, and the USDA Agricultural Research Service. Over 250 scientists, administrators, and policy makers participated, including individuals from the United States, Canada, Central America, South America, Australia, Western Europe, the Soviet Union, and South Africa. The agenda highlighted the technical and human resources available for international indicator development and monitoring efforts, identified science and policy issues that must be addressed for effectively using indicator information to monitor status and trends in the environment, and placed environmental challenges in a global context. A proceedings of the symposium is planned for publication by Elsevier Applied Science Publishers, Ltd., in late 1991.

Logistics

The long-term objective of the Logistics Group is to provide guidance and support to the Resource Groups on field operations and to enhance and economize EMAP field monitoring efforts through integrated team approaches. To help achieve this objective, a logistics guidance document, providing standard formats, checklists, and review processes, was completed in July 1990. This document provides general information to each Resource Group for logistics planning and ensures that a level of consistency in logistics approaches among the Groups will be maintained.

A principal activity of this Group in 1990 was to assist in the development of the logistics plans for the demonstration project in estuaries of the Mid-Atlantic region and, in cooperation with the USDA Forest Service, for the two forest pilot studies in New England and the Southeast. The Logistics Group is also assisting EMAP-Surface Waters in preparing for the 1991 pilot study on northeastern lakes. One important aspect of these activities is determining land ownership and site access, once site selection is finalized.

The Logistics Group, EMAP staff from EPA's Office of Modeling, Monitoring Systems, and Quality Assurance, and representatives from the EPA Regions are currently undertaking a joint effort to define the role for the Regional Offices in EMAP field operations.

Total Quality Management

The Total Quality Management Group is providing guidance, support, oversight, and planning assistance to the Resource Groups on quality assurance and quality control protocols for EMAP monitoring and assessment activities. This Group has focused much of its effort to date on preparing documentation critical to

Program-wide quality assurance aspects. Of highest priority has been the development of the EMAP Quality Assurance Program Plan, which serves as the key guidance document for Resource Groups as they prepare their specific quality assurance project plans. Because EMAP is an interagency, interdisciplinary program of national scale, the Quality Assurance Program Plan presents an integrated strategy for guiding and coordinating quality assurance activities across resource categories, regions, and monitoring programs.

In addition to assuring compliance to the EMAP Quality Assurance Program Plan, the Total Quality Management Group provides guidance and support for specific data collection and analysis activities of the Resource Groups. This Group is assisting EMAP-Surface Waters in drafting data quality objectives and helped prepare a laboratory methods manual and quality assurance project plan for the Mid-Atlantic demonstration project for estuaries; a quality assurance audit also was conducted for this demonstration project.

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- Frithsen, J.B., J. Gerritsen, S. Weisberg, M. Fabrizio, E. Barrows, and G. Saul.** 1990. EMAP analysis and interpretation strategy: A near coastal example. Presented at the 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 11-15, Washington, DC.
- Gibson, J.** 1989. Global chemical monitoring needs for the 1990s. Presented at the National Acid Deposition Program Technical Committee Meeting. October 23-26, Provincetown, MA.
- Herlihy, A.T., L.A. Baker, and P.R. Kaufmann.** 1990. Controls and speciation of aluminum in acidic surface waters of the United States. Presented at the International Conference on Acidic Deposition: Its Nature and Impacts, Royal Society of Edinburgh. September 16-21, Glasgow, Scotland.
- Hermann, K., M.J. Hewitt, and D.J. Norton.** 1990. Using existing sampling frames in a comprehensive national monitoring program. Presented at the Geographic Information Systems/

Land Information Systems Annual Conference, GIS/LIS '90. November 5-10, Anaheim, CA.

Holland, A.F. 1990. Recent data from the Near Coastal Demonstration Project. Presented to the Association of Ecosystem Research Centers. November 20, Washington, DC.

Holland, D., and T. Olsen. 1990. Wet deposition spatial and temporal patterns in North America. Presented at the Second International Environmetrics Conference: Statistical Methods for the Environmental Sciences, International Environmetrics Society. September 27-29, Como, Italy.

Holland, A.F., J.F. Paul, and K.J. Scott. 1989. EPA's approach to monitoring condition of the nation's near coastal waters. Presented at the Atlantic Estuarine Research Society/Southeast Estuarine Research Society Joint Meeting. April 7-8, Beaufort, NC.

Hughes, R.M. 1989. Biological integrity. Poster presentation at the National Symposium on Water Quality Assessment, U.S. Environmental Protection Agency, Office of Water. October 16-19, Ft. Collins, CO.

Hughes, R.M. 1989. Regional use of a fish assemblage index for water resource assessments. Presented at the 10th Annual Meeting of the Society of Environmental Toxicology and Chemistry. October 28 - November 2, Toronto, Ontario.

Hughes, R.M. 1989. What can biological monitoring tell us about the environmental health of aquatic ecosystems? Presented at the International Symposium on the Design of Water Quality Information Systems, Colorado State University. June 7-9, Ft. Collins, CO.

Hughes, R.M. 1990. Ecoregions and biological integrity of fish communities. Presented at the Annual Meeting of the Oregon Chapter of the American Fisheries Society. February 8, Welches, OR.

Hughes, R.M. 1990. Regional reference sites and biological criteria. Presented at the U.S. EPA Science Advisory Board Ecoregion Research Review. April 16, Corvallis, OR.

Hughes, R.M., and T. Oberdorff. 1990. Use of a fish index to assess the health of rivers in the Seine Basin. Presented at the National Museum of Natural History. June 21, Paris, France.

Hughes, R.M., D.P. Larsen, T. Whittier, and S.G. Paulsen. 1990. Environmental Monitoring and Assessment Program: Filling national data gaps and identifying additional needs. Presented at the Annual Meeting of the American Fisheries Society. August 30, Pittsburgh, PA.

Hughes, R.M., and R. Noss. 1990. Inland resources: Issues, status, and options in biodiversity. Presented at the Annual Meeting of the American Fisheries Society. August 28, Pittsburgh, PA.

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Hunsaker, C. 1990. Ecological indicators. Presented to the Association of Ecosystem Research Centers. November 20, Washington, DC.

Hunsaker, C., and D. Carpenter. 1990. Indicators of regional ecological health. Presented at the 75th Annual Meeting of the

Ecological Society of America. July 29 - August 2, Snowbird, UT.

Hunsaker, C.T., D.A. Levine, S.P. Timmins, R.V. O'Neill, and B.L. Jackson. 1990. Landscape characterization for assessing regional water quality. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

Jones, B. 1990. A landscape characterization approach to determine ecosystem status and trends. Presented to the Association of Ecosystem Research Centers. July 26, Snowbird, UT.

Jones, B., R. Linthurst, J. Messer, D. McKenzie, and J. Paul. 1990. Environmental Monitoring and Assessment Program: Conceptual overview. Presented at the 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 11-15, Washington, DC.

Jones, K.B. 1989. Biological indicators and monitoring in riparian ecosystems. Presented at an interagency workshop, New Mexico State University. January 9-10, Las Cruces, NM.

Jones, K.B. 1989. The fragmented landscape: The need for a large-scale ecological assessment program. Presented at the Conference on Global Natural Resource Monitoring and Assessments: Preparing for the 21st Century, International Union of Forestry Research Organizations and the United Nations Food and Agricultural Organization. September 24-30, Venice, Italy.

Jones, K.B. 1990. Agency roles in conserving biological diversity. Presented at the Conference for Maintaining Biodiversity, U.S. Bureau of Land Management. March 7-9, Phoenix, AZ.

Jones, K.B. 1990. Landscape characterization and ecological monitoring. Presented at the Fifth International Congress of Ecology. August 23-30, Yokohama, Japan.

Jones, K.B. 1990. The Environmental Monitoring and Assessment Program. Presented at the National Resources Inventory Workshop, USDA Soil Conservation Service. June 21.

Jones, K.B. 1990. The Environmental Monitoring and Assessment Program: An ecological monitoring program for the 1990's and beyond. Presented at the Fifth International Congress of Ecology. August 23-30, Yokohama, Japan.

Jones, K.B. 1990. The Environmental Monitoring and Assessment Program: An ecological monitoring program for the 1990's and beyond. Presented at the Geographic Information Systems/Land Information Systems Annual Conference, GIS/LIS '90. November 5-10, Anaheim, CA.

Kaufmann, P.R., A.T. Herlihy, and L.A. Baker. 1990. Sources of acidity in lakes and streams of the United States. Presented at the International Conference on Acidic Deposition: Its Nature and Impacts, Royal Society of Edinburgh. September 16-21, Glasgow, Scotland.

Klopatek, J.M. 1990. Cryptogamic crusts as indicators of disturbance in semiarid landscapes. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

- Larsen, D.P., and S.G. Paulsen.** 1990. A systematic grid design for estimation of status and trends in the condition of lakes. Presented at the North American Lake Management Society National Meeting. November 6-9, Springfield, MA.
- Larsen, D.P., T. Selle, D. Stevens, and S.G. Paulsen.** 1990. EMAP-Surface Waters lake pilot. Presented at the North American Lake Management Society National Meeting. November 6-9, Springfield, MA.
- Law, B.** 1990. Forest health monitoring. Presented to the Association of Ecosystem Research Centers. July 26, Snowbird, UT.
- Law, B.E., and K.H. Riitters.** 1990. First-year experiences and recommendations from the EMAP-Forests Monitoring Program. Poster presentation at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.
- Lazorchak, J.** 1989. Biomonitoring techniques and analyses. Presented at the Technical Workshop on Water Quality of the Upper Arkansas River Basin, Colorado, Colorado School of Mines and U.S. Environmental Protection Agency, Region 8. February 13-14, Golden, CO.
- Leibowitz, N.** 1990. EMAP-Wetlands: Monitoring status and trends in wetland condition. Presented at the 11th Annual Meeting of the Society of Wetlands Scientists. June 4-8, Breckenridge, CO.
- Leibowitz, N.C., and B. Wilen.** 1990. Interagency monitoring of wetlands status and trends. Presented at the 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 11-15, Washington, DC.
- Linthurst, R.A.** 1988. EPA's environmental monitoring and assessment program. Presented at the National Acid Deposition Program Technical Committee Meeting. October 24-27, Champaign, IL.
- Linthurst, R.A.** 1989. The scientific challenges of the future: Future directions based on 20 years of experience. Presented at the 9th Life Sciences Symposium, Oak Ridge National Laboratory. October 24-27, Knoxville, TN.
- Linthurst, R.A.** 1990. An approach to ecological monitoring. Presented at the Symposium on The Future of Environmental Monitoring: EMAP and NADP, the Environmental Monitoring and Assessment Program and National Acid Deposition Program. October 29-30, San Antonio, TX.
- Linthurst, R.A.** 1990. An overview of the Environmental Monitoring and Assessment Program. Presented to the Association of Ecosystem Research Centers. November 20, Washington, DC.
- Linthurst, R.A.** 1990. Evolving priorities for research in support of coastal management: The view of agency scientific personnel. Presented at the Coastal Society Twelfth International Conference, Our Coastal Experience: Assessing the Past, Confronting the Future. October 21-24, San Antonio, TX.
- Linthurst, R.A., K.W. Thornton, J.J. Messer, and L. Jackson.** 1990. Integrated monitoring for ecological condition: What are the real possibilities? Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.
- Loftis, J.C., and C.H. Taylor.** 1989. Testing for trends in water quality data. Presented at the International Symposium on the Design of Water Quality Information Systems, Colorado State University. June 7-9, Ft. Collins, CO.
- Mace, T.M.** 1990. Multistage remote sensing for a national environmental monitoring program database. Presented at the Geographic Information Systems/Land Information Systems Annual Conference, GIS/LIS '90. November 5-10, Anaheim, CA.
- McKenzie, D.** 1990. EMAP overview. Presented at the Third Annual Ecological Quality Assurance Workshop, Canada Centre for Inland Waters. April 24-26, Burlington, Ontario, Canada.
- McKenzie, D.** 1990. EMAP overview. Presented at the U.S. Environmental Protection Agency Statistics Conference. March 26-29, Williamsburg, VA.
- McKenzie, D.H.** 1990. Synthesizing indicator needs of scientific, policy, and regulatory communities. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.
- McMullen, D.** 1990. Using data quality objectives to plan environmental research. Presented at the Second International Environmetrics Conference: Statistical Methods for the Environmental Sciences, International Environmetrics Society. September 27-29, Como, Italy.
- Meier, E.P., D.A. Flemer, and J.F. Paul.** 1989. An ecological status and trends program, near coastal component. Presented at the Gulf Estuarine Research Society Meeting. Louisiana Universities Marine Consortium. April 7-8, Cocodrie, LA.
- Messer, J.** 1989. EPA's Environmental Monitoring and Assessment Program. Presented at the Southern Regional Meeting, National Council of the Paper Industry for Air and Stream Improvement. June 12-13, Asheville, NC.
- Messer, J.** 1989. Why monitor? Presented at the International Symposium on the Design of Water Quality Information Systems, Colorado State University. June 7-9, Ft. Collins, CO.
- Messer, J.** 1990. EMAP overview. Presented at a Workshop on Environmental Indicators, U.S. Environmental Protection Agency, Region 4. January 10, Atlanta, GA.
- Messer, J., R. Linthurst, and W.S. Overton.** 1989. An EPA program for monitoring ecological status and trends. Presented at the 40th Annual Meeting of the American Institute for Biological Sciences: Monitoring for Global Change, Ecological Society of America. August 6-10, Toronto, Ontario.
- Messer, J.J.** 1990. Ecological indicators in monitoring and risk assessment. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.
- Messer, J.J.** 1990. Review needs and schedules for the Environmental Monitoring and Assessment Program. Presented to the Ecological Processes and Effects Committee of the U.S. Environmental Protection Agency's Science Advisory Board. October 25, Washington, DC.
- Messer, J.J., R.A. Linthurst, and C. Riordan.** 1988. A national program for environmental monitoring and assessment.

Presented at the 2nd U.S.-U.S.S.R. Symposium on Air Pollution Effects on Vegetation. September 13-25, Gatlinburg, TN.

Meyer, J.R., C.L. Campbell, T.J. Moser, G.R. Hess, J.O. Rawlings, S. Peck, and W.W. Heck. 1990. Indicators of the ecological status of agroecosystems. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

Miah, M.J., G.E. Byers, R.D. Van Remortel, M.L. Papp, and B.A. Schumacher. 1990. Estimation of detection limits by using a linear calibration curve. Presented at the Annual Meeting of the Soil Science Society of America. October 21-26, San Antonio, TX.

Moser, T. 1990. Effects and measurements of airborne toxic chemicals, with emphasis on organic contaminants. Presented at the Symposium on The Future of Environmental Monitoring: EMAP and NADP, the Environmental Monitoring and Assessment Program and National Acid Deposition Program. October 29-30, San Antonio, TX.

Mouat, D.A., C.A. Fox, and M.R. Rose. 1990. Ecological indicator strategy for monitoring arid ecosystems. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

Neilson, R.P. 1990. Continental scale biome responses to climatic change. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

Newell, A.D. 1990. Sulfate and nitrate trends in the U.S. EPA Long-Term Monitoring Project. Presented at the International Conference on Acidic Deposition: Its Nature and Impacts, Royal Society of Edinburgh. September 16-21, Glasgow, Scotland.

Newell, A.D., D.J. Blick, and R. Hjort. 1990. Testing for trends when there is a change in methods. Presented at the Annual Meeting of the American Society of Limnology and Oceanography. June 10-15, Williamsburg, VA.

Norton, D.J. 1989. Landscape Characterization: A baseline for national ecological monitoring. Presented to the Bureau of Land Management. December, Washington, DC.

Norton, D.J. 1990. Landscape Characterization: A baseline for national ecological monitoring. Presented to the Assistant Administrator for the Office of Research and Development, U.S. Environmental Protection Agency. October, Washington, DC.

Norton, D.J. 1990. Landscape Characterization: A baseline for national ecological monitoring. Presented to the Nature Conservancy. December, Washington, DC.

Norton, D.J. 1990. Landscape Characterization: A baseline for national ecological monitoring. Presented to the U.S.D.A. National Resources Inventory Program. Washington, DC.

Norton, D.J. 1990. Landscape Characterization: A baseline for national ecological monitoring. Presented to the U.S. Fish and Wildlife Service. December, Washington, DC.

Norton, D.J. 1989. Landscape Characterization: Concepts, methods, and program plans. Presented at a meeting of the

Multimedia Sciences Committee, U.S. Environmental Protection Agency, Washington, DC.

Norton, D.J. 1990. Landscape characterization and temporal considerations in the U.S. EPA's Environmental Monitoring and Assessment Program (EMAP). Presented at the Regional Meeting of the American Society for Photogrammetry and Remote Sensing. July 18, Reston, VA.

Norton, D.J. 1990. Landscape Characterization: Concept, overview, and international perspectives. Presented to the Commonwealth Science and Industrial Research Organization. September 4, Canberra, Australia.

Norton, D.J. 1990. Landscape Characterization update. Presented to the Ecological Processes and Effects Committee of the U.S. Environmental Protection Agency's Science Advisory Board. October 25, Washington, DC.

Norton, D.J., and E.T. Slonecker. 1990. EMAP landscape characterization and common exposure settings. Presented at the Society for Environmental Toxicology and Chemistry (SETAC) Annual Meeting. November 11-15, Washington, DC.

Norton, D.J., and E.T. Slonecker. 1990. The Environmental Monitoring and Assessment Program's landscape characterization data base: New opportunities in spatial analysis. Presented at the Geographic Information Systems/Land Information Systems Annual Conference, GIS/LIS '90. November 5-10, Anaheim, CA.

Norton, D.J., D.M. Muchoney, and E.T. Slonecker. 1990. Ecological monitoring using remote sensing-supported GIS. Presented at the 56th Annual Meeting of the American Society of Photogrammetry and Remote Sensing. March 18-23, Denver, CO.

Olson, G.L., and R.P. Breckenridge. 1990. Assessing agroecosystem sustainability: An integrated approach. Presented at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

O'Neill, R.V., and D.J. Norton. 1990. Landscape characterization and ecological monitoring. Presented to the Association of Ecosystem Research Centers. November 20, Washington, DC.

Overton, S. 1989. A strategy for use of found samples in a rigorous monitoring design. Presented at the International Symposium on the Design of Water Quality Information Systems, Colorado State University. June 7-9, Ft. Collins, CO.

Overton, W.S. 1990. Statistical design. Presented to the Association of Ecosystem Research Centers. November 20, Washington, DC.

Overton, W.S., D.L. Stevens, and D. White. 1990. The EMAP design perspective: A prescription for environmental monitoring. Presented at the Second International Environmetrics Conference: Statistical Methods for the Environmental Sciences, International Environmetrics Society. September 27-29, Como, Italy.

Papp, M. 1989. EMAP-Forests. Presented at the Third Annual Integrated Monitoring Workshop, International Joint Commission. November 15-17, Victoria, British Columbia.

Paul, J.F. 1988. EPA's Environmental Monitoring and Assessment Program. Presented at the Sixteenth Annual Middle Atlantic Bight Physical Oceanography and Meteorology Workshop. November 3-4, Cambridge, MA.

- Paul, J.F.** 1989. An ecological status and trends program: EPA's approach to monitoring condition of the nation's near coastal waters. Presented at the Spring Meeting of Southern Association of Marine Laboratories, Belle W. Baruch Institute for Marine Biology and Coastal Research. April 18-20, Georgetown, SC.
- Paul, J.F.** 1989. EPA's Environmental Monitoring and Assessment Program. Presented at the Fifth National Park Service Environmental Roundtable. November 7-9, Lake Geneva, WI.
- Paul, J.F.** 1990. EMAP-Near Coastal. Presented at a Workshop on Coastal Ocean Physics, U.S. Environmental Protection Agency, Global Climate Change Program. January 8-9, Galveston, TX.
- Paul, J.F.** 1990. EMAP-Near Coastal. Presented at the 62nd Annual Meeting of the Eastern Branch of the Ecological Society of America. September 30 - October 3, Baltimore, MD.
- Paul, J.F.** 1990. Quality assurance aspects of EPA's Near Coastal Ecological Status and Trends Program. Presented at the Third Annual Ecological Quality Assurance Workshop, Canada Centre for Inland Waters. April 24-26, Burlington, Ontario.
- Paul, J.F., A.F. Holland, and K.J. Scott.** 1989. EPA's approach to monitoring condition of the nation's near coastal waters. Presented at the Pacific Estuarine Research Society Meeting. April 28-29, Astoria, WA.
- Paul, J.F., A.F. Holland, J.K. Summers, and K.J. Scott.** 1989. EPA's approach to monitoring condition of near coastal ecosystems. Presented at the 10th Biennial International Estuarine Research Conference. October 8-12, Baltimore, MD.
- Paul, J.F., A.F. Holland, J.K. Summers, and S.C. Schimmel.** 1990. EPA's Environmental Monitoring and Assessment Program: An ecological status and trends program. Presented at the 17th Annual Aquatic Toxicity Workshop. November 5-7, Vancouver, British Columbia.
- Paul, J.F., A.F. Holland, K.J. Scott, D.A. Flemer, and E.P. Meier.** 1989. An ecological status and trends program - EPA's approach to monitoring condition of the nation's ecosystems. Presented at the Oceans '89 Conference. September 18-21, Seattle, WA.
- Paul, J.F., A.F. Holland, S.C. Schimmel, J.K. Summers, and K.J. Scott.** 1989. EPA's Environmental Monitoring and Assessment Program, an ecological status and trends program. Presented at a Workshop sponsored by National Ocean Pollution Policy Board Work Group on Habitat Modification, U.S. Fish and Wildlife Service Research Center. December 5-6, Slidell, LA.
- Paul J.F., and A. Robertson.** 1990. EPA's Environmental Monitoring and Assessment Program: An ecological status and trends program. Presented to the NOAA National Marine Fisheries Laboratory. September 27, Beaufort, NC.
- Paul, J.F., K.J. Scott, A.F. Holland, and E.P. Meier.** 1989. Ecological status and trends program - EPA's approach to monitoring condition of the nation's ecosystems. Presented at the 32nd Annual Conference on Great Lakes Research. May 30 - June 2, Madison, WI.
- Paulsen, S.G.** 1989. Environmental Monitoring and Assessment Program: The Surface Water project. Presented at the National Symposium on Water Quality Assessment, U.S. Environmental Protection Agency, Office of Water. October 16-19, Ft. Collins, CO.
- Paulsen, S.G.** 1990. EMAP: Surface Water program. Presented at the American Society of Civil Engineers meeting. April, Houston, TX.
- Paulsen, S.** 1990. EMAP-Surface Waters. Presented to the Association of Ecosystem Research Centers. July 26, Snowbird, UT.
- Paulsen, S.** 1990. Surface Waters Health (EMAP): Brief overview, indicators of health and how they will be used. Presented at the Symposium on The Future of Environmental Monitoring: EMAP and NADP, the Environmental Monitoring and Assessment Program and National Acid Deposition Program. October 29-30, San Antonio, TX.
- Paulsen, S., and P. Larsen.** 1990. Environmental Monitoring and Assessment Program: Design and implementation of the surface water component. Presented at the 75th Annual Meeting of the Ecological Society of America. July 29 - August 2, Snowbird, UT.
- Paulsen, S., and R. Novitzki.** 1990. EMAP Overview. Presented at the All Scientists Meeting for the National Science Foundation's Long-term Ecological Research Network. September 29, Estes Park, CO.
- Paulsen, S., C. Chen, C. Palmer, and D. Heggem.** 1989. The contribution of measurement error to total error in analysis of data from an aquatic survey. Presented at the First International Conference on Environmetrics, International Environmetrics Society. April 4-7, Cairo, Egypt.
- Paulsen, S.G., D.L. Larsen, R. Hughes, W.L. Kinney, and J.E. Pollard.** 1990. Application of a national systematic grid to analyze status and trends in conditions of inland aquatic systems. Presented at the 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 11-15, Washington, DC.
- Pollack, A.K., and J. Ford.** 1989. The TIME project: The role of a data analysis plan in monitoring network design. Presented at the International Symposium on the Design of Water Quality Information Systems, Colorado State University. June 7-9, Ft. Collins, CO.
- Pollard, J., and D. Heggem.** 1989. Quality assurance sample design for large and small environmental water quality surveys: A look at the past and future. Presented at the First International Conference on Environmetrics, International Environmetrics Society. April 4-7, Cairo, Egypt.
- Pollard, J., and W. Kinney.** 1989. Macroinvertebrate sampling methods. Presented at the National Symposium on Water Quality Assessment, U.S. Environmental Protection Agency, Office of Water. October 16-19, Ft. Collins, CO.
- Pollard, J.E., and D.V. Peck.** 1990. Biological quality assurance for ecological monitoring: Can we use chemistry as a template? Presented at the Third Annual Ecological Quality Assurance Workshop, Canada Centre for Inland Waters. April 24-26, Burlington, Ontario, Canada.
- Preston, E.** 1990. Overview of EMAP-Wetlands interagency interactions. Presented at the Forested Wetlands Workshop, U.S. Department of the Interior, Fish and Wildlife Service. July 9-11, Vicksburg, MS.
- Ranasinghe, J.A., and A.F. Holland.** 1990. Benthos as indicators of low summer dissolved oxygen in Chesapeake Bay. Poster presentation at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.

- Reimold, R.J., and R.A. Linthurst. 1989. Development of reasonable condition indicators for our nation's coast. Presented at the 10th Biennial International Estuarine Research Federation Conference. October 8-12, Baltimore, MD.
- Riitters, K.H., and J.E. Barnard. 1989. Criteria for evaluating indicators of forest health. Presented at the Conference on Global Natural Resource Monitoring and Assessments: Preparing for the 21st Century, International Union of Forestry Research Organizations and the United Nations Food and Agricultural Organization. September 24-30, Venice, Italy.
- Schimmel, S.C., C.J. Strobel, R.M. Valente, J.S. Rosen, K. Summers, and A.F. Holland. 1990. EMAP Near Coastal (NC) Demonstration Project: Approach, goals, and preliminary results. Presented at the 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 11-15, Washington, DC.
- Schimmel, S.C., J.F. Paul, A.F. Holland, K.J. Scott, and T.P. O'Connor. 1989. EMAP, an ecological status and trends program: Near coastal component. Poster presentation at the Gulf of Maine Symposium, December 10-12, Portland, ME.
- Schumacher, B.A., and P.W. Shaffer. 1990. C:N and C:S ratios of forested soils in the eastern United States. Presented at the Annual Meeting of the Soil Science Society of America. October 21-26, San Antonio, TX.
- Scott, J., J. Messer, and S. Weisberg. 1990. EMAP indicator strategy: Application to near coastal ecosystems. Presented at the 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 11-15, Washington, DC.
- Scott, K.J., A.F. Holland, and J.F. Paul. 1989. EPA's approach to monitoring condition of the nation's near coastal waters. Presented at the Northeast Estuarine Research Society Meeting. May 29-30, Durham, NH.
- Scott, K.J., J.F. Paul, J.K. Summers, A.F. Holland, and T.P. O'Connor. 1989. Environmental Monitoring and Assessment Program for near coastal waters. Poster presentation at the 2nd Office of Marine and Estuarine Protection Technology Transfer Workshop, U.S. Environmental Protection Agency. December 3-5, New Orleans, LA.
- Scott, K.J., J.F. Paul, J.K. Summers, A.F. Holland, and T.P. O'Connor. 1989. Environmental Monitoring and Assessment Program for Near Coastal Waters. Poster presentation at the 10th Annual Meeting of the Society of Environmental Toxicology and Chemistry. October 29 - November 2, Toronto, Ontario.
- Slagle, R., L. Blume, B. Schumacher, M. Papp, W. Cole, and S. Baxter. 1989. Use of a laboratory data entry and verification system as a quality assurance tool applied to a regional soil characterization study. Presented at the First International Environmetrics Conference, International Environmetrics Society. April 4-7, Cairo, Egypt.
- Slonecker, E.T. 1990. Landscape Characterization overview. Presented to the U.S. Environmental Protection Agency's Regional Scientists. July, Warrenton, VA.
- Stoddard, J.L. 1989. Reconstruction of past and current episodes for historic hydrologic and chemical data, Catskill Mountains, New York. Presented at the American Geophysical Union Meeting. December 4-8, San Francisco, CA.
- Stoddard, J.L. 1990. Regional importance of nitrate in the acidification of surface waters of the United States. Presented at the International Conference on Acidic Deposition: Its Nature and Impacts, Royal Society of Edinburgh. September 16-21, Glasgow, Scotland.
- Summers, K. 1990. EMAP-Near Coastal. Presented to the Association of Ecosystem Research Centers. July 26, Snowbird, UT.
- Summers, J.K., J.R. Clark, and J.M. Macauley. 1990. The use of dissolved oxygen concentration as an indicator of ecological condition in Gulf of Mexico estuaries. Poster presentation at the International Symposium on Ecological Indicators, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and U.S.D.A. Agricultural Research Service. October 16-19, Ft. Lauderdale, FL.
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Recent and Upcoming Events

- **EMAP Forests Workshop.** Environmental Monitoring and Assessment Program and USDA Forest Service, December 3-6, 1990, Rodeway Inn Foothills, Denver, CO. *Contact: Craig Palmer (702) 798-2186 (By invitation only).*
- **Fall Meeting.** American Geophysical Union, December 3-7, 1990, Civic Center, San Francisco, CA. *Contact: John Stoddard (503) 757-4666 or FTS 420-4666.*
- **Interagency Meeting of Experts on Monitoring of Natural Terrestrial Ecosystems.** United Nations Environment Programme, December 3-7, 1990, University of Maine, Bangor, ME. *Contact: Jay Messer (919) 541-0150 or FTS 629-0150.*
- **Gulf of Mexico Symposium.** U.S. EPA Gulf of Mexico Program Office, December 3-5, 1990, Clarion Hotel, New Orleans, LA. *Contact: Doug Lipka (601) 688-3726 or FTS 494-3726.*
- **Chesapeake Bay Research Consortium Symposium.** Chesapeake Bay Research Consortium, December 4-6, 1990, Lord Baltimore Hotel, Baltimore, MD. *Contact: Joseph A. Mihursky (301) 326-6700.*
- **NOAA National Status & Trends Program Quality Assurance and Annual Meeting.** National Oceanic and Atmospheric Administration, December 10-13, 1990, Battelle Pacific Northwest Marine Laboratory, Squim, WA. *Contact: Andrew Robertson (301) 443-8933 or FTS 443-8933 (By invitation only).*
- **Water Quality Standards for the 21st Century.** U.S. EPA Office of Water, December 10-13, 1990, Hyatt Regency-Crystal City, Arlington, VA. *Contact: Bob Hughes (503) 757-4666 or FTS 420-4666.*
- **Pesticides in Natural Systems, How Can Their Effects Be Monitored?** U.S. EPA Region 10 and Environmental Research Laboratory-Corvallis, December 11-12, 1990, LaSells Stewart Center, Oregon State University, Corvallis, OR. *Contact: Mike Marsh (206) 442-2876 or FTS 339-2876.*
- **Task Force on Monitoring.** Bureau of Land Management, December 11-13, 1990, Hotel Westcourt, Phoenix, AZ. *Contact: Bill Kepner (702) 798-2193 or FTS 545-2193 (By invitation only).*
- **EMAP-Wetlands Field Pilot Study Workshop.** Environmental Monitoring and Assessment Program, December 17-18, 1990 (hotel to be determined). *Contact: Dick Novitzki (503) 757-4666 or FTS 420-4666.*
- **Winter Conference on Environmental Statistics.** American Statistical Association, January 3-5, 1991, New Orleans, LA. *Contact: Tony Olsen (503) 757-4666 or FTS 420-4666.*
- **NOPPB Working Group Workshop.** National Ocean Pollution Policy Board/Marine Ecosystem Monitoring Workgroup, January 8-10, 1991, Environmental Research Laboratory, Gulf Breeze, FL. *Contact: Sari Karaly (301) 673-5243 or FTS 673-5243 (By invitation only).*
- **Quarterly Executive Meeting for EMAP Information Management Committee.** Environmental Monitoring and Assessment Program, January 8-10, 1991, Houston, TX. *Contact: Eugene Meier (702) 798-2237 or FTS 545-2237 (By invitation only).*
- **Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology.** American Meteorological Society, January 13-19, 1991, New Orleans, LA. *Contact: Eugene Meier (702) 798-2237 or FTS 545-2237.*
- **Water Users' Group Meeting.** U.S. Geological Survey, January 14-18, 1991, New Orleans, LA. *Contact: Nancy Lopez (703) 648-5015 or FTS 959-5015 (By invitation only).*
- **4th Annual Ecological Quality Assurance Workshop.** Environmental Monitoring and Assessment Program, February 26-28, 1991, Andrew Breidenbach Environmental Research Center, Cincinnati, OH. *Contact: Bob Graves (513) 569-7325 or FTS 684-7325.*
- **Pollution Prevention Conference.** Chemical Manufacturer's Association, April 3-5, 1991, Sheraton Washington Hotel, Washington, DC. *Contact: John Koutsandreas (202) 382-5784 or FTS 382-5784.*

For more information, please contact Tom Dixon in EPA's Office of Modeling, Monitoring, and Quality Assurance, (202) 382-7238 or FTS 382-7238.

The EMAP *Monitor* is prepared by the Office of Modeling, Monitoring Systems, and Quality Assurance and the Office of Environmental Processes and Effects Research, within EPA's Office of Research and Development. The EMAP *Monitor* is intended to inform interested agencies and individuals of current activities and findings from the Environmental Monitoring and Assessment Program. If you currently do not receive the *Monitor* and would like to be added to the distribution list (or know of others who may be interested), please fill in the box (or boxes).

Return to Tom Dixon, EMAP *Monitor*, U.S. Environmental Protection Agency (RD-680), 401 M Street, SW, Washington, DC 20460.

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