

**ENVIRONMENTAL MONITORING AND
ASSESSMENT PROGRAM
1991 Project Descriptors**

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Preface

The Environmental Monitoring and Assessment Program (EMAP) is a joint effort of the Office of Modeling, Monitoring Systems, and Quality Assurance and the Office of Environmental Processes and Effects Research, within the Office of Research and Development.

This document has been prepared to provide information on the projects within EMAP completed in Fiscal Year 1990 and funded for Fiscal Year 1991. EMAP was formally initiated in 1990, and many of its component projects are just beginning. Some projects were conducted in the field in 1990, while others focused specifically on planning and strategy development for implementation within the next few years. Descriptions of the projects contained in this document as well as lists of deliverables and milestones reflect current program plans, but it is likely that the details for some projects (including titles and due dates for deliverables) will change as EMAP plans progress and are refined. It is anticipated that this document will be updated annually to reflect current plans, following the closure of each fiscal year budget cycle.

For further information on any part of EMAP, contact the appropriate Project Officer or Principal Investigator noted on each Project Descriptor.

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Acronyms

ADP	automated data processing
ANC	acid neutralizing capacity
AREAL	Atmospheric Research and Exposure Assessment Laboratory (EPA, Research Triangle Park)
ARMA	auto-regressive moving average
ARS	Agricultural Research Service (USDA)
ASA	American Statistical Association
BEST	Board on Environmental Studies and Toxicology (NAS)
DLG	digital line graph
DOI	U.S. Department of the Interior
DQO	data quality objective
DRI	Desert Research Institute
EMAP	Environmental Monitoring and Assessment Program
EMSL-C	Environmental Monitoring Support Laboratory-Cincinnati (EPA)
EMSL-LV	Environmental Monitoring Systems Laboratory-Las Vegas (EPA)
EPA	Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center (EPA, Warrenton, VA)
ERC	Ecological Research Center (UNLV)
ERL-C	Environmental Research Laboratory-Corvallis (EPA)
ERL-D	Environmental Research Laboratory-Duluth (EPA)
ERL-GB	Environmental Research Laboratory-Gulf Breeze (EPA)
ERL-N	Environmental Research Laboratory-Narragansett (EPA)
FHM	Forest Health Monitoring Program (USDA-FS)
FIA	Forest Inventory and Analysis (USDA-FS)
FS	Forest Service (USDA)
FTN	Ford, Thornton, Norton, and Associates
FTS	federal telephone system
FY	fiscal year
GIS	geographic information system
GPS	global positioning system
IBI	index of biotic integrity
IMC	Information Management Committee (EMAP)
LCD	Landscape Characterization Data Base
LESC	Lockheed Engineering and Sciences Corporation
LTM	Long-Term Monitoring Program (EPA)
LUDA	Land Use Data Acquisition (USGS)

Acronyms

METI	Mantech Environmental Technologies, Inc.
NA	not applicable
NADP	National Acid Deposition Program
NAPAP	National Acid Precipitation Assessment Program
NAS	National Academy of Sciences
NASS	National Agricultural Statistical Service (USDA)
NCSU	North Carolina State University
NDDN	National Dry Deposition Network
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey (NOAA)
NRC	National Research Council
NRI	National Resources Inventory (SCS)
NTN	National Trends Network
NWI	National Wetland Inventory (FWS)
OARM	Office of Administration and Resources Management (EPA)
OHEA	Office of Health and Environmental Assessment (EPA)
OIRM	Office of Information Resources Management (EPA)
OMMSQA	Office of Modeling, Monitoring Systems, and Quality Assurance (EPA)
ORD	Office of Research and Development (EPA)
ORNL	Oak Ridge National Laboratory
OSU	Oregon State University
OTS	Office of Toxic Substances (EPA)
OTTRS	Office of Technology Transfer and Regulatory Support (EPA)
QA	quality assurance
QAPP	Quality Assurance Program Plan
QC	quality control
SCS	Soil Conservation Service (USDA)
SOP	standard operating procedures
TBA	to be announced
UNLV	University of Nevada-Las Vegas
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSTB	Water Science and Technology Board (NAS)

Section 1: 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: climate change, acidic deposition, ozone depletion, nonpoint 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 presently 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 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. EMAP seeks to answer these questions by addressing the three overall objectives shown in Figure 1.

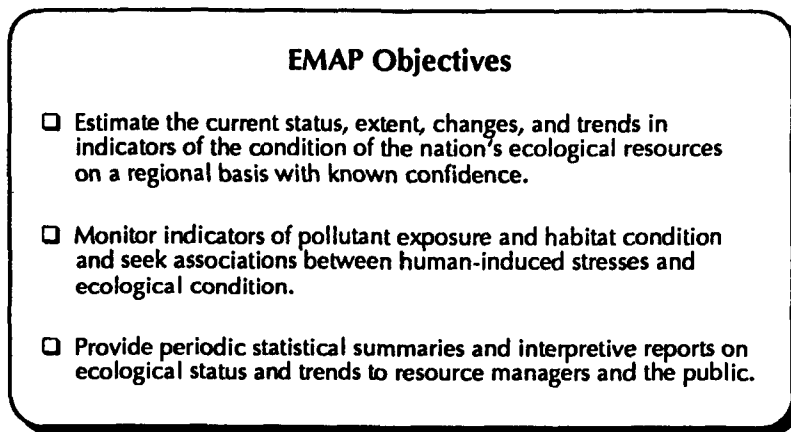


Figure 1. The three principal objectives of the Environmental Monitoring and Assessment Program.

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.

To ensure efficient execution of this approach, EMAP planning and field demonstration projects have involved other federal agencies as well as other organizations within EPA, including the Program and Regional Offices. 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 develop-

ment 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 efforts, 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 (Figure 2). Resource monitoring focuses on collection and interpretation of field data on the ecological condition of the eight EMAP resource categories. Several coordination activities support EMAP's resource monitoring efforts, including statistical analysis and network design; 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. Other coordination functions include technology transfer activities and liaison with the international community, other agencies, states, and EPA Regions. Integration

Environmental Monitoring and Assessment Program

Resource Monitoring	Coordination Activities	Integration Activities	Developmental Research
<ul style="list-style-type: none"> • Agroecosystems • Arid Lands • Forests • Estuaries • Great Lakes • Coastal Waters* • Surface Waters • Wetlands 	<ul style="list-style-type: none"> • Statistics and Design • Indicators • Logistics • Total Quality Management • Technology Transfer • International Activities 	<ul style="list-style-type: none"> • Air and Deposition • Landscape Characterization • Information Management • Integration and Assessment 	<ul style="list-style-type: none"> • Ecological Indicator Development • Environmental Statistics • Ecological Risk Characterization • Landscape Ecology

Figure 2. The four major elements of the Environmental Monitoring and Assessment Program: Resource Monitoring, Integration Activities, Coordination Activities, and Developmental Research. (*The Coastal Waters Group is not yet active.)

activities include several functions that facilitate the acquisition, management, and interpretation of monitoring data. 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.

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 how well standard operating procedures are performing 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 Association of Ecosystem Research Centers, 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, and plans are well under way for a similar project along the Gulf Coast to be conducted during the summer of this year. 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 this year, and the Wetlands Resource Group is planning to conduct a pilot study on selected coastal wetlands along the coast of Louisiana this summer.

During 1991, all Resource Groups are expected to 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.

Approximately \$24 million was allocated for EMAP in FY91. The relative distribution of these funds among the four major elements of the Program is shown in

Figure 3. Figure 4 illustrates the relative distribution of funds among the individual Resource and Task Groups within the four major Program elements. Consistent with EMAP's phased implementation, the three Resource Groups that are conducting field monitoring or pilot and demonstration projects in 1991 (Estuaries, Forests, and Surface Waters) have been allocated the largest proportion of the total budget. Funding levels for other Resource Groups generally reflect planning activities in preparation for field implementation in FY92 and beyond.

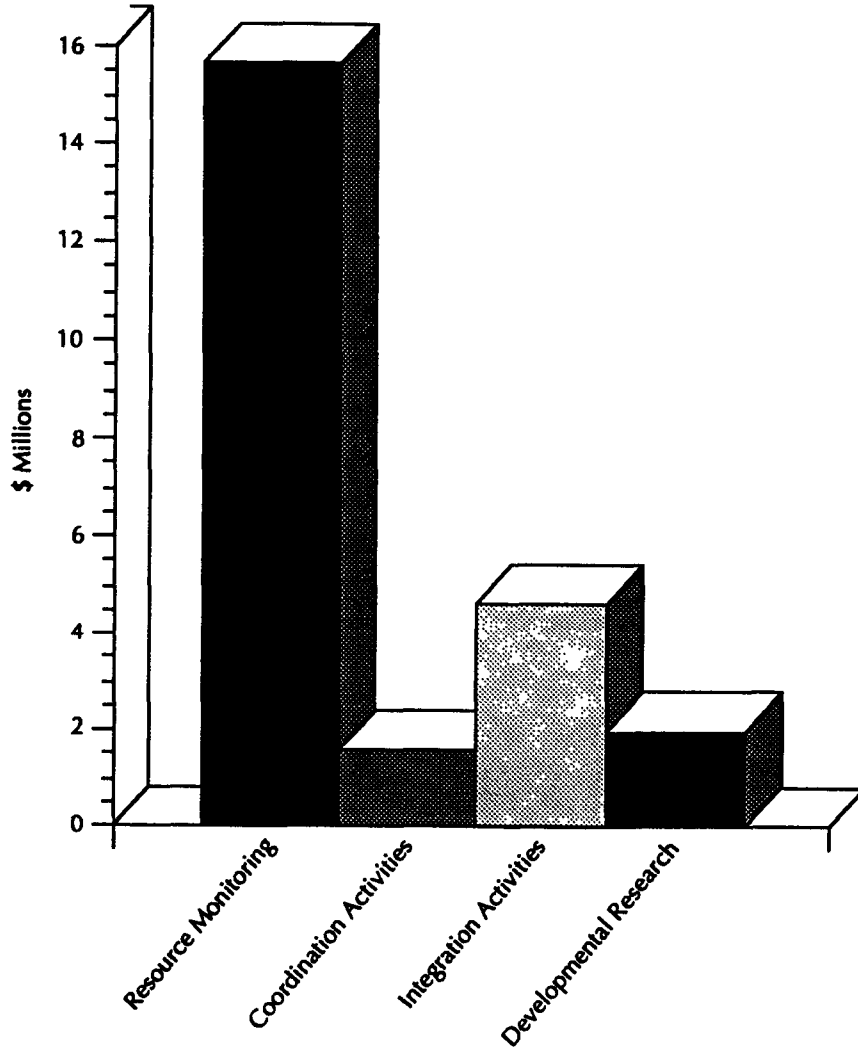
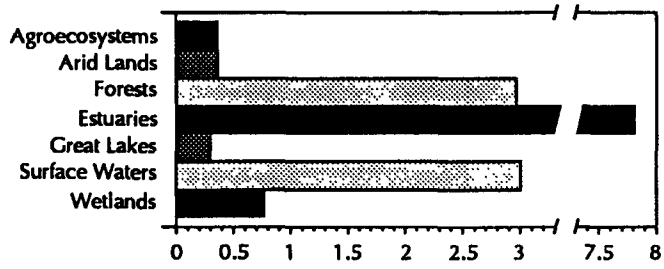
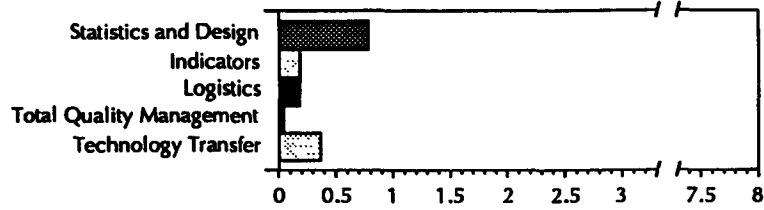


Figure 3. Relative FY91 funding for the four major elements of the Environmental Monitoring and Assessment Program.

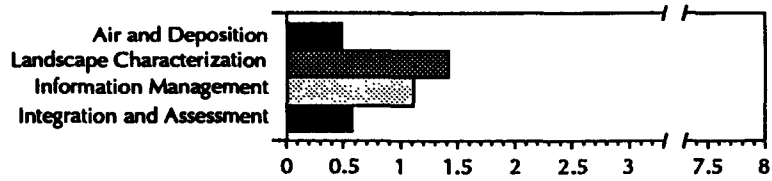
Resource Monitoring



Coordination Activities



Integration Activities



Developmental Research

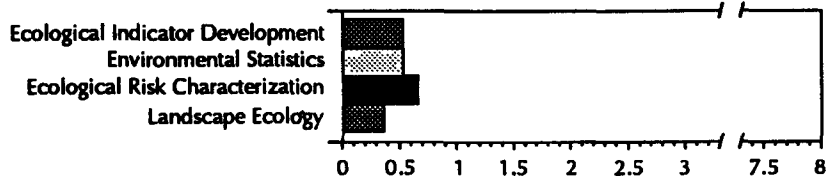


Figure 4. Relative FY91 funding for Resource and Task Groups within the four major elements of the Environmental Monitoring and Assessment Program.

This document is organized into five major sections: this Introduction and Overview and four sections that contain individual Project Descriptors for the four major elements of EMAP. Sections 2, 3, 4, and 5 contain individual Project Descriptors for Resource Monitoring, Coordination Activities, Integration Activities, and Developmental Research, respectively. Additionally, each Project Descriptor is coded (to assist in budget and deliverables tracking) and indexed for easy reference. The categories used to generate the three indices at the back of the document are (1) Regions and States – EPA Regions and states in which field projects or principal research activities are or will be conducted; (2) Project Officers – responsible for managing the project, providing technical direction and guidance, and ensuring coordination among related projects; and (3) Principal Investigators – responsible for ensuring the objectives are met and the work plan is executed. The Principal Investigators Index is further broken down into four categories: (1) Federal Employees, (2) University Cooperators, (3) Contractors/Consultants, and (4) Miscellaneous (Members of Scientific Societies and International Participants). Finally, a list of deliverables and due dates (current as of this writing) are provided for each project in the Appendix.

Section 2: Resource Monitoring

EMAP's ultimate success in providing a snapshot of current environmental conditions and identifying important trends in our ecological resources depends on the work presently being conducted by the Resource Groups. The currently operating Resource Groups are arrayed so that each concentrates on an important component of the environment: agroecosystems, arid lands, forests, estuaries, the Great Lakes, surface waters, and wetlands. An eighth Resource Group that will document the condition of the nation's coastal waters is planned for the future. Underlying the variety of activities and projects among the groups is a common Program orientation and integrated goal direction, which will ensure that all data bases developed will support EMAP's overall purpose. The principal EMAP objectives are to estimate the current status, extent, changes, and trends in indicators of the condition of our nation's resources on a regional basis; monitor indicators of pollutant exposure and habitat condition and seek associations between human-induced stresses and ecological condition; and provide periodic statistical summaries and interpretive reports on ecological status and trends to resource managers and the public. The Resource Groups' activities are focused toward satisfying these objectives.

Consistent with the carefully planned, phased implementation of EMAP, not all Resource Groups are at the same stage of development. Some of the seven Resource Groups are largely occupied with identifying, developing, and testing indicators and with designing their monitoring protocols in preparation for full implementation. Others have conducted small-scale pilot studies, and the Estuaries Resource Group, having completed a 1990 demonstration project in the Virginian Province, is preparing for a second demonstration in the Louisianian Province this summer. The Project Descriptors in this section provide details on projects completed in FY90 and continuing and newly initiated projects for FY91 for each Resource Group. Highlights of these activities follow.

In 1991, the Agroecosystems Resource Group (Section 2.1) is preparing its overall monitoring plan, assessing extramural data sources, working on indicator development, and formulating its reporting protocols. The National Monitoring Plan for Agroecosystems, to be finalized by late spring, will serve as the foundation for national-scale monitoring by this Group. In addition to agriculture-related indicators, the Group is currently evaluating indicators related to natural vegetation and wildlife. Data bases will be identified that could prove useful in assessing ecological condition of agroecosystems, and protocols will be developed for providing information gained through analysis and testing of agroecosystem indicators to other Resource Groups. Finally, an example summary produced in 1990 will serve as a useful tool for demonstrating potential presentation formats for statistical data summaries, to be produced annually once EMAP-Agroecosystems is fully implemented.

The Arid Lands Resource Group (Section 2.2) focuses on a variety of landscapes: deserts, grasslands, chaparral, woodlands, prairies, sagebrush-dominated shrubland, pinyon-juniper communities, and riparian areas. A first task for this Group has been to develop a working definition of arid ecosystems based on annual precipitation, precipitation versus evapotranspiration, temperature, and biological factors. Using this definition, EMAP-Arid Lands is preparing its National Monitoring Plan, which will be finalized in spring 1991. Also in 1991, the Group will begin planning for a pilot study on riparian systems to test network design, logistics, methodolo-

gies, and data and information handling. The findings from this pilot will form the basis for the development and implementation of monitoring and assessment in all arid land resources. By fall 1991, the Group plans to publish its conceptual approach and sampling framework for integrated assessments of arid lands. Production of an example statistical summary report, written for the public and policymakers, began in late 1990. Further work will be done on graphic displays and presentation methods to enhance this aspect of the Group's responsibility to report on ecological status and trends.

In 1990, EMAP-Forests and the USDA Forest Service conducted a survey of forest growth and visual symptoms of air pollution on forest canopies at 266 plots in New England (Section 2.3). The purpose of this study was to compare the approach for site selection proposed by EMAP-Forests with that used by the Forest Service in its Forest Health Monitoring program. In 1991, the results of this study are being used to refine the approach for continued monitoring in New England and for expansion to New Jersey, Maryland, Delaware, Virginia, Georgia, and Alabama. These data, along with supplemental data on air and deposition, will also form the basis for an annual statistical summary to be produced jointly by EMAP-Forests and the Forest Service. The experience gained in a second 1990 project, designed to evaluate plot design and logistics as well as variability in indicator measurements, also will be reported in 1991. For this project, several indicators of forest condition were measured at 20 sites in New England dominated by northeastern hardwoods and at 20 sites in Virginia dominated by loblolly pine. Development of a joint master plan for monitoring forest health in the United States is a key priority of EMAP-Forests and the Forest Service for 1991. Scientists from both organizations are working jointly to complete the plan, which will include priority forest classes and indicators, a sampling design, a total quality management plan, a logistics plan, and other principal components.

In 1990, the Estuaries Resource Group selected and evaluated a set of indicators in the Virginian Biogeographic Province Demonstration Project (Section 2.4). The area studied extends across the Virginian Province from Cape Cod (MA) southward to the Chesapeake Bay (DE, MD, VA). Sampling in this Province will continue in large estuaries, large tidal rivers, and selected small coastal systems through summer 1991. The 1990 project will help the Resource Group perfect its sampling design and operational strategies for later, cost-effective studies on a national scale. Indicators selected for monitoring included fish type and abundance, incidence of gross fish pathology, sediment organism type and abundance, water quality, sediment contaminant concentrations, and sediment toxicity to sensitive species. A preliminary report of results is expected in early 1991, with a final report the following fall. Regional implementation will continue with a 1991 Louisianian Demonstration Project and a proposed 1992 demonstration project in the Carolinian Province. These projects will help refine field and laboratory methods, logistics plans, data base management systems, and quality assurance plans that will guide future Resource Group efforts. An illustrative Near Coastal Example Interpretive Assessment was also produced, which emphasized presentation of results to show current status and trends and provided examples of questions that can and cannot be answered through EMAP.

Working with the existing EPA Great Lakes National Program Office, the Great Lakes Resource Group is presently investigating existing monitoring programs with respect to the EMAP goal and objectives (Section 2.5). Although this Resource Group is only in its early planning stages, a phased-in indicator evaluation strategy and pilot study design option are expected by late 1991. A possible pilot project,

now under discussion, would use EMAP approaches to evaluate zebra mussel distribution. Following successful pilot studies on one lower and one upper Great Lake, a lower lake demonstration project will precede full program implementation.

In summer 1991, an EMAP-Surface Waters pilot study in northeastern lakes will begin (Section 2.6). After access information is completed for 300 lakes in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut (EPA Region 1), as well as lakes in New York and New Jersey (EPA Region 2), site selection and sampling will start. The pilot study is an initial thrust in the Resource Group's efforts to establish field and laboratory procedures as well as rigorous data quality measures that will eventually enable long-term monitoring of the biological, chemical, and physical conditions of U.S. lakes nationwide. Another EMAP-Surface Waters project to monitor low acid neutralizing capacity waters for long-term trends is making use of a network originally established in EPA's acid deposition research program. This project will yield information from sites across the nation with emphasis on those waters believed likely to respond to changing levels of acidic deposition resulting from the Clean Air Act Amendments of 1990. The project will also compare these waters to those not expected to respond to decreased acidic deposition levels. Other EMAP-Surface Waters projects are examining indicators, design and implementation options, logistics and total quality management, and reporting formats. In addition to identifying and selecting the most appropriate indicators of aquatic condition, the Resource Group is developing implementation guidelines to support consistent, Program-compatible methods and standards for identifying candidate waters, selecting sampling sites, optimizing logistics and quality assurance protocols, and producing annual reports on national regional water quality status and trends.

The Wetlands Resource Group's National Research Plan was peer reviewed by scientists from six universities in November 1990 (Section 2.7). The final plan is expected in early 1991. Also in 1991, the Resource Group will conduct an indicator evaluation pilot study in coastal Louisiana to compare hydrology, vegetation associations, species composition and abundance, and other potential indicators. The pilot will assess these indicators in 20 wetlands considered to be in "good" or acceptable condition and 20 that are considered to be in unacceptable condition, based on the opinion of wetlands experts familiar with both the wetlands in the area and the perceived environmental threats. In cooperation with EMAP-Landscape Characterization, this Group also plans to conduct a pilot study to evaluate the design it proposes to use. This design pilot will address information gathering techniques pertinent to characterizing the status and extent of U.S. wetlands.

To meet their objectives and conduct their activities in the most effective manner, all of these Groups will draw upon the experience and expertise within other federal agencies and organizations that share responsibility for maintaining environmental quality or sustaining the nation's resources. In addition, as illustrated by these projects, the Groups are taking the necessary steps for ensuring efficient execution of the EMAP approach to monitoring the respective resources for which they are responsible.

Section 2.1: Agroecosystems

Development and Peer Review of National Monitoring Plan for Agroecosystems

Project Code: AG-90-001

EPA Region(s): All

Period of Performance: 1990-1991

State(s): All

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Objectives

Develop a detailed plan for national-scale monitoring of agroecosystems that highlights and evaluates monitoring strategies, including linkages with other agencies, evaluation of existing data, and pilot and demonstration studies.

Work Plan

This project is being accomplished through the interaction and activities of scientists from EPA, other agencies, universities, and institutes. Components of the National Monitoring Plan include a list of agroecosystem indicators to be measured; a sampling design, including use of the USDA National Agricultural Statistics Service (NASS) sampling frame in EMAP; a total quality management plan; a logistics plan; a description of the relationship of EMAP-Agroecosystems sampling to EMAP-Landscape Characterization; and descriptions of assessment, data base management, and reporting activities. The plan was peer reviewed in March 1991 in conjunction with peer reviews of the monitoring plans for EMAP-Arid Lands and EMAP-Forests. This joint review served to promote consistency among the three terrestrial monitoring plans and approaches. This plan will serve as the foundation for national-scale monitoring of agroecosystems within EMAP.

Deliverables/Milestones	Time Frame
• Draft monitoring plan	2/91
• Peer review	3/91
• National Monitoring Plan for Agroecosystems	4/91
• Agroecosystem indicators (journal article)	12/91

Development and Evaluation of Additional Indicators for Agroecosystems

Project Code: AG-91-002

EPA Region(s): NA

Period of Performance: 1991

State(s): NA

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Objectives

Initiate an ongoing research effort to develop and evaluate sets of indicators identified for possible use in monitoring ecological condition of agroecosystems.

Work Plan

Indicators reflecting condition of agricultural landscapes, which are not part of the agricultural production system, will be tested for utility in the monitoring of natural vegetation and wildlife; specific monitoring protocols for these landscape indicators will be developed and field tested. Indicators for monitoring contaminant import and export, pest density, animal production, and socioeconomic factors will be further developed. Preliminary field testing will be initiated for these indicators, if developmental information warrants.

Deliverables/Milestones	Time Frame
• Status report on agroecosystem indicator research	12/91

Identification and Evaluation of Existing Data Bases

Project Code: AG-91-003

EPA Region(s): All

Period of Performance: 1991

State(s): All

Project Officers

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Objectives

Identify agricultural data bases and evaluate them for possible use in assessing agroecosystem condition.

Work Plan

In cooperation with the USDA, a number of data sources have been identified, for example, those of NASS and the Soil Conservation Service-National Resources Inventory (SCS-NRI). Selected data from NASS have been obtained for preliminary analyses. Following these analyses, if warranted, additional data from past years will be obtained to analyze trends. A similar approach is planned for use of SCS data from both the NRI and other SCS data bases. Several other data sources have been identified and will be evaluated as time permits.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Critical evaluation of existing agricultural data bases for applicability to ecological assessment 	12/91

Development of Cross-Resource Linkages

Project Code: AG-91-004

EPA Region(s): NA

Period of Performance: 1991

State(s): NA

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Objectives

Interact with other EMAP Resource Groups to identify and further develop agroecosystem indicators that are relevant for monitoring condition of other EMAP resources and determine how data related to these indicators can be used in estimating the condition of other resources being monitored by EMAP.

Work Plan

Draft protocols for cross-resource monitoring will be developed and reviewed with other EMAP Resource Groups. One or two workshops with EMAP and non-EMAP participants will be held during the year for critical review of the protocols. Recommendations for cross-resource monitoring activities that may be useful at each EMAP design tier will be made.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Internal report on agroecosystem indicators relevant to cross-resource monitoring 	12/91

Example Annual Statistical Summary for Agroecosystems

Project Code: AG-90-005

EPA Region(s): NA

Period of Performance: 1990

State(s): NA

Project Officers

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Objectives

The objective of this project was to produce an example of an annual statistical summary for agroecosystems. Selected stress, exposure, and response indicators were used to illustrate how information on the condition of agroecosystems can be presented annually to decisionmakers and the public. The example presentation formats enabled effective communication between the Agroecosystems Resource Group and the intended audiences.

Work Plan

A list of questions and issues identified for agroecosystems was used to design and test a series of different presentation formats. The indicators evaluated included selected crop yields (e.g., soybeans, wheat), pest density, land use classification, and a soil erosion index. The report was written for policymakers and the public. For future summaries, existing data, data generated from characterization, and simulated data will be used to refine presentation and reporting techniques. These reports will be made over regional or biome scales, unless data are only available for smaller areas (e.g., vegetation associations). Field measurement and remote sensing data will be presented as maps generated by using GIS (geographic information system) techniques.

Deliverables/Milestones	Time Frame
• Final annual statistical summary example for agroecosystems	9/90

Section 2.2: Arid Lands

*Development and Peer Review of National Monitoring Plan for Arid Lands***Project Code:** AL-90-001**EPA Region(s):** 6, 7, 8, 9, 10**Period of Performance:** 1990-1991**State(s):** AR, AZ, CA, CO, IA, ID, KS, LA, MO, MT, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA, WY**Project Officer**William Kepner
EMSL-LV
(702) 798-3193
FTS 545-2193**Principal Investigator**Carl A. Fox
DRI
(702) 673-7322**Objectives**

Develop a comprehensive integrated plan for monitoring and assessing ecological condition in arid ecosystems. The plan will address monitoring for deserts, grasslands, chaparral woodlands, prairies, and pinyon-juniper communities.

Work Plan

No large-scale (regional) research plan for ecological monitoring currently exists for arid ecosystems in the United States. This project is being accomplished through a series of meetings and workshops involving scientists from EPA and other agencies, universities, and institutes. Components of the National Monitoring Plan will include an evaluation of existing data and development of a monitoring network design, lists of priority ecological indicators, a field sampling design, a logistics plan, analytical and measurement techniques, an information management plan (including quality assurance/quality control), and analytical and assessment reporting formats. The plan was peer reviewed in March 1991 in conjunction with peer reviews of the monitoring plans for EMAP-Agroecosystems and EMAP-Forests. This joint review served to promote consistency among the three terrestrial monitoring plans and approaches. This plan will be the foundation for implementation of ecological monitoring by EMAP-Arid Lands.

Deliverables/Milestones	Time Frame
• Draft monitoring plan	3/91
• Peer review	3/91
• National Monitoring Plan for Arid Lands	4/91

Riparian Pilot Study Plan**Project Code:** AL-91-002**EPA Region(s):** 6, 9**Period of Performance:** 1991**State(s):** AR, AZ, CA, LA, NM, NV, OK, TX**Project Officer**William Kepner
EMSL-LV
(702) 798-3193
FTS 545-2193**Principal Investigator**Carl A. Fox
DRI
(702) 673-7322**Objectives**

Develop a plan for implementing a pilot study in FY92 that will evaluate monitoring network design, logistics, sampling methodologies, ecological indicators, information management, quality assurance/quality control procedures, and integration of existing data and monitoring systems for riparian ecosystems. Evaluate data analysis techniques and reporting formats for expected assessment documents.

Work Plan

This project will be accomplished through a series of interactive meetings and workshops involving the Arid Lands, Surface Waters, and Wetlands Resource Groups; EPA and other federal and state agencies (e.g., the Bureau of Land Management); and university scientists. The pilot study plan will include strategies and procedures for regional assessment design, characterization, classification, sampling, logistics, information management, integration, and analysis. Specific sites and ecological indicators will be selected on a regional scale to develop assessment methodologies. Appropriate interagency agreements will be developed in order to ensure integration with existing monitoring networks.

Deliverables/Milestones	Time Frame
• Draft pilot study plan	4/91
• Review of study plan	8/91
• Final study plan	10/91

Arid Lands Integrated Assessment Design**Project Code:** AL-91-003**EPA Region(s):** All**Period of Performance:** 1991**State(s):** All**Project Officer**William Kepner
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(702) 798-3193
FTS 545-2193**Principal Investigator**Carl A. Fox
DRI
(702) 673-7322**Objectives**

Develop a conceptual approach and sampling framework for integrating historical, current, and proposed environmental data into an assessment of ecological condition for arid ecosystems. The developed design will serve as the basis for Annual Statistical Summaries and Interpretive Assessments for EMAP-Arid Lands.

Work Plan

Existing monitoring networks, data bases, and research programs will be evaluated by scientists from EPA, other federal and state agencies, and universities/research institutions to determine their appropriateness for incorporation into EMAP-Arid Lands. Indicators and data sets that are retrospective, field sampling based, or synoptic will be integrated to provide a methodology for determining the spatial and temporal variability (i.e., status, extent, and trends) of resources important to monitoring arid lands. A strategy for using the current EMAP network design and information gathered by EMAP-Landscape Characterization will be developed and incorporated into the assessment design for EMAP-Arid Lands.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> Integrated design for assessing the condition of arid lands (journal article) 	10/91

Example Annual Statistical Summary for Arid Lands**Project Code:** AL-90-004 **EPA Region(s):** NA**Period of Performance:** 1990-1991 **State(s):** NA**Project Officer**
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Carl A. Fox
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(702) 673-7322**Objectives**

The objective of this project is to produce an example of an annual statistical summary for arid lands. Selected stress, exposure, and response indicators are used to illustrate how information on the condition of arid lands can be presented annually to decisionmakers and the public. The example presentation formats will enable effective communication between the Arid Lands Resource Group and the intended audiences.

Work Plan

A series of questions and issues relevant to arid ecosystems is being used to develop an example of an annual statistical summary on the condition of arid lands. Examples for indicators of changes in land uses, changes in stressors, changes in exposure (e.g., air pollutant concentrations), and changes in ecological condition (functional and structural changes in ecosystems) are presented. The report is written for policymakers and the public. For future summaries, existing data, data generated from landscape characterization, and simulated data will be used to refine presentation and reporting techniques applicable at regional or biome scales, unless data are only available for smaller areas (e.g., vegetation associations). These presentation formats will include stacked bar charts showing the proportion of different types of arid lands in nominal, marginal, or subnominal categories for selected indicators; spatial maps showing the geographic distribution of indicators in these various categories; pie charts; time trends in indicators; and other techniques for displaying indicators of condition in arid lands.

Deliverables/Milestones	Time Frame
• Final annual statistical summary example for arid lands	4/91

Section 2.3: Forests

Development and Peer Review of National Monitoring Strategy and Plan for Forests

Project Code: FR-90-001

EPA Region(s): All

Period of Performance: 1990-1992

State(s): All

Project Officers

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Objective

Develop a master plan for a national forest health monitoring program that represents a joint effort between the USDA Forest Service and EPA. This plan will provide a comprehensive strategy for forest monitoring in the United States.

Work Plan

The USDA Forest Service (USDA-FS) and EPA are developing a joint national forest health monitoring program. This effort is being accomplished through a number of meetings and workshops involving USDA-FS and EPA scientists. Accommodating the monitoring needs of both agencies is a high priority. For example, it is likely that EMAP will use USDA-FS Forest Inventory and Analysis (FIA) sampling plots as its basis; selection of FIA sites is compatible with the proposed EMAP systematic grid. Several components of the plan are being developed by work groups consisting of scientists from both agencies. These components include a list of forest classes and indicators to be measured, a sampling design, a total quality management plan, a logistics plan, a description of the relationship of EMAP-Forests sampling to EMAP-Landscape Characterization, and a description of assessment, data base management, and reporting activities. The development of the plan is two-staged: (1) development of a monitoring and research strategy document that addresses the USDA-FS/EPA concepts formulated to date and those anticipated to be formulated over the next five years and (2) development of the national monitoring plan. The monitoring and research strategy document is being prepared principally by EPA individuals, and the national monitoring plan is being prepared jointly by EPA and the USDA Forest Service. The strategy was reviewed in March 1991 in conjunction with peer reviews of the monitoring plans for EMAP-Agroecosystems and EMAP-Arid Lands. This joint review served to promote consistency among the three terrestrial monitoring plans and approaches.

Deliverables/Milestones	Time Frame
• Indicators for monitoring ecological condition in forests (journal article)	11/90
• Draft monitoring and research strategy	3/91
• Peer review	3/91
• EMAP-Forests Monitoring Strategy for FY91	4/91
• Draft national monitoring plan for forests	2/92
• Peer review	3/92
• Final National Monitoring Plan for Forests	4/92

Support for the USDA Forest Health Monitoring Program

Project Code: FR-90-002

EPA Region(s): 1, 2, 3, 4

Period of Performance: 1990-1992

State(s): AL, CT, DE, GA, MA, MD, ME, NH, NJ, RI, VA, VT

Project Officers

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Objective

In 1990 the USDA Forest Service and State governments, in cooperation with EMAP-Forests, implemented monitoring in New England. Data on growth and the visual symptoms indicator were collected on 266 plots. EMAP-Forests supported this activity by developing the quality assurance program, acquiring and programming portable data loggers, and assisting in the development of quality assurance and methods manuals. The objective of this project is to continue to provide such support for each region as the Forest Health Monitoring (FHM) program moves toward full implementation.

Work Plan

In 1991, FHM is being implemented in New England, New Jersey, Maryland, Delaware, Virginia, Georgia, and Alabama. EMAP-Forests is responsible for (1) quality assurance and quality control, (2) sample preparation and laboratory analyses, (3) procurement and programming of portable data logging equipment, (4) assistance in developing field and analytical methods manuals, (5) global positioning system (GPS) and geographic information systems (GIS) support, and (6) other activities for which EMAP-Forests has the expertise to assist FHM. The field efforts for the project will be undertaken principally by the USDA Forest Service in association with their Forest Inventory and Analysis (FIA) program. EMAP-

Forests will evaluate (1) the effectiveness of the quality assurance and data base management procedures and (2) existing data bases and select and use appropriate auxiliary data to supplement indicator data collected in the field.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Regional Quality Assurance Project Plan	6/91
• Regional quality assurance officer training	6/91
• Methods manuals and standard operating procedures	6/91
• Data base evaluation and review	12/91
• Analysis complete	5/92

Regional Demonstrations of Forest Health Monitoring Approaches

Project Code: FR-91-003

EPA Region(s): 1, 4

Period of Performance: 1991-1992

State(s): AL, CT, GA, MA, ME, NH, RI, VT

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Objective

Identify and evaluate associations among developmental indicators for implementation in full-scale field monitoring. Data will support the production of annual statistical summaries for EMAP-Forests.

Work Plan

In 1991, the Forests Resource Group, in cooperation with the USDA Forest Service and State governments, will participate in regional demonstration projects in New England (51 sites), Georgia (37 sites), and Alabama (35 sites). Forest classes in selected hexagonal areas will be sampled by using the EMAP design, and data will be collected for a set of indicators. EMAP-Forests is responsible for developing the plan for the demonstration projects, which will be implemented after extensive reviews of the plan by both agencies. EMAP-Forests is responsible for (1) implementation plans and procedures, (2) quality assurance and quality control, (3) logistics, (4) data collection, (5) information management, (6) sample preparation and laboratory analysis, and (7) data analysis and reporting. The field efforts associated with the projects will be undertaken principally by the State Forest Service, the USDA Forest Service, and the USDA Soil Conservation Service. Several research indica-

tors also will be tested as part of these demonstration projects at approximately 40 sites (20 in New England and 20 in Georgia and Alabama).

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Implementation plan	5/91
• Methods manual	5/91
• Field sampling manual	6/91
• Quality assurance plan	6/91
• Report on results	7/92

Forest Health Monitoring Plot Design and Logistics Study

Project Code: FR-90-004

EPA Region(s): 1, 3

Period of Performance: 1990-1992

State(s): CT, MA, ME, NH, RI, VA, VT

Project Officers

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Principal Investigators

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Objectives

The purposes of the joint 1990 USDA-FS/EPA study on plot design and logistics were to (1) provide field data that would enable the costs and practicality of various measurements of forest condition to be assessed and (2) identify important sources of variation in the measurements for two major forest classes. The objectives of this project are to summarize the findings for each measurement tested and to synthesize the summary information and discuss its implications for plot design and logistics with respect to monitoring.

Work Plan

Field work was completed in FY90, and laboratory analyses will be completed in early FY91. Investigators from three EPA Laboratories and the USDA-FS will analyze their specific measurements and contribute to a summary report. This summary report will be supplemented by reports covering logistics, quality assurance, information management, and plot design, which will be incorporated into the summary report. The analyses and formats will be coordinated through periodic conference calls, memoranda, and meetings, as necessary. The first complete draft is expected in June 1991, and a peer-reviewed version is scheduled for October 1991 delivery.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
<ul style="list-style-type: none"> • Summary report on results of FHM plot design and logistics study 	10/91

Statistical Summary of the 1990 New England Forest Health Monitoring Survey

Project Code: FR-91-005

EPA Region(s): 1

Period of Performance: 1991

State(s): CT, MA, ME, NH, RI, VT

Project Officers

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Principal Investigator

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Objective

Report on the findings of the 1990 New England Forest Health Monitoring Project through the production of a statistical summary (See also Project FR-90-002).

Work Plan

In 1990, the USDA Forest Service and State governments, in cooperation with EMAP-Forests, implemented monitoring in New England. Data on growth and the visual symptoms indicator were collected on 266 plots. These data, along with air and deposition data, will be evaluated and summarized, and a statistical summary report produced. The report will include descriptive statistics to illustrate the landscape- and regional-scale patterns of forest ecological condition. The descriptive statistics will be presented for each major forest class in a region with spatial maps showing distribution of various condition indicators. EMAP-Forests will assist in the development of this report. The report will undergo external peer review as well as extensive reviews by both agencies.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
<ul style="list-style-type: none"> • First annual statistical summary – New England 	8/91
<ul style="list-style-type: none"> • Final report on the EMAP-Forests Pilot Project in the northeastern United States 	10/91

Example Annual Statistical Summary for Forest Resources

Project Code: FR-90-006

EPA Region(s): NA

Period of Performance: 1990

State(s): NA

Project Officers

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Objectives

The objective of this project was to produce an example of an annual statistical summary for the types of data to be generated by EMAP-Forests. Selected stress, exposure, and response indicators were used to illustrate how information on the condition of forest resources will be presented annually to decisionmakers and the public. The example presentation formats are intended to foster more effective communication between EMAP-Forests and the intended audiences on how EMAP data will be displayed.

Work Plan

Existing and synthetic data were presented for selected stress, exposure, and response indicators for forest resources. The report illustrates how forest condition indicators might be displayed and presented once the EMAP forest monitoring network is fully implemented. As such, it is intended only as an example of an annual statistical summary. The example summary includes descriptive statistics on landscape- and regional-scale patterns of forest condition that can be obtained from the EMAP network design. These descriptive statistics are presented as (1) pie charts of forest condition (e.g., good, marginal, poor) for each major forest class in a region, (2) spatial maps showing the geographic distribution of various condition indicators, (3) histograms and line graphs showing trends in forest condition indicators over time, (4) cumulative frequency distributions showing the proportion of the forest resource as a function of the condition indicator, and (5) other population-based presentation formats. The example summary presents the types of questions EMAP has been designed to answer, how the data will be displayed in future annual summaries that use authentic data, and the general format of an annual statistical summary. This example summary is used to initiate discussions with scientific administrators, policy analysts, and various public organizations on effective techniques for displaying and presenting EMAP data.

Deliverables/Milestones	Time Frame
• Final annual statistical summary example for forests	11/90

Section 2.4: Estuaries

*Development of a Near Coastal Monitoring Implementation Plan***Project Code:** ES-90-001**EPA Region(s):** 1, 2, 3**Period of Performance:** 1990-1991**State(s):** CT, DE, MA, MD, NJ, NY, PA, RI, VA**Project Officer**John F. Paul
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(401) 782-3037
FTS 838-6037**Principal Investigator**A.F. Holland
Versar, Inc.
(301) 964-9200**Objectives**

Develop a research plan that describes the implementation of EMAP for near coastal ecosystems. The plan will be consistent with the overall objectives of EMAP, but will describe in detail how the regional implementation will proceed in near coastal ecosystems, starting with the estuaries in the Virginian Biogeographic Province (Cape Hatteras to Cape Cod) in FY90. The plan will be developed in concert with the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program.

Work Plan

A research plan was prepared that details how the Program objectives of EMAP can be implemented on a regional basis for the estuaries of the conterminous United States. Several one-day workshops were held with scientists from academia and federal, regional, and state agencies to review indicators appropriate for implementation. A panel of recognized estuarine scientists has been convened to serve as a technical steering committee during the implementation of the Near Coastal Demonstration Project in the estuaries of the Virginian Province. This panel has peer reviewed the program plan and will provide technical oversight as the information from the Demonstration Project is analyzed, assessments with the data are conducted, and national-scale implementation activities are recommended. Coordination of the Near Coastal Plan with NOAA will be handled through the EPA/NOAA Joint Committee for Coastal and Marine Environmental Quality Monitoring.

Deliverables/Milestones	Time Frame
• Draft near coastal implementation plan	3/90
• Peer review of near coastal implementation plan	4/90
• Final Research Plan for EMAP-Near Coastal Monitoring and Assessment Program	4/91
• Revised Near Coastal Quality Assurance Plan	5/91
• Revised Near Coastal Data Management Plan	6/91
• Revised Near Coastal Methods Manual	7/91
• Recommendations for national-scale implementation of EMAP in estuaries	10/91

Virginian Province Demonstration Project**Project Code:** ES-90-002**EPA Region(s):** 1, 2, 3**Period of Performance:** 1990-1992**State(s):** CT, DE, MA, MD, NJ, NY, PA, RI, VA**Project Officer**Steven C. Schimmel
ERL-N
(401) 782-3078
FTS 838-6078**Principal Investigator**Steven C. Schimmel
ERL-N
(401) 782-3078
FTS 838-6078**Objectives**

Address EMAP objectives by implementing a regional-scale demonstration project in the estuaries of the Virginian Biogeographic Province (Cape Hatteras to Cape Cod). As part of this Demonstration Project, the utility, sensitivity, and applicability of the selected EMAP estuarine indicators will be evaluated on a regional scale; standardized methods for indicator measurements that can be transferred to other study areas and made available for other monitoring efforts will be developed; the effectiveness of the EMAP network design for quantifying the extent and magnitude of pollution problems in the near coastal environment will be determined; logistical issues associated with implementing the network design will be identified and potentially resolved; the usefulness of results for planning, priority setting, and determining the effectiveness of pollution control actions will be demonstrated; and the value of the EMAP approach and regional-scale assessments will be demonstrated.

Work Plan

An implementation plan describing how to conduct a monitoring and assessment program that is consistent with the objectives of EMAP was developed from a number of workshops and interagency discussions. Existing data and information from the Virginian Province were used to select appropriate indicators; demonstration assessments were performed with the selected indicators to ensure they were appropriate with respect to the overall Program objectives. Development of the implementation plan included other activities such as preparation of field and laboratory methods manuals, quality assurance plans and manuals, and logistics plans. These activities were coordinated with other ongoing activities in EMAP to ensure Program-level compatibility. An operational data management system was developed, reviewed, and implemented. After all of the plans associated with this Demonstration Project had been reviewed and approved, the field component was initiated during the summer of 1990.

Samples collected during the 1990 field activities are being processed and will be analyzed to test the utility of the measurements conducted. Assessments will be conducted to report on the status of the estuaries in the Virginian Province. A preliminary report on the field activities of this Demonstration Project will be ready for review in February 1991; a final report on the Demonstration Project will be delivered in October 1991.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Methods manuals for the Demonstration Project	4/90
• Quality assurance plan for the Demonstration Project	4/90
• Implementation plan for the Demonstration Project	6/90
• Data management system for the Demonstration Project	8/90
• Preliminary report on the Demonstration Project	2/91
• Implementation Plan for Virginian Province Monitoring in FY91	5/91
• Final report on the Demonstration Project	10/91
• Report on the 1991 field activities in the Virginian Province	11/91
• Data summary on 1991 monitoring in the Virginian Province	2/92
• Statistical summary for data collected in 1991 in the Virginian Province	6/92

Louisianian Province Demonstration Project

Project Code: ES-90-003

EPA Region(s): 4, 6

Period of Performance: 1990-1992

State(s): AL, FL, LA, MS, TX

Project Officer

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Principal Investigator

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Objectives

Continue with the regional implementation plan in estuaries by conducting a demonstration project in the Louisianian Biogeographic Province (Gulf of Mexico) in FY91.

Work Plan

Using the experience gained in the preparation of the research plan for the Demonstration Project in the Virginian Province, an implementation plan will be developed for the Louisianian Province. This plan will be consistent with the overall objectives delineated in the Near Coastal Program Plan, but will incorporate province-specific needs and experience. The measurements taken during the Virginian Province monitoring activities will serve as a starting point for indicator selection. It is anticipated that a core set of indicators will be common among the regions, but region-specific indicators may also need to be identified. The work conducted in the Demonstration Project in the Virginian Province for preparation of field and laboratory manuals, quality assurance plans and manuals, logistics plans, and data base management systems will enable the implementation in the Louisianian Province to proceed in an orderly fashion. Monitoring in the Gulf of Mexico will be initiated in FY91, with the first assessment report available in FY92.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Draft program plan for the Louisianian Province Demonstration Project	10/90
• Final program plan for the Louisianian Province Demonstration Project	4/91
• Training manual for 1991 Louisianian Province monitoring activities	5/91
• Quality assurance plan for 1991 Louisianian Province monitoring activities	5/91
• Data management plan for 1991 Louisianian Province monitoring activities	5/91
• Revised methods manual for use in 1991 Louisianian Province monitoring activities	6/91
• Field operations manual for 1991 Louisianian Province monitoring activities	6/91
• Initiation of Louisianian Province field sampling	6/91
• Preliminary report on the Louisianian Province Demonstration Project	2/92
• Final report on the Louisianian Province Demonstration Project	10/92

Carolinian Province Demonstration Project

Project Code: ES-91-004

EPA Region(s): 3, 4

Period of Performance: 1991-1994

State(s): FL, GA, NC, SC, VA

Project Officer

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Principal Investigator

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Objectives

Continue with the regional implementation plan in estuaries by conducting a demonstration project in the Carolinian Biogeographic Province (South Atlantic) in FY93.

Work Plan

Using the experience developed in the preparation of the research plan for the Near Coastal Demonstration Projects in the Virginian and Louisianian Provinces, an implementation plan will be developed for the Carolinian Province. This plan will be consistent with the overall objectives delineated in the Near Coastal Program Plan, but will incorporate province-specific needs and experience. The measurements taken during the Virginian and Louisianian Province monitoring activities will serve as a starting point for indicator selection. It is anticipated that a core set of indicators will be common among the regions, but region-specific indicators may also need to be identified. The work conducted in the Demonstration Projects in the Virginian and Louisianian Provinces for preparation of field and laboratory manuals, quality assurance plans and manuals, logistics plans, and data base manage-

ment systems will enable the implementation in the Carolinian Province to proceed in an orderly fashion. Monitoring in the South Atlantic will be initiated in FY93, with the first assessment report available in FY94.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Draft program plan for the Carolinian Province Demonstration Project	10/92
• Implementation plan for the Carolinian Province Demonstration Project	2/93
• Final program plan for the Carolinian Province Demonstration Project	3/93
• Initiation of Carolinian Province field sampling	6/93
• Preliminary report on the Carolinian Province Demonstration Project	2/94
• Final report on the Carolinian Province Demonstration Project	10/94

Near Coastal Example Interpretive Assessment

Project Code: ES-90-005

EPA Region(s): NA

Period of Performance: 1990-1991

State(s): NA

Project Officer

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Principal Investigator

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Objectives

The EMAP approach was evaluated in the Demonstration Project in the Virginian Biogeographic Province in the summer of 1990. An example interpretive assessment was produced to show how EMAP-Estuaries data might be displayed and used to answer assessment questions related to estuaries. Issues addressed include (1) the current status of estuaries and (2) the relationships between watershed land use or atmospheric deposition and estuarine conditions that might explain observed patterns or trends in regional estuarine condition.

Work Plan

A synthetic data set of dissolved oxygen patterns in the Chesapeake Bay and other large estuaries, along with a Monte Carlo sampling algorithm, was used to refine the network sampling approach with respect to sampling frequency, duration, and temporal and spatial variability. This synthetic data set was augmented with data on response indicators such as benthic species composition, exposure indicators such as sediment contaminant levels, and stress indicators such as land use and atmospheric deposition. The synthetic data set was modified to reflect the distribution of system attributes ranging from small to large estuaries and the distribution of land use and deposition species typical of the Virginian Province. Existing data were screened for indicator ranges, station locations, sampling frequency, period

of record, and system types, and also were used to augment the synthetic data set. The data set was formulated to contain realistic associations among response indicators and among exposure and response indicators. Samples were drawn from this data set using an interpenetrating frame. Association analyses such as regression and cluster analyses were used to determine relationships among indicators and to test detectability of trends using different levels of spatial/temporal variability in the data. The synthetic data set also was used to investigate the associations between watershed land use and nutrient loadings, nutrient loadings and response indicators, and watershed land use and response indicators. Relationships between atmospheric deposition response surfaces and the distribution of response indicators were evaluated using pattern recognition analyses.

This information was presented in the form of an example interpretive assessment, which emphasizes presentation of the results – how these data can be displayed to show current status and trends in indicators of ecological condition. Distribution functions can be used to indicate the proportion of estuaries in a region with indicator values less than some criterion value; pie charts and stacked bar charts can be used to indicate the proportion of estuaries with values of response or exposure indicators in various categories; and spatial displays (e.g., maps) can be used to identify patterns in stress, exposure, and response indicators with values in various categories. Trends in indicator values might be presented as changes in lower quartile or median values through time or changes in categories in stacked bar charts. This report provides an example of the questions EMAP can and cannot answer, the presentation of data to decisionmakers, and potential refinements in the network design.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Example interpretive assessment for estuaries	2/91

Section 2.5: Great Lakes
Great Lakes Demonstration Project

Project Code: GL-91-001**EPA Region(s):** 2, 3, 5**Period of Performance:** 1991-1994**State(s):** IL, IN, MI, MN, NY, OH, PA, WI**Project Officer**

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Principal Investigator

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Objectives

Address EMAP objectives through the development and implementation of a demonstration project in one of the Great Lakes. As part of this demonstration project, indicators and sampling design options will be evaluated and tested. Plans for implementation in all of the Great Lakes will be developed.

Work Plan

A compilation and review of current monitoring activities in the Great Lakes will be conducted. Components necessary to EMAP but not in current programs will be identified, and the research needed to address these components will be determined. The resultant plan will describe a phased approach to evaluating indicators and design options through pilot studies in one of the lower and one of the upper Great Lakes. Following successful completion and evaluation of the pilot studies, a demonstration project in one of the lower Great Lakes will be conducted. Plans for implementation in all five Great Lakes will be developed. Planning and implementation of the demonstration project will be a cooperative effort with the U.S. EPA Great Lakes National Program Office.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Draft program plan for conducting a pilot study in the Great Lakes 	11/91

Section 2.6: Surface Waters
Assessment of Changes in Surface Water Chemistry

Project Code: SW-90-001**EPA Region(s):** 1, 2**Period of Performance:** 1990-1992**State(s):** CT, MA, ME, NH, NJ, NY, RI, VT**Project Officer**

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Principal Investigator

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Objectives

Monitor the effects of acidic deposition on surface waters to provide regional assessments of patterns and trends in surface water chemistry in the low acid neutralizing capacity (ANC) systems of approximately 10 regions of the nation. A specific objective of this task is to assess the relationship between changes in regional acidic deposition and changes in regional surface water condition.

Work Plan

The foundation of the project is a spatially extensive network of low ANC surface water sites (both lakes and streams), which are sampled annually for complete major ion chemistry, aluminum species, dissolved carbon, and several other variables likely to respond to changes in acidic deposition. Regions selected for monitoring are those expected to experience changes in the amount of acidic deposition they receive, as a result of the Clean Air Act Amendments of 1990 (e.g., the Northeast), or those that are expected to be unaffected by new regulations (e.g., the West). Information from these spatially extensive sites is used to determine regional changes in acid-base status, which can be related to regional changes in sulfur, nitrogen, and base cation deposition.

In addition, the monitoring network includes a small number of sites in each region that are sampled more than once per year. These sites are associated in a statistically rigorous manner with subpopulations of sites in the spatially extensive network. Data from these sites are used to assess changes in surface waters in non-index periods (e.g., changes in the frequency and extent of spring acidic episodes) and to help interpret regional changes observed in the spatially extensive network. Regions are prioritized to allow phased implementation of sampling at both types of sites.

Deliverables/Milestones	Time Frame
• Data user's guide to the Long-Term Monitoring Program: Quality assurance plan and data dictionary	11/90
• Statistical summary of long-term monitoring data (LTM data report)	12/90
• Special issue of the Journal of Water, Air, and Soil Pollution: Synthesis of Acid Deposition Long-Term Monitoring Data Through 1989 (10 papers)	6/91

Strategy for Using Indicators to Assess Surface Water Condition**Project Code:** SW-90-002 **EPA Region(s):** All**Period of Performance:** 1990-1992 **State(s):** All**Project Officer**Daniel McKenzie
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FTS 420-4666**Principal Investigator**Robert Hughes
METI
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FTS 420-4666**Objectives**

Develop a comprehensive strategy for using indicators to assess surface water condition; define and implement a process for selecting a core set of currently available indicators of surface water condition; and establish and implement a strategy for improving upon existing indicators and developing new indicators of surface water condition.

Work Plan

Producing an assessment of surface water condition requires a comprehensive strategy for selecting from the myriad of measurements that can be made and reducing these data into a concise statement about surface water condition. End-points that reflect societal and scientific concerns about surface water condition are being examined. A combination of biological, chemical, and physical measurements, analyses, and indices is being studied to address these concerns. Through the use of literature, existing data bases, and field tests, the Surface Waters Resource Group is developing an indicator strategy, evaluating the suitability of proposed indicators, determining expected spatial and temporal variability, developing regional modifications for selected indicators, and selecting the most appropriate criteria for establishing a nominal-subnominal boundary for each indicator. The long-term program includes improving existing indicators, developing new indicators, and incorporating these indicators into EMAP. This work is being performed in coordination with aquatic scientists in other federal and state agencies.

Deliverables/Milestones	Time Frame
• Strategy and priorities for developing indicators of surface water condition	7/91

Design and Implementation of Surface Water Monitoring

Project Code: SW-90-003

EPA Region(s): All

Period of Performance: 1990-1992

State(s): All

Project Officer

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Principal Investigators

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Objectives

Design and plan the implementation of a national surface water status and trends program. A framework is being developed that will enable use of biological, chemical, and physical indicators to quantify the current regional and national ecological condition of lakes and streams as well as changes or trends in these conditions. A long-term monitoring program based on this design is being implemented and, in conjunction with the indicator strategy, will produce annual reports on the condition of surface waters and plausible explanations of this current condition or changes in condition.

Work Plan

The Surface Waters Resource Group is evaluating the EMAP design in order to ensure that the objectives and approach for monitoring and assessment of surface waters are consistent with the overall Program. Source materials for identifying lake and stream resources are being collected; rules for selecting lake and stream sample units and their inclusion probabilities, subpopulation classifications, and hexagon and watershed characterization requirements are being identified; and implementation guidelines are being developed. The rules and guidelines will be tested during a lake demonstration project to be conducted in the Northeast in FY91; a stream pilot is being planned as a future effort. Subsequent annual surveys of a set of biological, chemical, and physical indicators in these aquatic resources will provide data for estimates of national and regional conditions that will be reported annually. More in-depth interpretive reports will be produced on a regular but less frequent basis.

Deliverables/Milestones	Time Frame
• EMAP strategy for surface water monitoring	2/91
• Association of surface water condition with potential stresses	8/91

Logistics and Total Quality Management for EMAP-Surface Waters**Project Code:** SW-90-004 **EPA Region(s):** All**Period of Performance:** 1990-1992 **State(s):** All**Project Officer**
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John Baker
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Develop and implement the long-term logistics and total quality management approach for EMAP-Surface Waters.

Work Plan

EMAP-Surface Waters is implementing a long-term, national effort to monitor the biological, chemical, and physical condition of a statistically representative subset of the nation's lakes and streams each year. This effort poses considerable logistical and quality assurance challenges. Sampling these systems consistently and comparably across the country during a short index period each summer will be difficult. Working with federal, state, and private organizations, a comprehensive plan is being developed and implemented for gaining site access and coordinating field logistics; identifying field and laboratory procedures and analyses; training field crews; handling sample transport; and tracking, analyzing, and retrieving data. An extensive effort devoted to data quality assurance has begun with the development of data quality objectives, to be established prior to field implementation. Procedures for tracking the quality of data at various locations (quality control) are being developed, refined, and implemented. The approach and statistical procedures for assessing data quality are being identified, developed, and implemented. Because of the emphasis on biological indicators in EMAP, particular attention is being given to the control and assessment of the quality of quantitative and descriptive biological data. Total quality management is an integral part of the Surface Waters Resource Group. The concepts of quality control, assessment, and improvement are being extended from their applications in data quality to the entire Program.

Deliverables/Milestones	Time Frame
• Final quality assurance plan for Northeast Lakes Pilot	4/91
• Information management plan for Northeast Lakes Pilot	5/91
• Implementation plan for Northeast Lakes Pilot	6/91
• Field operations manual for Northeast Lakes Pilot	6/91

Example Annual Statistical Summary for Surface Waters and Wetlands**Project Code:** SW-90-005**EPA Region(s):** NA**Period of Performance:** 1990-1991**State(s):** NA**Project Officer**

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Objectives

Produce an example of an annual statistical summary for surface waters and wetlands. Selected stress, exposure, and response indicators are being used to illustrate how information on the condition of surface waters and wetlands can be presented annually to decisionmakers and the public. The example presentation formats enable effective communication between the Surface Waters and Wetlands Resource Groups and the intended audiences.

Work Plan

The envisioned annual statistical summaries for EMAP-Surface Waters and Wetlands will be presented using data on indicators from existing sources and simulated data sets. This example summary includes various types of data presentation methods for selected response, exposure, and stress indicators. Hypothetical associations among indicators of ecological condition, land use, and other stressors are displayed. Particular attention is devoted to identifying the most appropriate levels of data aggregation, methods of presentation, and analytical tools to portray relationships between anthropogenic stresses and regional and national condition in wetlands, lakes, and streams. The example data are summarized and displayed in a manner expected to be consistent with the needs of policymakers and the public.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> Final annual statistical summary example for surface waters and wetlands 	6/91

Section 2.7: Wetlands

Development of Monitoring Strategies for Wetlands

Project Code: WL-90-001 **EPA Region(s):** 5, 6, 8, 10
Period of Performance: 1990-1992 **State(s):** IL, LA, ND, SD, WA

<p>Project Officer Daniel McKenzie ERL-C (503) 757-4666 FTS 420-4666</p>	<p>Principal Investigators Richard Novitzki METI (503) 757-4666 FTS 420-4666</p>
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Objectives
 Develop and refine a national-scale monitoring and assessment plan for wetlands. Evaluate the adequacy of the proposed EMAP design using existing digitized wetland maps developed by the U.S. Fish and Wildlife Service's National Wetland Inventory. Plan and initiate a pilot project to test indicators of wetland condition in salt marsh systems of Louisiana. Evaluate (1) sensitivity of the proposed metrics for detecting known levels of stress and (2) variability of proposed indicators of wetland condition. A design pilot and an indicator pilot will help refine EMAP-Wetlands statistical frames, proposed indicators, and interpretive techniques needed for a full-scale monitoring effort anticipated in the midwestern and southeastern United States.

Work Plan
 EMAP-Wetlands will (1) prepare a peer-reviewed research plan; (2) evaluate the adequacy of the proposed EMAP design in the Design Evaluation Pilot, using digitized wetland inventory data bases for the state of Illinois and portions of the states of Washington, North Dakota, and South Dakota; and (3) test the sensitivity and variability of proposed indicators of wetland condition in the Indicator Evaluation Pilot in Louisiana. The Design Evaluation Pilot will be a coordinated effort among EMAP-Wetlands, U.S. Fish and Wildlife Service's National Wetland Inventory, and EMAP-Landscape Characterization. The proposed EMAP-Wetlands classification and EMAP design grid density will be assessed. The Indicators Evaluation Pilot will be a coordinated effort among EMAP-Wetlands, EMAP-Estuarines, and experts on Louisiana wetlands. Both a peer-reviewed pilot project plan and quality assurance plan will be prepared prior to field work. Interagency coordination with the U.S. Fish and Wildlife Service will continue as each agency's role in monitoring wetlands is addressed and defined.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Research Plan for Monitoring Wetland Ecosystems 	2/91

Section 3: Coordination Activities

As mentioned in the Introduction, EMAP has created six groups dedicated to ensuring that resource monitoring activities are conducted in a coordinated manner among and between Resource Groups. These Coordination Groups – Statistics and Design, Indicators, International Activities, Logistics, Total Quality Management, and Technology Transfer – are charged with the responsibility of developing standardized protocols and procedures for all aspects of monitoring and assessment, from sampling design to data analysis and reporting, and ensuring such protocols are followed by all Resource Groups. By working closely with each Resource Group, the Coordination Groups have developed a better understanding of the specific needs and objectives of the individual groups and how they fit into the overall Program. Based on this interaction, the Coordination Groups have been able to produce Program documents that provide guidance on design, indicators, logistics, and quality assurance; in addition, these groups have offered support to Resource Group planning and contributed valuable input to the individual research plans. The following paragraphs summarize the steps being taken by these Coordination Groups toward establishing a cohesive program.

The Statistics and Design Group (Section 3.1) prepared and is now refining an EMAP design document, which describes the overall EMAP sampling design, addresses the design's flexibility, and discusses approaches for site selection. This Group will also address specific design issues for each Resource Group as they arise during implementation stages, and will assist in modifying and refining the design framework for each resource monitoring effort, as needed. The Group will ensure, however, that such adaptations comply with the overall framework so that an integrated approach is maintained. To assess the precision and accuracy of the design, this Group is also developing a statistical quality control strategy, applicable to all Resource Group data collection and analysis activities. EMAP-Statistics and Design will coordinate the implementation of the strategy by each Resource Group. The practical application of statistics to enhance identification and assessment of the magnitude of environmental problems is also being explored by this Group. Finally, the Group has organized a panel of American Statistical Association members to review all statistics and design activities and to establish a process for peer review of statistical components of the Resource Groups' research plans. As more Resource Groups take to the field in FY91, EMAP-Statistics and Design will continue to evaluate and refine the rigorous, statistical monitoring sampling design so that ecological status and trends can be estimated and assessed in the most effective manner.

Members of the Indicators Group (Section 3.2) have also made significant contributions to the Program by producing two key documents: the Ecological Indicators Report for the Environmental Monitoring and Assessment Program and the Indicators Development Strategy for EMAP. The emphasis of the first document is the approach to be used for describing ecological condition and defining a common indicator selection strategy to facilitate integration and coordination among the Resource Groups. The second document focuses more on the criteria and process for selecting, evaluating, and reevaluating indicators. The Indicators Group will be responsible for assisting Resource Groups in the identification and prioritization of indicators as well as determining current and anticipated requirements for assessing ecological condition. This Group will interact with the Resource Groups to ensure that appropriate indicators are developed and applied, consistent with the overall EMAP indicator strategy. To obtain information on the

identification, application, research, and monitoring aspects of ecological indicators, an international symposium was held in October 1990. Presentations and contributions by international participants in the research and policymaking communities will aid EMAP-Indicators as plans are made for the future direction and priorities of ecological indicator research and implementation.

The Logistics Group (Section 3.3) has also prepared a guidance document, which provides general information to each Resource Group for logistics planning. These standard formats, checklists, and review procedures will ensure that a level of consistency in logistics approaches among the Resource Groups will be maintained. This Group is also addressing the importance of regional involvement in EMAP field operations and, to this end, has prepared a logistics proposal to the EPA Regional Offices. Another primary task of this Group is the determination of land ownership and site access. EMAP-Logistics will continue to work closely with Resource Groups during implementation phases to address these and other logistical issues.

Total Quality Management (Section 3.4) has focused much of its effort to date on the preparation of documentation critical to Program-wide quality assurance aspects. Of highest priority has been the development of the EMAP Quality Assurance Program Plan, which presents an integrated strategy for guiding and coordinating quality assurance activities across resource categories, regions, and monitoring programs. In FY91, the Group will be responsible for ensuring that the policies specified in the Plan are implemented and for providing support and guidance to the Resource Groups as they prepare their individual quality assurance project plans and methods manuals.

Effective communication of Program findings is the impetus behind the activities of Technology Transfer (Section 3.5). This Group must ensure that appropriate and accurate information is transmitted from EMAP to its wide spectrum of data users: the public, decisionmakers who require information to set environmental policy, program managers who must assign priorities to research and monitoring projects, scientists who desire a broader understanding of ecosystems, and managers and analysts who require an objective basis for evaluating the effectiveness of the nation's environmental policies. Technology Transfer is responsible for keeping interested parties informed about Program direction, current activities, significant accomplishments, and available products. In addition to this precise dissemination of information, this Group must also coordinate communication among EMAP Senior Managers and assist in the development of Program-wide policies and procedures regarding the output of products, preparation of budgets and planned program accomplishments, and outyear planning. Finally, a critical task fulfilled by this Group is the tracking, storage, and distribution of EMAP technical reports and products.

Although EMAP's goal is to monitor the condition of the *nation's* ecological resources, the Program must not exclude the potential for expanding its concept on an international basis. The prospect of global-scale environmental monitoring networks is not only alluring, but closer to reality with the ongoing work by EMAP. As one of its first projects, the International Group (Section 3.6) is conducting a comprehensive water quality survey in Nepal. Several catchments will be sampled, and water quality at these sites will be described and related to biological condition. In addition, a rationale will be developed for a representative network of sites to be established for monitoring pollution and ecological condition. Other international activities are currently being considered for future projects.

Interaction between the Coordination Groups and Resource Groups is necessary to achieve an efficient and nonduplicative approach to meeting the goal and objectives of EMAP. Communication and cooperation among the six Coordination Groups, however, is also critical for minimizing effort expended while maximizing information gained by the Resource Groups. EMAP's success depends on the complementary expertise as well as the combined efforts of these Groups. The following Project Descriptors provide details of the ongoing and planned activities of the Coordination Groups.

Section 3.1: Statistics and Design

Development of the EMAP Sampling Design Framework

Project Code: SD-90-001 **EPA Region(s):** All
Period of Performance: 1990-1993 **State(s):** All

Project Officer **Principal Investigator**
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Objectives

EMAP requires a rigorous, statistical, integrated monitoring sampling design framework as the basis for estimating and assessing ecological status and trends on a regional and national basis. The primary focus of this project is to specify and evaluate the sampling design framework, determine the protocols for collecting status and trends data, and define common data analysis methods applicable to the design. The design must enable sampling of any spatially distributed and identifiable ecological resource without having an explicit sampling frame. The integrated monitoring strategy is based on the following design criteria: consistent representation of environmental reality by use of probability samples, representation of all ecological resources and environmental entities, provision for the capacity to respond quickly to a new question or issue, and spatial distribution of the sample of any resource according to the distribution of the resource.

Work Plan

The EMAP sampling design framework is being developed by a sampling design group with experience in ecological survey statistical design. The first task completed was the development of a preliminary design framework. This framework is serving as the basis for discussions with all EMAP Resource Groups for determination of their perspective and constraints. The first task will result in a technical report describing the sampling design framework. Subsequent tasks will address specific design issues identified during the conceptualization and initial implementation stages of the design by Resource Groups. One current specific task is the development of a global triangular grid sampling framework that provides planar projection surfaces with minimal distortion for subcontinental-sized areas on the earth and flexible configurations for optimal placement in arbitrary locations.

The design development includes discussions with statistical design staffs of existing national monitoring programs. In addition, this project will identify for investigation, and rely on the results from, many statistical research issues being addressed by Project ST-90-001, Statistical Research on Design Aspects of EMAP.

Deliverables/Milestones	Time Frame
• Cartographic and geometric components of a global sampling design for environmental monitoring (journal article)	3/91
• Integrated sampling design for EMAP	8/91

Coordination of EMAP Sampling Design Implementation

Project Code: SD-90-002 **EPA Region(s):** NA
Period of Performance: 1990-1993 **State(s):** NA

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Objectives
 Provide the coordination and technical support required to ensure that the EMAP sampling design framework is implemented by all EMAP Resource Groups.

Work Plan
 The coordination required to implement the EMAP sampling design framework is being accomplished by establishing a statistics and design team, composed of EMAP-Statistics and Design and the lead statisticians from all EMAP Resource and Task Groups. This team will implement and refine the design framework for each resource monitoring effort. In addition, statistical design staff from cooperating agencies will be integral members of the implementation process. Implementation includes careful, explicit definition of resource populations, required level of landscape characterization and classification, development of resource sampling frames integrated with a common EMAP sampling frame structure, selection procedures for a double sample protocol for field sampling, and development of data analysis procedures. The implementation process involves participation of the design team during the development of Resource Group research plans, planning for pilot and demonstration field studies, and evaluation of these studies for design refinement.

Deliverables/Milestones	Time Frame
• Report on technical design and analysis	8/91

Investigation of Statistical Issues in EMAP Quality Assurance

Project Code: SD-91-003 **EPA Region(s):** NA
Period of Performance: 1991-1993 **State(s):** NA

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Objectives

EMAP requires not only a rigorous, statistical, integrated monitoring sampling design, but also a quality assurance program that has statistical quality control procedures that are consistent with the design. The objective of this project is to develop a statistical quality control program that integrates the sampling design and quality assurance programs to ensure that cost-effective quality assurance programs are designed to produce required precision and accuracy information for EMAP.

Work Plan

The project will develop a statistical quality control strategy for EMAP, including the development of supplemental field sampling designs and laboratory quality control analysis designs applicable to all Resource Group data collection and analysis activities. The strategy will be consistent with the EMAP sampling design framework and will be incorporated into the EMAP Quality Assurance Program Plan. In addition, the project will coordinate the implementation of the strategy by each Resource Group.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Total quality approach to environmental monitoring and assessment (journal article) 	7/91
<ul style="list-style-type: none"> • Proceedings paper on statistical thinking and tools for improving excellence in ecological projects 	8/91

American Statistical Association Review of EMAP Statistics and Design Activities

Project Code: SD-91-004

EPA Region(s): NA

Period of Performance: 1991-1993

State(s): NA

Project Officer

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Principal Investigator

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Objectives

Provide for the review of all statistical analysis and sampling design activities conducted by EMAP. The review process includes review of the EMAP sampling design and analysis framework and review of statistical aspects of the design implementation and operation.

Work Plan

A comprehensive program for review of all statistics and design activities has been established to provide the oversight necessary for the successful implementation of EMAP. A cooperative agreement with the American Statistical Association (ASA) provides the foundation for the project. An ASA review panel has been established

to provide overall review, advice, and identification of statistical research issues important to EMAP's success. In addition, the ASA in coordination with the review panel will identify ASA representatives to be members of all EMAP Resource Group peer review panels.

Deliverables/Milestones

Time Frame

- Summary of ASA review of EMAP task group activities

8/91

Section 3.2: Indicators

Research Strategy for Developing Indicators of Ecological Condition

Project Code: IN-90-001 **EPA Region(s):** NA

Period of Performance: 1990-1991 **State(s):** NA

<p>Project Officer Anthony R. Olsen ERL-C (503) 757-4790 FTS 420-4790</p>	<p>Principal Investigator TBA</p>
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Objectives
 The Ecological Indicators Report (EPA/600/3-90/060) for EMAP provides a conceptual framework for what is meant by ecological condition, what techniques might be used to measure it, and how such measurements might be used to provide explanations for that condition through the use of association analyses. This project has two main objectives: (1) to present general guidelines, criteria, and procedures for indicator selection and evaluation and (2) to establish an organizational framework for coordinating and integrating indicator development and use within EMAP.

Work Plan
 The indicator development strategy provides overall general guidance for EMAP Resource and Task Groups involved with development of indicators and is intended to represent a consensus among participants in the groups. A workshop was held in June 1990 to collect, generate, and discuss ideas. On the basis of this workshop, and other information sources, a draft document was prepared and sent to EMAP participants for comment, and the document has been finalized to reflect all comments received. Major elements of the document include guidelines for developing conceptual models that identify relationships between indicators and assessment endpoints and values; criteria and processes for selecting, developing, and evaluating indicators; a discussion of activities necessary for integration of indicator use across Resource Groups; and a description of the roles and responsibilities of the EMAP Technical Coordinator for Indicators.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Report on ecological indicators for determining the condition of major ecosystems in the United States 	7/90
<ul style="list-style-type: none"> • The Indicator Development Strategy for EMAP 	2/91

*International Symposium on Ecological Indicators***Project Code:** IN-90-002 **EPA Region(s):** NA**Period of Performance:** 1990-1991 **State(s):** NA**Project Officer**Daniel McKenzie
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FTS 420-4666**Principal Investigator**Eric Hyatt
AREAL
(919) 541-0673
FTS 629-0673**Objectives**

Organize and conduct an international symposium to exchange state-of-science information on the identification, application, research, and monitoring of ecological indicators. Discuss how these indicators can be used within a regional/ national monitoring program to interpret condition in ecological resources. Convene international scientists, researchers, administrators, and policy makers to discuss the need for a broader understanding of ecosystems and research priorities, anticipating emerging environmental problems, and addressing national and international monitoring, regulatory, and policy needs.

Work Plan

The International Symposium on Ecological Indicators was held October 16-19, 1990, in Fort Lauderdale, FL. The symposium was sponsored by the U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. DOI Minerals Management Service, and USDA Agricultural Research Service. The agenda included plenary sessions on the first day that addressed the need for environmental monitoring and presented an overview of current programs, plus the development of ecological indicators and their use in monitoring and regulatory programs. The second day presented concurrent sessions on the development and application of indicators in specific resource categories: surface waters, forests, estuaries, wetlands, agroecosystems, and arid lands. Presentations on the third day addressed multiple scales (landscape, regional, and global) and uses and interpretations of indicator information. Plenary sessions on the final day addressed present and future ecological monitoring, including future directions and priorities for ecological indicator research and implementation. Agency administrators, members of Congress, international environmentalists, and distinguished scientists were invited as speakers. A proceedings of the symposium is scheduled for completion in October 1991.

Deliverables/Milestones	Time Frame
• International Symposium on Ecological Indicators	10/90
• Proceedings of the International Symposium on Ecological Indicators	10/91

Section 3.3: Logistics

Logistics Program Planning for EMAP

Project Code: LG-90-001 **EPA Region(s):** All
Period of Performance: 1990-1991 **State(s):** All

Project Officer **Principal Investigator**
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Objectives

Provide guidance and support to the Resource Groups on aspects of field operations and enhance and economize EMAP field monitoring efforts through integrated team approaches. A coordinated approach toward field operations (logistics) will greatly enhance the effectiveness of data collection activities within the overall EMAP effort.

Work Plan

This project's principal 1990 activities focused on the development of an EMAP logistics overview and guidance document. This document included standard formats, checklists, and review processes for use by the Resource Groups in the development of the logistics portions of their monitoring and implementation plans. The information in this document will enable a level of consistency to be maintained in the approaches used for logistics and should ensure that all the essential procedures are followed. The logistics plans will help to integrate the activities of each of the Resource Groups by documenting and scheduling all implementation activities.

In addition to the logistics overview and guidance document, the Logistics Group has begun to develop several other key documents that will identify strategies for making effective use of personnel in conducting field sampling operations. One of these documents is an EMAP logistics proposal to the EPA Regional Offices. The Regional Offices are expected to be an integral part of EPA's overall field operations. It is, therefore, important that the regions be involved in planning and implementing EMAP monitoring activities. The EMAP logistics proposal to the EPA Regions is the initial step toward regional involvement in EMAP field operations. Working with the directors of the Regional Environmental Services Divisions, the Logistics Group will begin to identify primary Regional contacts and define their roles. These investigations will also assist in developing six-year options and alternatives for EMAP-Logistics.

Deliverables/Milestones	Time Frame
• Data base proprietary information strategy	3/90
• EMAP logistics overview and guidance document	7/90
• EMAP logistics proposal to EPA Regions	10/91
• Six-year options and alternatives for EMAP logistics	11/91

Section 3.4: Total Quality Management

Quality Assurance and Quality Control Program Planning for EMAP

Project Code: TQ-90-001 **EPA Region(s):** NA
Period of Performance: 1990-1991 **State(s):** NA

Project Officer **Principal Investigator**
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 EMSL-C EMSL-C
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Objectives

Provide guidance, support, and oversight on quality assurance (QA) and quality control procedures and planning to the monitoring and assessment activities in EMAP. This coordination will ensure that

1. data generated for EMAP are of sufficient quality to meet Program needs;
2. procedures and processes used in EMAP will produce the desired results;
3. procedures, processes, and data are sufficiently documented; and
4. data generated by one EMAP Resource Group are adequately defined for valid comparison with data generated by other EMAP Resource Groups.

Work Plan

The EMAP Quality Assurance Program Plan (QAPP) is the foundation for QA activities within EMAP. This document not only reflects EMAP's commitment to quality but also provides specific mechanisms and policy guidance by which quality can be maintained, quantified, and documented. Because EMAP is an interdisciplinary program of national scale, the QAPP presents an integrated strategy for guiding and coordinating QA activities across resource categories, regions, and programmatic lines. The Total Quality Management Group will concentrate its FY91 efforts toward implementing the policies proffered in the QAPP. This plan will be updated to integrate changes in Program management, structure-specific objectives, and resources as experience dictates.

In addition to assuring compliance to the EMAP QAPP, the Total Quality Management Group will provide specific guidance and support to EMAP data collection and analysis activities. In 1991, the emphasis will be on providing support to the EMAP Resource Groups. This support includes assistance in developing and reviewing QA project plans and methods manuals for Resource Group activities.

Deliverables/Milestones	Time Frame
• Quality Assurance Annual Report and Work Plan	9/90
• EMAP Quality Assurance Program Plan	8/91

Section 3.5: Technology Transfer

Development of EMAP Program-Level Informational Materials

Project Code: TT-90-001

EPA Region(s): NA

Period of Performance: 1990-1992

State(s): NA

Project Officer

Tom Dixon
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Principal Investigator

Chris Saint
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Objectives

Ensure that interested parties are kept informed about Program direction, current activities, significant scientific accomplishments and milestones, and available products (including major Program reports and planning documents). As EMAP approaches full implementation, the prior dissemination of such information will have proven valuable in enlisting the assistance of EPA Program Offices, EPA Regional Offices, the states, and the academic community.

Work Plan

During the past year, EMAP's first year of formal operation, a memorandum of the previous month's significant accomplishments, briefings and meetings, and publications and presentations has been distributed routinely to over 140 individuals in EPA Program Offices, Regional Offices, and ORD Laboratories. The distribution list will continue to be updated, and this product will remain EMAP's principal vehicle for communication within EPA.

A second major product in 1990 was the FY90 Project Descriptors document, which succinctly describes the objectives and work plans of the specific projects within EMAP. This document is to be updated annually and is intended for a broader audience than is the Monthly Memorandum.

The production of a new information product is being implemented in FY91. The EMAP Monitor, which will be issued three or four times per year, contains an overview of EMAP (updated annually), a feature article (describing the Program's major event of the quarter), summary updates of EMAP Resource and Task Group activities, a calendar of upcoming events, EMAP publications and presentations, and senior personnel in the Program. The audience for this product includes all those individuals who receive the Monthly, as well as key personnel in other federal agencies and the states and members of the academic community.

The first issue of the annual report on EMAP publications will be produced in FY91. For this first issue, presentations also will be included as entries. This document is a bibliographic listing of reports, guidance documents, research plans, and journal articles produced by EMAP personnel. Presentations include those made to scientific organizations and governmental institutions.

Several other informational products are planned, including brochures and videos. These products will be tailored for specific audiences, including the public at large,

federal agency administrators, Congressional staff, and others, as determined by the needs of EMAP to disseminate information.

Long-range plans include setting up briefings with EPA Regional and Program Offices and the states to begin identifying their needs with respect to EMAP Technology Transfer; sponsoring a symposium on some key scientific topic of interest to EMAP, such as landscape ecology or biodiversity; and consideration of establishing an EMAP-sponsored journal as a vehicle for publishing peer-reviewed articles authored by or of interest to EMAP scientists.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• EMAP Monthly Memoranda	Monthly
• EMAP Project Descriptors Document	4/91
• Publications Report	4/91
• EMAP Monitor	1/91; 7/91

Development of Policies and Procedures for EMAP Communications

Project Code: TT-90-002

EPA Region(s): NA

Period of Performance: 1990-1992

State(s): NA

Project Officer

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Principal Investigator

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Objectives

The purpose of this project is threefold: (1) to coordinate the production and dissemination of support products aimed at facilitating communications among EMAP Senior Managers; (2) to develop Program-wide administrative policies and procedures and a ten-year technology transfer plan; and (3) to provide a "clearing house" for tracking, storing, and distributing EMAP technical reports and other technical products.

Work Plan

Facilitating communications among EMAP Senior Managers is accomplished by using several routine communication tools. Summaries of weekly conference calls, highlighting key issues and action items with dates, are distributed to the EMAP Steering Committee within two days of the call. Personnel lists containing mailing addresses and telephone and facsimile numbers are periodically updated to reflect changes in personnel designated as lead managers and are then distributed Program-wide for use by EMAP Senior Managers and their support staff. Calendars for the current and upcoming months are distributed each month to the EMAP Steering Committee to assist in the scheduling of meetings and briefings; the calendars assist the Committee in avoiding conflicts with other scheduled meetings and also help maximize effective travel by promoting the scheduling of back-to-back meetings in the same location.

To accomplish the second objective, an administrative manual and a ten-year technology transfer plan are being produced. The administrative manual is an operational guideline that includes (1) a style guide with appendices for producing reports, which is consistent with ORD guidelines, but "customized" for use within EMAP, and (2) policies and procedures for internal Program communications, peer review of projects and outputs, and printing of Program documents. The technology transfer plan expands on the administrative manual to incorporate changing needs for both internal and external information dissemination as EMAP becomes larger and more complex. The document is envisioned to contain (1) refined guidance for preparing EMAP products; (2) an expansion of guidance for internal communications; (3) procedures for ensuring effective public relations; (4) guidance on data acquisition, management, access, and confidentiality; and (5) more definitive procedures for clearance and publication of specific types of EMAP products.

To meet the third objective, a centralized computer tracking system is being developed. This system will provide a centralized data base, with online access for particular elements, for the purpose of tracking EMAP publications, mailing lists, budgets, and distribution of products.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Administrative Manual	4/91
• Final Ten-Year Technology Transfer Plan	11/91

Section 3.6: International Activities

EMAP International Activities: Regional Assessment of Pollution Sources and Effects in Nepal

Project Code: IT-90-001

EPA Region(s): NA

Period of Performance: 1990-1991

State(s): NA

Project Officer

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Principal Investigators

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Objectives

The overall goals of the EMAP international effort are to encourage the development of global-scale environmental monitoring networks and to initiate the extension of the EMAP concept on an international basis. This project represents an initial effort aimed at meeting these broad goals. The specific objectives of this project are to (1) establish a framework for water quality monitoring within Nepal, (2) provide a description of water quality at several "problem" sites, and (3) begin a species inventory of aquatic biota at several sites with differing water quality in an attempt to determine an index of water quality based on biological diversity.

Work Plan

This project is a joint effort among EPA, Duke University, the Institute of Hydrology in the United Kingdom, and the Government of Nepal. A comprehensive water quality survey is being conducted on several catchments in Nepal. Samples are being collected over a three- to four-week period, when streamflow is low and concentrations of many pollutants are expected to be maximal (autumn or spring). These samples are being analyzed for heavy metals, major ions, and pesticides. Additional measurements are being made in the field, including concentrations of nitrate and dissolved oxygen, specific conductivity, pH, and temperature. Local scientists are being trained to take samples and operate field instruments to provide a basis for continuity of monitoring at selected sites, after this project is completed. At each sampling site, aquatic biota are being examined to establish the species diversity under differing water quality.

The chemical and biological data bases collected are being analyzed jointly with Nepalese scientists to establish (1) the relationships between biology and water quality, (2) the geographical distribution of water quality problems, and (3) a rationale for a representative network of sites to monitor pollution and ecological condition.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> Report on the relationship of water quality and the diversity of aquatic biota for selected sites in Nepal 	12/91

Section 4: Integration Activities

Four groups within the current EMAP organizational structure perform activities 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 environmental problems.

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 of 1990. 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.

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). Principal activities of this Group for 1991 include developing sampling frames for EMAP-Wetlands and EMAP-Surface Waters and coordinating use of outside data bases for frame materials. This Group is also applying, evaluating, and refining landscape characterization methods and designs. As an initial step in this process, a pilot study was conducted in Maryland in FY90. Results are being used to identify other topics that require research, planning, and pilot testing prior to full-scale implementation. The Landscape Characterization Group also plans to design and implement several pilot studies in FY91 aimed at refining characterization methods and demonstrating the overall landscape characterization approach, especially through the use of historical remote sensing data. Study areas are being selected based on known ecological problems and in areas where cooperation 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.

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 is being 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 interacting with the Resource Groups to develop their specific information management plans and ADP (automated data processing) plans.

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. In FY90, this Group participated with the Estuaries Resource Group in preparing an example interpretive assessment 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 data reports currently planned to be published annually by each Resource Group.

The following Project Descriptors provide details on the ongoing and planned activities of the four Integration Groups. Section 4.1 covers the Air and Deposition Group, Section 4.2 describes activities of EMAP-Landscape Characterization, Section 4.3 contains a description of EMAP-Information Management activities, and Section 4.4 presents activities of EMAP-Integration and Assessment.

Section 4.1: Air and Deposition
Support for the National Dry Deposition Network

Project Code: AD-90-001 **EPA Region(s):** All
Period of Performance: 1990-1992 **State(s):** All

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Objectives

The National Dry Deposition Network (NDDN) is presently collecting data in support of the Acid Deposition Program. The NDDN is considered to be the infrastructure on which to base EMAP air and deposition research in the future. This network is the only currently operating air concentration network that collects data from geographic areas of interest to EMAP. Network sites are located in non-urban areas. Data from this network are needed to estimate both spatial and temporal exposures to ecological resources in EMAP survey regions.

Work Plan

Standard concentration monitors will be deployed at 51 sites throughout the United States to obtain concentration measurements using standardized procedures for collecting and analyzing dry deposition samples. Quality control audits will be performed to document the quality of the data collected and to improve network performance. The concentration data collected at these sites will be converted to dry deposition velocities using the leaf area index and large area deposition approaches to be developed by NOAA and EPA jointly during FY91. This information will be reported in a form suitable for use in reports resulting from both EMAP and implementation of Clean Air Act Amendments. In addition to the field monitoring component of this effort, prototype concentration monitors will be deployed at certain research sites, and work will continue on developing sensors and samplers that will be used to refine NDDN protocols in the future.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Annual data report and analysis for the National Dry Deposition Network 	10/91

Investigation of Existing Network Capabilities

Project Code: AD-90-002

EPA Region(s): All

Period of Performance: 1990-1991

State(s): All

Project Officers

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Principal Investigators

Tim Haas
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Objectives

EMAP will rely, in part, on atmospheric exposure information from existing sampling networks, in particular the National Acid Deposition Program's National Trends Network (NADP/NTN) and the National Dry Deposition Network. Analyses must be performed to determine how well these existing monitoring networks characterize exposure in non-urban environments. This information will be used to design a network that will provide data of known accuracy and precision for estimating spatial and temporal trends in exposure.

Information from this project and Project AD-90-003 will be used by the EMAP Resource Groups to relate atmospheric exposure levels to ecological condition in their respective resources. The information also will be used by policymakers who will implement Clean Air Act Amendments to determine the effectiveness of emission reduction regulations.

Work Plan

Data from existing networks will be gathered and compiled into a data base. In addition to being used for this project, these data will be made available to the EMAP Resource Groups for their analyses. The data base will serve as a central archive for atmospheric data collected in non-urban areas. EMAP is providing partial support for 9 stations, an NADP Coordinator, and funding for the field audit program.

An advisory panel consisting of recognized experts in spatial statistics will be formed to provide advice and guidance to the Project Officer and Principal Investigator. This panel will meet regularly to review progress of the project.

Deliverables/Milestones	Time Frame
• Report describing contents of non-urban atmospheric data base	8/90
• Air and deposition monitoring and assessment plan for EMAP	4/91

Study to Determine Optimum Status and Trends Network

Project Code: AD-90-003 **EPA Region(s):** All
Period of Performance: 1991-1992 **State(s):** All

Project Officer **Principal Investigator**
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Objectives
 EMAP will rely, in part, on atmospheric exposure information from existing sampling networks, in particular the National Dry Deposition Network. Results of evaluations conducted in other projects will be used as a basis for supplementing existing networks with new and relocated sites. Enhanced networks will provide non-urban exposure data with the precision and accuracy required by EMAP Resource Groups to conduct association analyses with ecological effects data. Data collected by this network will also enable EMAP-Air and Deposition to estimate quantitatively spatial and temporal trends in non-urban exposure.

Finally, the information will be used by researchers and policymakers who will implement Clean Air Act Amendments to determine the effectiveness of emission reduction regulations.

Work Plan
 Spatial variability estimates of pollutants of interest and how well present systems characterize exposure to non-urban areas will be obtained from results of other projects. This information will be used to design an optimum spatial network. The analysis will indicate where additional sites are needed, where redundant sites occur, and where unusual situations (topographic features) require nontraditional methods for network design. The optimum spatial network will be supplemented, as needed, to ensure that required trends information can be obtained.

Deliverables/Milestones	Time Frame
• Report describing an optimum "trends" network	6/91
• Report describing an optimum "status" network	6/92

Section 4.2: Landscape Characterization

Sampling Frame Development for Ecological Resource Monitoring

Project Code: LC-90-001	EPA Region(s): 1, 2, 3, 4, 5, 6, 8, 10
Period of Performance: 1990-1994	State(s): AL, CT, FL, GA, IL, IN, MA, MD, ME, MI, MN, MS, NC, ND, NH, NJ, NY, OH, RI, SC, TX, VT, WA, WI
Project Officer Douglas J. Norton EPIC (703) 349-8970 FTS 557-3110	Principal Investigator Douglas J. Norton EPIC (703) 349-8970 FTS 557-3110

Objectives

Provide data for the development of sampling frames that are consistent with landscape characterization data on ecological resource extent and distribution; develop sampling frames jointly with EMAP Resource Groups and EMAP-Statistics and Design; and coordinate the use of outside data bases for frame materials and ensure their compatibility and translatability with landscape characterization data.

Work Plan

This project has three principal elements: (1) coordination of outside data base use for frame development; (2) development of a surface waters sampling frame; and (3) development of a wetlands sampling frame.

The base grid of the EMAP design (Tier 1) is a national network of 12,600 uniformly spaced points covering the conterminous United States. This grid network is central to (1) the gathering of landscape characterization data (the Landscape Characterization Database or LCD) and (2) the selection of sampling sites by all EMAP Resource Groups. EMAP-Landscape Characterization is identifying, classifying, and mapping ecological resources and cultural activities as land use and land cover patterns, in association with the EMAP grid. EMAP Resource Groups have a need to identify classes and subclasses of their target resources that occur near each grid point and to develop, according to sample selection rules, a subset for monitoring by choosing one unit (or patch) of the resource class or subclass at each of a number of grid locations. These two main uses of the Tier 1 grid, although distinct, are related: Both the sampling of a given resource class and the characterization of its extent and distribution rely on a subset of units (or patches) selected from the same statistical "universe" (i.e., all existing occurrences of the resource). Consequently, close coordination is needed between efforts to measure ecological condition and efforts to estimate resource extent and distribution so that both types of measurements can be accurately correlated and integrated.

This coordination responsibility resides with EMAP-Landscape Characterization. Ideally, the data for constructing a sampling frame for each Resource Group would be derived from a common data base, such as the Landscape Characterization Database (LCD), because errors that would result from using different subsets or resource units (or patches) for characterization and measurements of ecological

condition would be eliminated. The LCD will require several years to complete, and thus alternative information must be used in the interim. Therefore, an intermediate step of verifying the validity and compatibility of frame development materials, as well as the ease with which such materials can be translated to and re-generated from the data in the LCD, has been added to the sample development process. In FY90, interim standards for evaluation of outside data for sampling frames were developed. These evaluations will be completed during FY91, provided all Resource Groups finalize their choice of frame data sources and their statistical sample selection protocols. The finalization process will involve the respective EMAP Resource Groups, EMAP-Landscape Characterization, and EMAP-Statistics and Design.

In addition to overall coordination, EMAP-Landscape Characterization is developing sampling frames specifically for use by the Surface Waters and Wetlands Resource Groups. Sampling frame development for EMAP-Surface Waters has been divided into two separate efforts, one for lakes and one for streams; both will be drawn from the USGS DLG (Digital Line Graph) Hydrology maps, digitized from the blue-line data of conventional topographic quadrangles. The lake frame methodology was completed and applied jointly with EMAP-Surface Waters in EPA Regions 1, 2, and 5 during FY90; completion of a national frame is expected by the end of FY91. Development of the stream sampling frame will follow in FY92. The wetlands frame will be derived from the National Wetlands Inventory (NWI) maps, which will require updating for areas where recent data are unavailable or rapid change has taken place. During FY91, comparative pilot studies will be conducted jointly with NWI and EMAP-Wetlands. Finalized frame development methods will be applied in the southeastern United States in late FY91 to develop a sample of estuarine emergent wetlands for monitoring during the FY92 field season. Completion of the national wetland frame is expected by FY94.

Deliverables/Milestones	Time Frame
• Wetlands frame for Gulf estuarine emergents – Data set completed	10/91
• Sampling frame for surface waters – Data set completed	11/91

Development of the Landscape Characterization Pilot Sites Network

Project Code: LC-90-002	EPA Region(s): 1, 2, 3, 4, 5, 9
Period of Performance: 1990-1992	State(s): AZ, DE, GA, MA, MD, MN, NH, NV, NY, PA, VA, VT, WV
Project Officer Douglas J. Norton EPIC (703) 349-8970 FTS 557-3110	Principal Investigator Douglas J. Norton EPIC (703) 349-8970 FTS 557-3110

Objectives

Apply, evaluate, and refine new EMAP-Landscape Characterization design and methods; focus on detecting real environmental problems in diverse regional settings; involve EPA Regions, States, and cooperating federal agencies; and establish characterization data base nuclei in order to evaluate usefulness to clients. After an initial year of program design, these objectives are the high priority program development areas that remain. In addition, each individual project will cover a special investigation topic to address and resolve a specific technical or logistical issue before the program can be made fully operational.

Work Plan

This project has five principal elements: (1) methods development/refinement/evaluation studies, (2) change detection pilot study, (3) equipment/information management, (4) quality assurance/ quality control development, and (5) development of the EMAP-Landscape Characterization Research Plan.

During FY90, the basic EMAP-Landscape Characterization methods were designed for characterizing the physical, biological, and cultural composition and pattern captured in the EMAP Tier 1 sampling sites. The concept for a Geographic Information Systems (GIS) environment for a national data base was formulated that would contain spatial environmental information such as land use/land cover, road networks, surface hydrology, soils, and elevation. Remote sensing from aerial photographs and satellite images, along with many existing data bases, would be the sources of the national Landscape Characterization Database (LCD). This data base would provide EMAP with (1) a mechanism for monitoring changes in distribution, abundance, and pattern of ecological resources and (2) a geographic framework against which measurements of ecological condition can be compared, correlated, analyzed, and used by EMAP clients.

The Ten-Hexagon Pilot Project, which was the first EMAP-Landscape Characterization pilot study, involved a transect of ten 40-km², hexagon-shaped EMAP sampling sites spanning three ecoregions. This pilot served as a methods refinement study and a means to identify other topics needing pre-implementation research, planning, and pilot testing. Full-scale, national implementation of EMAP-Landscape Characterization is expected to require an additional one to two years of developmental effort. Most of this effort will center on a diverse, nationally distributed network of pilot projects in FY91. These projects will share a common set of objectives, while individually featuring a topic such as change detection, information management and interagency data exchange, quality assurance/quality control, accuracy assessment, production equipment testing, and integration with Resource Group data.

The collective results of the pilot projects will also provide critical input to the EMAP-Landscape Characterization Research Plan, scheduled for completion October 1991, and to the subsequent EMAP-Landscape Characterization Implementation Plan to be produced in 1992.

Deliverables/Milestones	Time Frame
• FY90 pilot implementation plan for EMAP-Landscape Characterization	12/89
• Revised EMAP-Landscape Characterization concept and plans	3/91
• Ten-Hexagon Pilot Project final report	5/91
• EMAP-Landscape Characterization Research Plan	10/91
• EMAP-Landscape Characterization Quality Assurance/Quality Control Plan	11/91

Section 4.3: Information Management

Development and Implementation of Information Management for EMAP

Project Code: IM-90-001

EPA Region(s): NA

Period of Performance: 1990-1992

State(s): NA

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Objectives

Plan, develop, and implement a comprehensive Information Management Program for EMAP; provide support to EMAP Resource Groups, Coordination Groups, and Integration Groups in developing information management capabilities; and provide an information management system for EMAP that will make EMAP data/information easily accessible to all interested users.

Work Plan

An Information Management Team, led by the Information Management Director, has been assembled at EMSL-LV to lead the planning, development, and implementation of the Information Management Program and system for EMAP. An Information Management Committee (IMC) has been chartered to assist the Director in coordinating, reviewing, and approving activities of the Information Management Team and information management-related products from the EMAP Resource Groups and managers. The IMC, chaired by the Director, consists of information managers from each Resource Group, ADP (automated data processing) coordinators from each EMAP laboratory, Information Management Team representatives, representatives from the Offices of Administration and Resources Management (OARM) and Information Resources Management (OIRM), and EMAP Technical Directors. The Information Management Team is working closely with the IMC and OARM/OIRM to develop the strategy and plans for implementing the Information Management Program and system. The plans are being documented in accordance with OIRM's System Design & Development Guidance. Initially, three documents, the Mission Needs Analysis, Preliminary Design and Options Analysis, and the EMAP Information Resources Management Plan, are being prepared with the assistance of the OIRM/OARM staff. Efforts are also being initiated to implement components of the overall Information Management Program and system, such as information standards, data catalogs, and data dictionaries, and to coordinate EMAP requirements with other federal and international information

management program activities. The development of the information management system will be phased in over a five-year period, with early emphasis on developing information management capabilities at the Resource Group level (FY90-91 emphasis has been on the Estuaries and Forests Resource Groups). The experience and requirements of the Resource Groups and EMAP managers will facilitate the development of the overall EMAP information management system, which should be fully operational by FY95. This system will meet the requirements identified in the mission needs analysis and will provide easy access to EMAP data for all users.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Data confidentiality in EMAP: Issues and recommendations	6/90
• Essential Elements of Information: Mission Needs Analysis	4/91
• Essential Elements of Information: Preliminary Design and Options Analysis	10/91
• Essential Elements of Information: EMAP Information Resources Management Plan	10/91

Section 4.4: Integration and Assessment
Program-Level Integration and Assessment for EMAP

Project Code: IA-91-001

EPA Region(s): NA

Period of Performance: 1991-1992

State(s): NA

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Objectives

Examine and explain the major products, data, and operational needs of each EMAP Task Group relative to integration and assessment to provide a framework for achieving EMAP's goal. This project will also include development of a strategy and structure for providing products to each EMAP data user, or client, through internal and external communication strategies. The project will establish frameworks for both Task Group-specific and Program-wide needs related to integration and assessment.

Work Plan

Integration Framework: The level of inclusion and detail of information presented will vary according to the profile of the client. Therefore, the initial phase will focus on identifying key target groups for EMAP integration products. One tier of target groups is the EMAP Technical Directors and Technical Coordinators, and another tier is the external community, for example, Congress and the public. In the initial phase, the particular needs of each target group and the products they require will be detailed, concentrating first on those with the highest priority needs according to the EMAP vision, goal, and objectives. A strategic planning approach will ensure that the EMAP goal and objectives drive the day-to-day operations of the Program. The Integration and Assessment Group will establish a common approach for the Task Groups in a push toward integrated products, which will allow integration at varying levels and which will provide an EMAP-wide perspective.

Among the major tasks associated with the Integration Framework are (1) client descriptions and needs assessment; (2) inventory of data needs, communication needs, management needs, and near-term measures of success for each Task Group; (3) coordination with the EMAP Technical Coordinators on all integration needs including information management, statistics and design, logistics, indicators, and total quality management; and (4) outreach activities with clients, as identified by the internal/external communication strategies.

Assessment Framework: A key component of integration and assessment that has not been previously addressed is the development of consistent definitions and descriptions of many of the concepts and terms associated with integration and assessment. Therefore, early activities of the Integration and Assessment Group will be to develop an integration and assessment dictionary and description of approach and an integration and assessment operating plan. EMAP's major integrative and assessment components will be described in sufficient detail to enable the

individual Task Groups to proceed in a unified manner. A multiyear operating plan will be developed from the dictionary. The plan will include the objectives, measures of success, and planned activities and tasks needed to achieve integrated EMAP products. At a minimum, the plan will address technical integration (e.g., for core definitions and stressor information); Program integration (e.g., for National Program Manager interfaces); and policy integration (for consideration by decisionmakers at legislative levels).

Integration and Assessment: The Integration and Assessment Plan will provide both example and actual reports on the overall status and trends in condition of multiple ecological resources. These reports will be aimed at the identification of region-wide emerging problems and correlations (or possibly causal postulations) and will serve as vehicles for assessing the relationships between regulatory/control programs and ecological risk reduction.

The Plan will strive to ensure that all products generated from the Task Groups are consistent with the ecological risk reduction paradigm. That is, the products must be directly translatable for risk assessment, risk management, and risk communication, based on the Office of Research and Development's Ecological Risk Assessment Program. The Plan will also include a description of research needs within ORD and outside of the Agency.

Deliverables/Milestones	Time Frame
• Final EMAP assessment strategy	6/90
• Integration and Assessment conceptual plan	4/91
• Program plan for EMAP	6/91
• Client/Target groups inventory and needs assessment	6/91
• Integration and Assessment dictionary of terms and description of approach	6/91
• Final Integration and Assessment operating plan and communications strategy	10/91

Preparation of Guidance for Annual Statistical Summaries

Project Code: IA-90-002 **EPA Region(s):** NA
Period of Performance: 1990 **State(s):** NA

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Objectives
 EMAP will produce two types of reports, Annual Statistical Summaries and periodic Interpretive Assessments. The Statistical Summaries will describe the indicators monitored within EMAP and the data quality objectives (DQOs) that guide their measurement, as well as provide graphic displays of results with known levels of associated uncertainty. Initially, "mock ups" of the annual reports are prepared as

examples or "case studies" of the information that will be provided for each ecological resource when EMAP is fully implemented. These example Annual Statistical Summaries inform potential users of EMAP data as to what will and will not be produced within EMAP and aid in ensuring the ultimate design will meet users' needs. The objective of this project was to provide guidance to aid EMAP Resource Groups in developing and preparing these example reports.

Work Plan

Guidance, which explained the purpose and format, was prepared to ensure continuity, consistency, and comparability among the example Annual Statistical Summaries. The audience for these reports is Congressional staff members, the EPA Administrator, scientific administrators, and the informed lay public. The guidance included how to prepare and present questions that EMAP will and will not answer (based on the EMAP goal and objectives, indicators being monitored by each Resource Group, and the monitoring network design). The Groups were asked to include the DQOs for the indicators proposed for monitoring in the reports, so that the users could decide whether the resolution proposed for these indicators would satisfy their needs. The guidance also discussed the types of illustrative examples to include in the reports, such as frequency distributions, descriptive statistics, spatial displays and maps, indices, and associations among response and exposure/habitat indicators. An outline for the major sections of the Annual Statistical Summary was included as part of the guidance.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Guidance document for example Annual Statistical Summaries	2/90

National Academy of Sciences Review of EMAP

Project Code: IA-90-003

EPA Region(s): NA

Period of Performance: 1990-1993

State(s): NA

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Objectives

The National Academy of Sciences (NAS), through the National Research Council (NRC), will perform a study and produce a report that provides an unbiased assessment of the scientific quality and responsiveness of the overall EMAP concept in meeting the nation's environmental monitoring and assessment needs.

Work Plan

The NRC, using both its Water Sciences and Technology Board (WSTB) and Board on Ecological Studies and Toxicology (BEST), will review and evaluate the overall objectives of the Program, the indicator and sampling design strategies, data collection methods, data analysis and interpretation, and communication plans. The

WSTB and BEST will appoint a committee of approximately 15 members representing an appropriate range of experts in ecological disciplines represented by EMAP to conduct the review. The committee will meet approximately 10 times over the three-year contract. Briefing sessions will be held with EPA scientists involved in the design and execution of the Program, members of the Science Advisory Board, and external peer reviewers. The committee will consult with a liaison group assembled by EPA and will solicit input regarding special needs and interests from such organizations with respect to the above issues. Staffs of the WSTB and BEST will provide technical and administrative support to the committee. These boards are responsible for ensuring that NAS and NRC policies and procedures are followed. The WSTB and BEST will establish liaisons with other appropriate agencies and NRC boards to ensure communication and coordination with other potential users of the study results.

Deliverables/Milestones	Time Frame
• Broad tentative review of EMAP strategic plan and national research plans for ecological resource categories	5/91
• Review of EMAP landscape characterization and indicator plans	2/92
• Comprehensive review of EMAP	12/93

Section 5: 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; this research is described in previous sections. Additionally, EMAP has identified four major areas of research that are cross-cutting and is currently establishing research programs for these areas: ecological indicator development, environmental statistics, ecological risk characterization, and landscape ecology. These four areas cover a broad range of research, but each area is an integral part of ORD's Ecological Risk Assessment Program. Briefly, Ecological Indicator Development is focusing on (1) the development of a center for diagnosing marine fish diseases and (2) the development of conceptual models and methodologies for biodiversity indicators, testing of relationships between landscape indices and biodiversity measures, and the evaluation of the appropriateness of tested indicators for fulfilling EMAP objectives. Environmental Statistics will explore statistical research as it applies to the EMAP design (e.g., protocols for using found data, sampling methods for representing conditions in extensive resources), as well as spatial and temporal issues. Guidelines for performing ecological risk assessments will be developed by Ecological Risk Characterization. Landscape Ecology will investigate the landscape as a monitoring and reporting unit and its feasibility as a mechanism for integrating measurements of indicators of ecological condition with measurements of ecosystem characteristics. Specific research projects are discussed in further detail in this section.

Section 5.1: Ecological Indicator Development

Review and Development of Diagnostic Indicators for Marine Ecosystems

Project Code: IR-90-001

EPA Region(s): All

Period of Performance: 1990-1992

State(s): All

Project Officer

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Objectives

Develop a center for diagnosing marine fish diseases that will provide support for EPA research and regulatory programs. This center will provide guidance for conducting routine marine toxicological and histopathological tests and provide support for development of marine indicators to be used by EMAP.

Work Plan

A workshop was held in August 1989 to begin developing a strategy for marine bioindicator research. The strategy resulting from this workshop will be used as a nucleus for developing a long-term marine indicator research strategy for EPA's Office of Research and Development. In concert with preparation of this long-term strategy, a proposal for the diagnostic center to support the marine monitoring efforts is being developed. Initial development of the diagnostic center will be through cooperative agreements with recognized institutions; eventually the center will acquire its own inhouse expertise. Annual reports will be produced on the use of the diagnostic center in support of EMAP and other monitoring and research efforts within EPA.

Deliverables/Milestones	Time Frame
• Diagnostic indicators for marine ecosystems: physiology, biochemistry, and pathology (review article)	10/90
• Status report on the use of the Marine Fish Diagnostic Center to support indicator development in EMAP-Estuaries	10/90
• Proceedings of the Gulf Breeze symposium on marine and estuarine disease research	10/91
• Bioindicators for marine systems: individuals, populations, and communities (review article)	10/91

Biodiversity Indicators Research

Project Code: IR-90-002

EPA Region(s): NA

Period of Performance: 1990-1992

State(s): NA

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Objectives

Develop conceptual models and methodologies for biodiversity indicators, with emphasis on landscape-level indices for fish and wildlife diversity and composition; test the relationships between landscape metrics and diversity, composition, and abundance through analysis of existing data bases and literature; evaluate the appropriateness of tested indicators for fulfilling EMAP objectives; and provide implementation guidelines.

Work Plan

Validation of relationships of environmental conditions and biodiversity: Research is being conducted through a combined extramural and EPA inhouse effort. The initial emphasis is on developing and refining conceptual models for relating compositional biodiversity to landscape-level indices. This research is based on thorough searches of literature and existing data bases for information on population and community response to measurable landscape patterns. Landscapes for further study and evaluation are being identified and prioritized, based primarily on the amount and quality of existing information.

Northeast biodiversity indicators research: The focus of this research effort is to examine landscape cover pattern and diversity as well as bird diversity. Statistical models for relating this information to indicators of regional bird diversity are being evaluated. Initial activities are focusing on existing bird data bases for New England. Efforts are being coordinated with the EMAP-Forests and Landscape Characterization activities in New England.

Deliverables/Milestones	Time Frame
• Report on an index of community structure and integrity for aquatic birds in New England	2/92
• Report on landscape characteristics along selected Breeding Bird Survey routes and EMAP 40-km ² hexagons in New England	5/92
• Report on cross-validation of Breeding Bird Survey and Christmas Bird Count measures of avian population trends in New England	12/92
• Report on changes in bird distribution in relation to landscape characteristics in New England	12/92

Section 5.2: Environmental Statistics
Statistical Research on Design Aspects of EMAP

Project Code: ST-90-001**EPA Region(s):** NA**Period of Performance:** 1990-1992**State(s):** NA**Project Officer**

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Objectives

Design and evaluate a statistical monitoring framework, protocols for collecting status and trends data, and data analysis methods. EMAP requires a rigorous, statistical, integrated monitoring framework in order to estimate and assess ecological status and trends on a regional and national basis.

Work Plan

The basic EMAP statistical design has been developed. Initial research efforts in this project are being directed toward completing the technical documentation on the design, analysis procedures, sampling schemes, reclassification, and aggregation procedures for reporting. Because new methods of data analysis are required for EMAP, statistical research is being conducted on several topics, including the use of time series and other methods for assessing trends in populations and regional patterns, spatial statistics and the presentation of spatial patterns, protocols for using found data, statistical design for quality assurance, and sampling methods for representing conditions in extensive resources such as the Chesapeake Bay, Everglades, and Ohio River. To accommodate the increasing need for statisticians in environmental studies such as EMAP, a strategy for developing a training program in environmental statistics is being formulated.

Deliverables/Milestones	Time Frame
• Report on technical aspects of calibration in surveys	12/90
• Concepts and techniques for combining results of two probability samples (journal article)	6/90
• Research strategy for developing statistical methods for analysis and reporting of EMAP data: A five-year plan	2/91
• Strategy for creating a center for research and training in environmental statistics	3/91

Research on Temporal Statistical Issues**Project Code:** ST-90-002**EPA Region(s):** NA**Period of Performance:** 1990-1992**State(s):** NA**Project Officer**

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Objectives

The most likely field sampling scheme for EMAP is one in which individual sites are visited once every four years. The group of sites sampled in one year will be distinct from the groups of sites sampled during the other years of the four-year cycle. Within a region, these groups of sites will conform to an "interpenetrating design," resulting in regional reporting on ecological condition within that region. The objectives of this project are to explore the properties of this design using a rigorous statistical analysis to (1) devise methods for estimating trends in indicators from the series of population estimates derived from the four-year cycle; (2) assess, and adjust if necessary, the probable magnitude of effects introduced by sampling different groups of sites in each of the four years; (3) associate changes in temporal and spatial patterns in response indicators with explanatory variables and exposure and stress indicators; (4) evaluate the merits of alternative design options; (5) establish minimum detectability levels of trends, under various models for error variances; and (6) aid development of sampling plans by evaluating alternative sample sizes.

Work Plan

Several techniques for estimating trends, such as linear statistical models of trends, non-parametric trend tests, and conventional time series approaches (Auto-Regressive Moving Average [ARMA]), are being compared to techniques that are potentially more sensitive for trend detection. One such technique is an extension of the ARMA models that is structured to include the relationships between regression and time series methodologies; this technique specifically addresses items (2) and (3) above. A second approach is evaluating the Bayesian steady-state model to construct a test for a shift in the location parameter distribution. A third approach is evaluating the use of finite sampling methods to construct tests for trends. Extensive simulation trials are being conducted to investigate and assess the various models, estimation techniques, and design options with data sets constructed to reflect existing data set characteristics. The statistical power of the tests to detect trends is being established for data sets containing both linear and dynamic time trends.

Deliverables/Milestones	Time Frame
• Mathematical derivations of ARMA, the trend model (journal article)	7/90
• Report summarizing the use of an ARMA-based model for regional trend detection	5/91

Research on Spatial Statistical Issues

Project Code: ST-90-003 **EPA Region(s):** NA
Period of Performance: 1990-1992 **State(s):** NA

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Objectives

The EMAP design is based on a systematic grid of points arranged across the landscape. Observations at these grid points will be used to estimate characteristics of regional populations of ecological resources. Initial statistical efforts have focused on the regional population and temporal trends issues. This project focuses on research related to spatial statistical issues that will enhance the interpretation, reporting, and assessment of EMAP information.

Work Plan

The primary task in FY91 is to identify the spatial statistical issues that are relevant to the EMAP design and objectives. A workshop will be held on the application of spatial statistics to environmental monitoring survey data. A strategy will be developed that establishes the specific research requirements and priorities for addressing these issues. This strategy will identify (1) the methods to be developed for incorporating spatial pattern information into population estimates generated from the EMAP sampling frame to improve estimation of ecological condition, (2) alternative statistical graphics techniques for display of geographic data, and (3) issues for integrating spatial statistics and geographic information systems algorithms. The spatial pattern and model-based approaches to refining and improving estimates of ecological condition will be addressed in the research strategy.

Deliverables/Milestones	Time Frame
<ul style="list-style-type: none"> • Statistical graphics for applying geographic data to report ecological status and condition (journal article) 	5/91

Section 5.3: Ecological Risk Characterization

Development of an Ecological Risk Strategic Plan

Project Code: RC-91-001

EPA Region(s): NA

Period of Performance: 1991-1992

State(s): NA

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Objectives

Develop, review, and publish guidelines for performing ecological risk assessments. This project is part of the "Ecorisk" Guidelines Program being coordinated by the Agency's Risk Assessment Forum (RAF).

Work Plan

In cooperation with EPA Program Offices, EMAP's Risk Characterization Group will hold a series of workshops aimed at developing three foundation documents for the Guidelines Program. This series includes (1) four workshops to evaluate case studies illustrating the "state of the practice" in ecological risk assessments, (2) a strategic planning workshop to discuss the major issues related to the development of subject-specific ecological risk assessment guidelines, and (3) a framework development workshop to produce a report on the general principles of ecological risk assessment.

Deliverables/Milestones	Time Frame
• Case Studies Workshop – Part 1	5/91
• Case Studies Workshop – Part 2	6/91
• Case Studies Workshop – Part 3	6/91
• Case Studies Workshop – Part 4	6/91
• Strategic Planning Workshop	5/91
• Framework Development Workshop	5/91
• Ecological Risk Case Studies Report	10/91
• Preliminary Ecological Risk Framework Report	10/91
• Ecological Risk Strategic Plan	10/91

Section 5.4: Landscape Ecology

Development of Methods for Monitoring and Analyzing Landscapes

Project Code: LE-90-001

EPA Region(s): All

Period of Performance: 1990-1995

State(s): All

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Objectives

Develop, test, and apply methods for analyzing and monitoring landscapes as discrete entities; analyze indicators of landscape composition and pattern that, through integration, may help explain observed ecological condition.

Work Plan

This project has seven principal elements: (1) characterization simulation studies, (2) characterization statistical design, (3) national land use/cover classification, (4) landscape types classification, (5) landscape indicators research, (6) landscape/resource measurement integration, and (7) the Landscape Ecology Core Group.

Within EMAP, a landscape is defined as a heterogeneous mosaic of ecological and land use features of consistent composition and pattern throughout. This project involves the development of monitoring and analysis methods using landscape as the spatial scale and unit. This perspective on monitoring and analysis differs fundamentally from that of the EMAP Resource Groups in which the focus is on an individual unit of the landscape (a "single tile" of the "mosaic"). EMAP Resource Groups will report on ecological condition in terms of a particular class of resources, such as oak-hickory forests or emergent estuarine wetlands. In contrast, this project will explore the landscape as a monitoring and reporting unit and its feasibility as a mechanism for integrating measurements of indicators of ecological condition with measurements of ecosystem (and adjacent land use) characteristics. This research will be coordinated with the EMAP Resource Groups.

The overall design for EMAP-Landscape Characterization is driven by the concepts of landscape and integration; therefore, this project will continually refine and test a statistical design that supports these aims. During FY91, a sampling strategy for landscape characterization will be completed, and simulation studies using existing digital land use/land cover data will be conducted. The simulation studies will compare the EMAP sample data set (land use/land cover patterns and extent within the hexagons) to the full data set (total patterns and extent in the entire landscape

study area). Results will be evaluated in terms of achieving EMAP-Landscape Characterization objectives.

Development of a landscape classification system is also a priority activity in this project. During FY90, an ecologically oriented land use/land cover classification system was developed for EMAP. During FY91 and FY92, EMAP-Landscape Characterization will co-sponsor a national, interagency land classification system development effort with the U.S. Geological Survey (USGS) National Mapping Division and will also lead an effort to design a national classification system for landscape types. These systems (the interagency system, the EMAP system, and the landscape system) are all integral components of the EMAP-Landscape Characterization design.

Landscape indicators help explain linkages between ecological function and physical structure, such as habitat; landscape indicators generally measure composition (such as relative percentage of area in each land use or resource type) and pattern (such as the size, contiguity, or distribution of land uses and resources). Monitoring landscapes as proposed will require that EMAP-Landscape Characterization identify or develop a set of indicators and determine how this set should be measured and analyzed to reflect landscape condition. In a multiyear effort, operational and developmental landscape indicators will be tested and applied in the EMAP-Landscape Characterization context.

Using integration principles and applying landscape ecology in assessment are areas requiring not only a research and development orientation but also an interdisciplinary team approach. EMAP-Landscape Characterization will emphasize coordination with EMAP Resource Groups and other EMAP Task Groups, as appropriate, in its landscape ecology research efforts. EMAP-Landscape Characterization has established a Landscape Ecology Core Group that will maintain linkages with all EMAP elements and promote appropriate applications of this discipline throughout EMAP.

<i>Deliverables/Milestones</i>	<i>Time Frame</i>
• Multi-staged approach to landscape characterization (journal article)	10/90
• Status and trends of ecosystems in the United States: A landscape approach (journal article)	2/91
• Characterization statistical design report	6/91
• LUDA simulation study results/report	7/91
• Interagency land classification task force meeting series completed	10/91

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Appendix: Deliverables and Milestones

Project Code	Date
AG-90-001	
• Draft monitoring plan	2/91
• Peer review	3/91
• National Monitoring Plan for Agroecosystems	4/91
• Agroecosystem indicators (journal article)	12/91
AG-91-002	
• Status report on agroecosystem indicator research	12/91
AG-91-003	
• Critical evaluation of existing agricultural data bases for applicability to ecological assessment	12/91
AG-91-004	
• Internal report on agroecosystem indicators relevant to cross-resource monitoring	12/91
AG-90-005	
• Final annual statistical summary example for agroecosystems	9/90
AL-90-001	
• Draft monitoring plan	3/91
• Peer review	3/91
• National Monitoring Plan for Arid Lands	4/91
AL-91-002	
• Draft pilot study plan	4/91
• Review of study plan	8/91
• Final study plan	10/91
AL-91-003	
• Integrated design for assessing the condition of arid lands (journal article)	10/91
AL-90-004	
• Final annual statistical summary example for arid lands	4/91

FR-90-001

- Indicators for monitoring ecological condition in forests (journal article) 11/90
- Draft monitoring and research strategy 3/91
- Peer review 3/91
- EMAP-Forests Monitoring Strategy for FY91 4/91
- Draft national monitoring plan for forests 2/92
- Peer review 3/92
- Final National Monitoring Plan for Forests 4/92

FR-90-002

- Regional Quality Assurance Project Plan 6/91
- Regional quality assurance officer training 6/91
- Methods manuals and standard operating procedures 6/91
- Data base evaluation and review 12/91
- Analysis complete 5/92

FR-91-003

- Implementation plan 5/91
- Methods manual 5/91
- Field sampling manual 6/91
- Quality assurance plan 6/91
- Report on results 7/92

FR-90-004

- Summary report on results of FHM plot design and logistics study 10/91

FR-91-005

- First annual statistical summary – New England 8/91
- Final report on the EMAP-Forests Pilot Project in the northeastern United States 10/91

FR-90-006

- Final annual statistical summary example for forests 11/90

ES-90-001

- Draft near coastal implementation plan 3/90
- Peer review of near coastal implementation plan 4/90
- Final Research Plan for EMAP-Near Coastal Monitoring and Assessment Program 4/91
- Revised Near Coastal Quality Assurance Plan 5/91
- Revised Near Coastal Data Management Plan 6/91

• Revised Near Coastal Methods Manual	7/91
• Recommendations for national-scale implementation of EMAP in estuaries	10/91
ES-90-002	
• Methods manuals for the Demonstration Project	4/90
• Quality assurance plan for the Demonstration Project	4/90
• Implementation plan for the Demonstration Project	6/90
• Data management system for the Demonstration Project	8/90
• Preliminary report on the Demonstration Project	2/91
• Implementation Plan for Virginian Province Monitoring in FY91	5/91
• Final report on the Demonstration Project	10/91
• Report on the 1991 field activities in the Virginian Province	11/91
• Data summary on 1991 monitoring in the Virginian Province	2/92
• Statistical summary for data collected in 1991 in the Virginian Province	6/92
ES-90-003	
• Draft program plan for the Louisianian Province Demonstration Project	10/90
• Final program plan for the Louisianian Province Demonstration Project	4/91
• Training manual for 1991 Louisianian Province monitoring activities	5/91
• Quality assurance plan for 1991 Louisianian Province monitoring activities	5/91
• Data management plan for 1991 Louisianian Province monitoring activities	5/91
• Revised methods manual for use in 1991 Louisianian Province monitoring activities	6/91
• Field operations manual for 1991 Louisianian Province monitoring activities	6/91
• Initiation of Louisianian Province field sampling	6/91
• Preliminary report on the Louisianian Province Demonstration Project	2/92
• Final report on the Louisianian Province Demonstration Project	10/92
ES-91-004	
• Draft program plan for the Carolinian Province Demonstration Project	10/92
• Implementation plan for the Carolinian Province Demonstration Project	2/93
• Final program plan for the Carolinian Province Demonstration Project	3/93

Appendix: Deliverables and Milestones

• Initiation of Carolinian Province field sampling	6/93
• Preliminary report on the Carolinian Province Demonstration Project	2/94
• Final report on the Carolinian Province Demonstration Project	10/94
ES-90-005	
• Example interpretive assessment for estuaries	2/91
GL-91-001	
• Draft program plan for conducting a pilot study in the Great Lakes	11/91
SW-90-001	
• Data user's guide to the Long-Term Monitoring Program: Quality assurance plan and data dictionary	11/90
• Statistical summary of long-term monitoring data (LTM data report)	12/90
• Special issue of the Journal of Water, Air, and Soil Pollution: Synthesis of Acid Deposition Long-Term Monitoring Data Through 1989 (10 papers)	6/91
SW-90-002	
• Strategy and priorities for developing indicators of surface water condition	7/91
SW-90-003	
• EMAP strategy for surface water monitoring	2/91
• Association of surface water condition with potential stresses	8/91
SW-90-004	
• Final quality assurance plan for Northeast Lakes Pilot	4/91
• Information management plan for Northeast Lakes Pilot	5/91
• Implementation plan for Northeast Lakes Pilot	6/91
• Field operations manual for Northeast Lakes Pilot	6/91
SW-90-005	
• Final annual statistical summary example for surface waters and wetlands	6/91
WL-90-001	
• Research Plan for Monitoring Wetland Ecosystems	2/91

SD-90-001	
• Cartographic and geometric components of a global sampling design for environmental monitoring (journal article)	3/91
• Integrated sampling design for EMAP	8/91
SD-90-002	
• Report on technical design and analysis	8/91
SD-91-003	
• Total quality approach to environmental monitoring and assessment (journal article)	7/91
• Proceedings paper on statistical thinking and tools for improving excellence in ecological projects	8/91
SD-91-004	
• Summary of ASA review of EMAP task group activities	8/91
IN-90-001	
• Report on ecological indicators for determining the condition of major ecosystems in the United States	7/90
• The Indicator Development Strategy for EMAP	2/91
IN-90-002	
• International Symposium on Ecological Indicators	10/90
• Proceedings of the International Symposium on Ecological Indicators	10/91
LG-90-001	
• Data base proprietary information strategy	3/90
• EMAP logistics overview and guidance document	7/90
• EMAP logistics proposal to EPA Regions	10/91
• Six-year options and alternatives for EMAP logistics	11/91
TQ-90-001	
• Quality Assurance Annual Report and Work Plan	9/90
• EMAP Quality Assurance Program Plan	8/91
TT-90-001	
• EMAP Monthly Memoranda	Monthly
• EMAP Project Descriptors Document	4/91
• Publications Report	4/91
• EMAP Monitor	1/91; 7/91

TT-90-002

- Administrative Manual 4/91
- Final Ten-Year Technology Transfer Plan 11/91

IT-90-001

- Report on the relationship of water quality and the diversity of aquatic biota for selected sites in Nepal 12/91

AD-90-001

- Annual data report and analysis for the National Dry Deposition Network 10/91

AD-90-002

- Report describing contents of non-urban atmospheric data base 8/90
- Air and deposition monitoring and assessment plan for EMAP 4/91

AD-90-003

- Report describing an optimum "trends" network 6/91
- Report describing an optimum "status" network 6/92

LC-90-001

- Wetlands frame for Gulf estuarine emergents – Data set completed 10/91
- Sampling frame for surface waters – Data set completed 11/91

LC-90-002

- FY90 pilot implementation plan for EMAP-Landscape Characterization 12/89
- Revised EMAP-Landscape Characterization concept and plans 3/91
- Ten-Hexagon Pilot Project final report 5/91
- EMAP-Landscape Characterization Research Plan 10/91
- EMAP-Landscape Characterization Quality Assurance/Quality Control Plan 11/91

IM-90-001

- Data confidentiality in EMAP: Issues and recommendations 6/90
- Essential Elements of Information: Mission Needs Analysis 4/91
- Essential Elements of Information: Preliminary Design and Options Analysis 10/91
- Essential Elements of Information: EMAP Information Resources Management Plan 10/91

IA-91-001	
• Final EMAP assessment strategy	6/90
• Integration and Assessment conceptual plan	4/91
• Program plan for EMAP	6/91
• Client/Target groups inventory and needs assessment	6/91
• Integration and Assessment dictionary of terms and description of approach	6/91
• Final Integration and Assessment Operating Plan and Communications Strategy	10/91
IA-90-002	
• Guidance document for example Annual Statistical Summaries	2/90
IA-90-003	
• Broad tentative review of EMAP strategic plan and national research plans for ecological resource categories	5/91
• Review of EMAP landscape characterization and indicator plans	2/92
• Comprehensive review of EMAP	12/93
IR-90-001	
• Diagnostic indicators for marine ecosystems: physiology, biochemistry, and pathology (review article)	10/90
• Status report on the use of the Marine Fish Diagnostic Center to support indicator development in EMAP-Estuaries	10/90
• Proceedings of the Gulf Breeze symposium on marine and estuarine disease research	10/91
• Bioindicators for marine systems: individuals, populations, and communities (review article)	10/91
IR-90-002	
• Report on an index of community structure and integrity for aquatic birds in New England	2/92
• Report on landscape characteristics along selected Breeding Bird Survey routes and EMAP 40-km ² hexagons in New England	5/92
• Report on cross-validation of Breeding Bird Survey and Christmas Bird Count measures of avian population trends in New England	12/92
• Report on changes in bird distribution in relation to landscape characteristics in New England	12/92
ST-90-001	
• Report on technical aspects of calibration in surveys	12/90
• Concepts and techniques for combining results of two probability samples (journal article)	6/90

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• Research strategy for developing statistical methods for analysis and reporting of EMAP data: A five-year plan	2/91
• Strategy for creating a center for research and training in environmental statistics	3/91
ST-90-002	
• Mathematical derivations of ARMA, the trend model (journal article)	7/90
• Report summarizing the use of an ARMA-based model for regional trend detection	5/91
ST-90-003	
• Statistical graphics for applying geographic data to report ecological status and condition (journal article)	5/91
RC-91-001	
• Case Studies Workshop – Part 1	5/91
• Case Studies Workshop – Part 2	6/91
• Case Studies Workshop – Part 3	6/91
• Case Studies Workshop – Part 4	6/91
• Strategic Planning Workshop	5/91
• Framework Development Workshop	5/91
• Ecological Risk Case Studies Report	10/91
• Preliminary Ecological Risk Framework Report	10/91
• Ecological Risk Strategic Plan	10/91
LE-90-001	
• Multi-staged approach to landscape characterization (journal article)	10/90
• Status and trends of ecosystems in the United States: A landscape approach (journal article)	2/91
• Characterization statistical design report	6/91
• LUDA simulation study results/report	7/91
• Interagency land classification task force meeting series completed	10/91