United States
Environmental Protection
Agency

Office of Acid Deposition,
Environmental Monitoring and
Quality Assurance
Washington DC 20460

EPA/600/M-89/015
July 1989

Research and Development

EPA AERP status

AQUATIC EFFECTS RESEARCH PROGRAM, AN OVERVIEW

In 1980, Congress passed the Acid Precipitation Act, thus establishing the Interagency Task Force on Acid Precipitation. Given a 10-year mandate, the Task Force implemented the National Acid Precipitation Assessment Program (NAPAP) to investigate the causes and effects of acidic deposition. NAPAP includes task groups formed to study emissions and controls, atmospheric chemistry, atmospheric transport, atmospheric deposition and air quality, terrestrial effects, effects on materials and cultural resources, and aquatic effects.

The AERP, formed in 1983 as part of the NAPAP Aquatic Effects Task Group, is responsible for assessing the effects of acidic deposition on aquatic ecosystems. Already, published AERP reports have described the chemical characteristics of lake and stream resources in regions of the United States potentially sensitive to acidic deposition. Complementing these findings, a report summarizing correlative relationships between watershed and surface water chemical characteristics and forecasting future conditions for deposition scenarios in the Northeast and the Southern Blue Ridge Province will be published by the summer of 1989. (For a complete listing of published AERP documents, see the mail order form attached to this *status*.) Current AERP field efforts focus primarily on watershed process studies and manipulations.

By 1990, the end of the 10-year mandate, Congress requires NAPAP to provide a full assessment of the acidic deposition phenomenon. An important aspect of current AERP efforts involves synthesizing results from past and current research to describe the state of science for acidic deposition effects on aquatic systems. Another aspect involves integrating the state of science information with illustrative emission control scenarios to provide an assessment useful for policy decisions concerning alternative control strategies. A group of AERP scientists is now working on this task, which will provide valuable aquatic information for the NAPAP reports to Congress. A summary of these activities can be found on page 8.

Status of AERP Activities--This issue of the *status* includes sections that provide information about recently published AERP materials and projects in progress. Table 1 summarizes the present status of projects within the AERP.

Project	Design	Implementation	Reporting
National Surface Water Survey			
National Lake Survey, Phase I (East and West)	Complete	Complete	Complete
National Lake Survey, Phase II (NE)	Complete	Complete	1990
National Stream Survey, Phase I	Complete	Complete	Complete
Direct/Delayed Response Project			
NE and SBRP Soil Survey	Complete	Complete	Summer 1989
Mid-Appalachian Soil Survey	Complete	Ongoing	Fall 1990
Watershed Processes and Manipulations			
Watershed Manipulation Project	Complete	Ongoing	Fall 1989
Watershed Recovery Project	Complete	Ongoing	Fall 1990
Little Rock Lake Experimental Acidification Project	Ongoing	1983	Annually
Episodic Response Project			
Episodes	Complete	Fall 1988	Winter 1989-90
Regional Episodic and Acidic Manipulations Project	Complete	Ongoing	Summer 1990
Temporally Integrated Monitoring of Ecosystems	Ongoing	1991	Annually
Biologically Relevant Chemistry	Ongoing	Ongoing	Winter 1988-89
Indirect Human Health Effects	Ongoing	Ongoing	Fall 1990

Table 1. Present status and projected dates for stages of major AERP projects.

AERP FEATURE ARTICLE

Technical Information Project

Introduction--In a November 23, 1988, memorandum, L. M. Thomas, then EPA Administrator, commented on the importance of technology transfer:

> We have accomplished a great deal of environmental progress during the eighteen-year history of the Agency. The work of environmental protection is now a fundamental element of American society, with a wide array of institutions contributing. EPA plays a critical role among these institutions. Effective institutional cooperation to achieve a more efficient use of environmental resources is needed as we seek simultaneously to continue to improve environmental quality and maintain economic vitality. The most critical element in such cooperation is the effective sharing of environmental knowledge and expertise. Technology transfer facilitates such sharing as we conduct our various and expanding environmental protection responsibilities.

The need for technology transfer in the area of aquatic effects research is well established. A review of historical data conducted prior to initiation of the National Surface Water Survey indicated that a comprehensive data base did not exist, in part due to a lack of comparability in methodologies, parameters measured, and quality assurance. The AERP, through its component programs, developed methodologies and quality assurance procedures designed to provi comparable data of known quality. EPA regional offices, state and local agencies, universities, and

other organizations have a critical need for the technologies developed by the AERP. The AERP Technology Information Project was created in 1986 to meet this need.

The Technical Information Project facilitates and enhances the transfer of AERP information and technology to EPA regional and program offices as well as other Federal, state, and local agencies; the business community; and the academic and educational communities. More specifically, the objectives of this Project are to assist organizations involved in acidic deposition research to avoid duplication of efforts and to make maximum use of related research; promote communications among all organizations involved in acidic deposition monitoring activities; and provide a mechanism to distribute available AERP information.

To meet these objectives, the Technical Information Project plans and implements the distribution of information about current AERP activities and facilitates the synthesis and distribution of the results of the studies and projects conducted by the many AERP participants. Among the participants are personnel from the EPA's Environmental Research Laboratory in Corvallis, Oregon; Environmental Monitoring Systems Laboratory in Las Vegas, Nevada; Environmental Research Laboratory in Duluth, Minnesota; and Atmospheric Research and Exposure Assessment Laboratory in Research Triangle Park, North Carolina. Other participants include personnel from other federal agencies [U.S. Department of Agriculture (including the Forest Service and the Soil Conservative Service), U. S. Geological Survey, and the National Oceanographic and Atmospheric Administration]; national laboratories (Oak Ridge National Laboratory and Battelle-Pacific Northwest Laboratories); state and private universities; and private consulting firms.

Implementation--The results of AERP activities are presented in various forms:

1. this AERP *status*, a periodic publication that reports on the current status of AERP activities, includes a section for states to exchange information about acidic deposition monitoring activities and provides a means to obtain other AERP products;

2. major project reports that describe a project and the companion documents that describe aspects of the same project;

3. data bases with accompanying user guides;

4. handbooks that compile the most up-to-date AERP field and laboratory protocols for aquatic and soil surveys;

5. abstracts of AERP publications and presentations in one publication for specific time periods; and

6. brief descriptions of AERP research activities in one volume for specific time periods.

This periodic publication, the AERP *status*, gives summaries of projects currently in progress and information about available AERP products. It also includes an order form through which interested parties can obtain AERP products. In addition, the *status* provides a mechanism for states to exchange information and updates about acidic deposition monitoring activities in their area. The order form in each new issue lists additional products as they become available. Approximately 1,400 copies of each issue are distributed.

The major reports and companion documents are document sets that consist of the manuals and reports used during or prepared as a result of a particular AERP project. Complete or partial document sets either are or will be available for lake, stream, and soil surveys. The major data reports describe the project objectives, methods, and results and provide a summary and conclusions. There are several companion documents that accompany each major data report:

1. The *quality assurance plan* describes the design for activities devised to ensure that survey procedures are performed consistently and that the quality of the generated data can be determined. This plan includes guidance for training of participants; identifying data quality objectives; providing quality assurance and quality control for field operations, sample handling, and analytical procedures; conducting performance and system audits; designing a data management system; verifying and validating data; and evaluating the quality assurance data.

2. A *field operations report* describes the planning of field operations and the actual activities, which include preparing for field operations, operating field stations and field laboratories, and collecting field samples. Summaries include recommendations and observations.

3. An *analytical methods manual* describes the chemical and physical variables measured and the analytical methods used for that survey.

4. The *quality assurance report* describes the actual quality assurance program as it may have been modified for that survey, provides an assessment of the quality assurance activities, and makes an assessment of the quality of the survey data in terms of completeness, comparability, representativeness, detectability, accuracy, and precision.

Data bases resulting from AERP projects should be valuable to a wide variety of potential users, such as limnologists, geographers, ecologists, soil scientists, foresters, and environmental and watershed scientists representing government, academic, and private sectors. The data bases are unique sources of statistically representative, consistent data derived from lake, stream, and soil surveys related to acidic deposition monitoring. Each data base consists of two components: a computer diskette or tape contains the validated data for a particular AERP project and a user's guide provides instructions on how to use the disk or tape and information about how the quality of the data was assessed. To date, more than 50 copies of the Eastern Lake Survey-Phase I and Western Lake Survey data bases have been distributed.

AERP handbooks are guidance documents that contain procedures for field and laboratory operations and quality assurance for surface water and soil chemistry sampling. The information in these handbooks is derived from both published and unpublished field and laboratory manuals for aquatic and soil surveys. The handbooks provide a step-by-step approach for field and laboratory activities and synthesize the quality assurance process. They should assist organizations involved in designing and implementing monitoring activities related to acidic deposition or to other kinds of surface water and soil surveys. Nearly 500 copies of the analytical methods handbook for surface water chemistry have been distributed to date.

Published collections of abstracts of publications and presentations provide scientists and administrators, both within and outside EPA, with a concise reference to the available literature generated by the AERP. These collections contain bibliographic citations and brief descriptions of the publications and presentations authored or co-authored by AERP personnel. About 250 copies of the first of these documents for fiscal year 1988 have been distributed.

The *Research Activity Descriptors* contain concise descriptions of ongoing AERP projects. These summaries provide scientists and administrators with the most current information on the research strategy of the AERP and the projects contributing to that strategy.

How to Get AERP Products--These AERP products are available at no charge from the Center for Environmental Research Information (CERI). Specific products may be ordered, or interested parties may request a copy of the *status* which contains an order form listing all the available products. Send requests to:

CERI, AERP Publications
U.S. Environmental Protection Agency
26 W. Martin Luther King Drive
Cincinnati, Ohio 45268

For further information about the AERP Technical Information Project, address inquiries to:

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Technical Director
AERP Technical Information Project
EPA Environmental Monitoring Systems
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(702) 798-2358
(FTS) 545-2358

COMPLETED AERP ACTIVITIES

This section lists projects for which recently published materials are available. These materials may be ordered by filling in the order form at the end of this *status*. As indicated on the form, it should be returned to the address given for the Center for Environmental Research Information (CERI).

Direct/Delayed Response Project

The *Direct/Delayed Response Project: Quality Assurance Report for Physical and Chemical Analyses of Soils from the Southern Blue Ridge Province of the United States* is available for the first time in this issue of the *status*. The Southern Blue Ridge Province soil survey was conducted during 1986. Fifty-one physical and chemical parameters were examined to characterize a statistical sampling of watersheds in a region of the United States that was believed to be susceptible to the effects of acidic deposition. This report provides an assessment of the data quality terms of detectability, internal consistency, precision, accuracy, representativeness, completeness, and comparability.

Descriptions of Research Activities

The *Research Activity Descriptors: FY89* provides scientists and administrators, both within and outside the EPA, with the most current information on the AERP research strategy and the projects contributing to that strategy. Brief descriptions of AERP research activities cover those funded in fiscal year 1989 and those proposed for funding in fiscal year 1990. This publication can be ordered by means of the form in this issue of the *status*.

CURRENT AERP ACTIVITIES

The following summaries describe the status of acidic deposition research projects currently in progress.

Direct/Delayed Response Project

The Direct/Delayed Response Project (DDRP) was designed to examine critical scientific and policy questions as to whether or not acidification is continuing in certain regions, whether or not it is just beginning in other regions, how extensive the effects might become, and over what time scales effects might occur. DDRP was the subject of a feature article in the March 1989 AERP *status*, which gives more detail about the objectives, study regions, approach, data analyses, and preliminary results of this project. At this date, data from the study watersheds in the Northeast and Southern Blue Ridge Province have been analyzed and results have been described in a draft report that is currently undergoing external peer review. A final report will be prepared in late summer 1989.

As described in the March 1989 *status*, 36 watersheds are being studied in the Mid-Appalachian region. These watersheds have been mapped and sampled and soils analyses are complete for the samples collected. The mapping, sampling, and analytical protocols for this survey differ only slightly from those described in earlier issues of the *status* for the Northeast and Southern Blue Ridge Province regions. Data analyses similar to those performed for the watersheds sampled in the previous two surveys will be performed for watersheds included in the Mid-Appalachian study. A final report on the Mid-Appalachian Region will be prepared for inclusion in the NAPAP 1990 Integrated Assessment.

Address inquiries concerning the DDRP to:

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DDRP Technical Director
EPA/Environmental Research Laboratory-Corvallis
200 S.W. 35th Street
Corvallis, Oregon 97333
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FTS: 420-4666, ext. 304

Watershed Processes and Manipulations

Watershed studies conducted as part of AERP are using three approaches to further understand the effects of acidic deposition on surface waters. Process-oriented research on natural systems aims to improve our understanding of the nature and function of specific watershed mechanisms that contribute to surface water acidification. Watershed manipulations focus on understanding the integrated response of the biogeochemical processes that operate within a watershed and contribute to surface water quality. Developing and testing surface water acidification models combines current understanding of surface water acidification with the results of the other two areas of research to help quantify the uncertainties associated with forecasting future surface water chemistries with models. The Watershed Manipulation Project, Watershed Recovery Project, and Little Rock Lake Acidification Project are watershed studies currently in progress.

Watershed Manipulation Project (WMP)--The WMP involves process-oriented research designed to assess the quantitative and qualitative responses of watershed soils and surface waters to altered levels of acidic deposition. Hypothesis testing at the southeastern Maine research site is being conducted by an interdisciplinary team consisting of a site team, six scientific task teams, and an EPA management team.

As part of the WMP, "An Evaluation and Analysis of Three Dynamic Watershed Acidification Codes (MAGIC, ETD, and ILWAS)" was prepared by the WMP modeling group at Battelle-Pacific Northwest Laboratories. The report presents an independent assessment of the adequacy of Direct/Delayed Response Project (DDRP) watershed process models to forecast surface water acidification resulting from acidic deposition in the eastern United States. The assessment addresses model process formulations,

differences among codes in simulation of acid neutralizing capacity, and recommendations for further research to increase the forecast reliability of the three DDRP models. The report concludes that, although each model has limitations in making long-term forecasts, such forecasts will be useful in the development of a national policy for limiting the emissions of acidic deposition precursors.

Address inquiries concerning the WMP to:

Timothy C. Strickland
WMP Technical Director
EPA/Environmental Research Laboratory-Corvallis
200 SW 35th Street
Corvallis, Oregon 97333
(503) 757-4666, ext. 353
FTS: 420-4666, ext. 353

Watershed Recovery Project (WRP)--The WRP is focusing on the question of how air drying affects the measured sulfate adsorption and desorption isotherms of soils. Wet and dry sulfate adsorption and desorption isotherms have been determined for 60 soil samples obtained from 20 sites in the Southern Blue Ridge Province. The samples are being analyzed for other properties such as cation exchange capacity, pH, exchangeable bases, organic matter, and extractable iron and aluminum. These analyses will be used to develop regression equations estimating wet isotherms from dry isotherms, providing a link with the data base of the Direct/Delayed Response Project.

Laboratory analysis of the 40 samples obtained from watersheds in the Northeast is complete. The data are being used to develop the regression equations for this region.

Address inquiries concerning WRP to:

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Little Rock Lake Experimental Acidification Project--The artificial acidification of Little Rock Lake (April 1988 *status*) in northern Wisconsin offers researchers the chance to study the responses of whole ecosystems to the effects of acidification. As the seventh summer of intensive research approaches, the results of last year's acidification to a pH level of 5.1 are becoming available. Compared to the curtained-off reference basin of the lake at a pH level of 6.1, water concentrations of calcium, manganese, and iron have increased substantially; aluminum concentration has increased slightly to 15 μg/L; and concentrations of cadmium, copper, and lead have not changed. Internal alkalinity generation has increased greatly as a result of bacterial sulfate reduction. Decomposition of oak leaves was dramatically reduced in association with a less viable bacterial community. Phosphorus is more strongly adsorbed to sediments, supporting the *contention that acidification promotes increased* oligotrophication. Preliminary model predictions forecast that complete chemical recovery from a pH level of 5.2 would occur in 8 to 9 years, with 50 percent recovery in about 2 years.

Seven species of pelagic zooplankton have been reduced or eliminated while three have increased in abundance. No such responses have been observed in littoral species, although transient changes occurred in association with the particularly dense *Mougeotia* mat of 1987. Fall-emerging Tanytarsini midges, spring-emerging Chironomini midges, and *Caenis* mayflies have been greatly reduced. Continued absence of young-of-the-year rock bass indicates drastically reduced survival or elimination. Black crappie, often cited as a more sensitive species, reproduced successfully last summer at a 5.1 pH level. A laboratory study is underway to obtain further information on the poor overwinter survival of young-of-the-year largemouth bass at pH levels of 5.5 and 5.1.

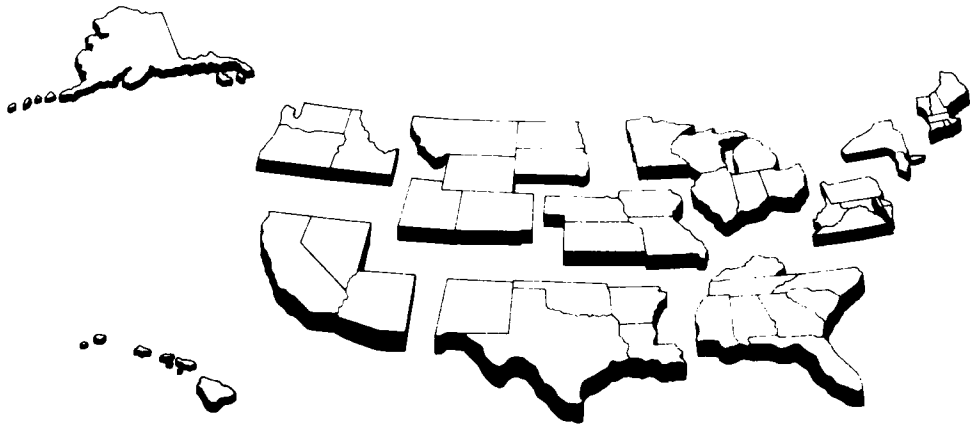
Address inquiries concerning the Little Rock Lake Experimental Acidification Project to:

John Eaton
Little Rock Lake Project Technical Director
EPA/Environmental Research Laboratory-Duluth
6201 Congdon Boulevard
Duluth, Minnesota 55804
(218) 720-5557
FTS: 780-5557

Episodic Response Project

Several approaches to understanding acidic episodes in surface waters have had only partial success for a number of reasons. Both intensive studies and survey approaches have been generally data-limited, primarily as a result of the unpredictable nature of snowmelt and rainstorm events. Most of these studies have employed manual sampling as the principal field sampling approach, and thus episodes that begin on weekends or at night are typically missed. Survey

STATE INFORMATION



The AERP status provides a forum for states to exchange information and updates about acidic deposition monitoring activities. Highlighted state activities are presented below.

California

During the first half of 1989 the Research Division of the California Air Resources Board completed the final technical assessment of the aquatic effects research funded under the Kapiloff Acid Deposition Research and Monitoring Program. The focus of this 5-year research effort was the Integrated Watershed Study (IWS) at Emerald Lake, Sequoia National Park. A final review of the IWS projects and modeling efforts was conducted on February 16-17, 1989, at the University of California, Santa Barbara. Participants evaluated the three watershed modeling approaches that were funded as part of the Kapiloff Program.

Research Division staff developed a research and monitoring plan for the next 5 years that includes an aquatic effects section. This plan was approved by the Air Resources Board in May 1989, following consultation with other California State agencies and the Board's Scientific Advisory Committee on Acid Deposition. This Atmospheric Acidity Protection Program is designed to lead to standards for acidic deposition or atmospheric acidity to protect sensitive human populations and natural ecosystems. This 5-year program will be funded as of July 1, 1989.

Field research will begin in the Sierra Nevada during 1989. The aquatic effects research program will increase our understanding of the quality and quantity of acidic inputs to high-elevation watersheds of the Sierra Nevada and the responses of these systems to increases in acidic deposition. More work will be done to establish dose-response relationships for sensitive aquatic biota in lakes, streams, and ponds.

Address inquiries on above information to:

Dr. Kathy A. Tonnessen
California Air Resources Board
P.O. Box 2815
Sacramento, California 95812
(916) 324-1744

Illinois

Acidic (pH < 5.5) surface waters in many "sensitive" watersheds of eastern North America and northern Europe receive disproportionately large amounts of their water from highly acidic (pH < 5.0), organic-rich soils and peats, and from acidophilic ecosystems. The Illinois State Water Survey has completed field and literature surveys of similar sensitive watersheds in the Southern Hemisphere that are not receiving man-made acidic deposition.

This study indicates that these Southern Hemisphere sensitive control watersheds that are not receiving acidic deposition can have proportions of highly acidic clear and colored surface waters equal to and even greater than that reported for regions receiving acidic deposition. Such naturally acidic surface waters contain few living organisms and are characterized by a sparse fauna and flora typical of acid-stressed aquatic ecosystems.

Acidic surface waters appear to be the rule rather than the exception for studied areas of the Pacific Coastal Plain of eastern Australia. The existence of the few lakes and streams with pH > 5.5 appears to be related to watershed disturbance which is, in turn, related to soil acidity. Surveys show that 84 percent of the examined generally larger, main Coastal Plain lakes have a pH level < 5.5 and 79 percent have a pH level ≤ 5.0.

Reported concentrations of dissolved organic carbon (DOC) for highly acidic waters range from 0.5 mg/L to 39 mg/L. Acid stress in aquatic ecosystems is related to both H^+ and aluminum, both of which act to disrupt ion and gas regulation of aquatic organisms. Clear to moderately colored waters with a pH level < 5.0 contain toxic aluminum. Essentially all solution aluminum in Australian clear water with pH < 5.0 (DOC less than 2 mg/L) is toxic aluminum.

In New Zealand, analysis of Westland lakes and streams suggests that highly acidic (pH < 5.0) surface waters also may be the rule rather than the exception in forested podzol soil watersheds developed on the granites and glacial tills west of the Alpine Fault of the South Island of New Zealand.

In Tasmania, there are corresponding west-to-east gradients in climate, soil, and vegetation. Highly acidic podzol soils and peats, and associated acidophilic vegetation, occur in the moist and recently glaciated, mountainous sensitive watersheds of the west as do the acidic waters--37 percent of the sampled surface waters have pH < 5.5, and 28 percent have pH < 5.0. No waters with pH < 5.0 occur in the nonglaciated and drier east. Overall, 10 percent of the 170 surveyed Tasmanian surface waters have pH < 5.0.

Most reports of widespread and recent aquatic acidification are not based on direct observation but are the necessary conclusion of the fundamental premise of accepted acidification theory; that is, in the absence of acidic deposition, water chemistry of sensitive watersheds is geologically controlled by weathering of mineral bases that produces alkalinity. However, this study suggests that near-surface runoff through highly acidic, organic-rich materials is not geologically controlled by weathering of mineral bases in the absence of acidic deposition, but is naturally controlled by organic and biologically produced acids. It is suggested that the principal effect of acidic deposition is the qualitative shift of the nature of acidity (from organic and biologically produced acids to H_2SO_4), rather than a large quantitative increase in surface water acidity, as predicted by theory.

Address inquiries on above information to:

Mr. Edward C. Krug
Illinois State Water Survey
2204 Griffin Drive
Champaign, Illinois 61820
(217) 333-7824

New Hampshire

The New Hampshire Department of Environmental Services operates several lake monitoring programs

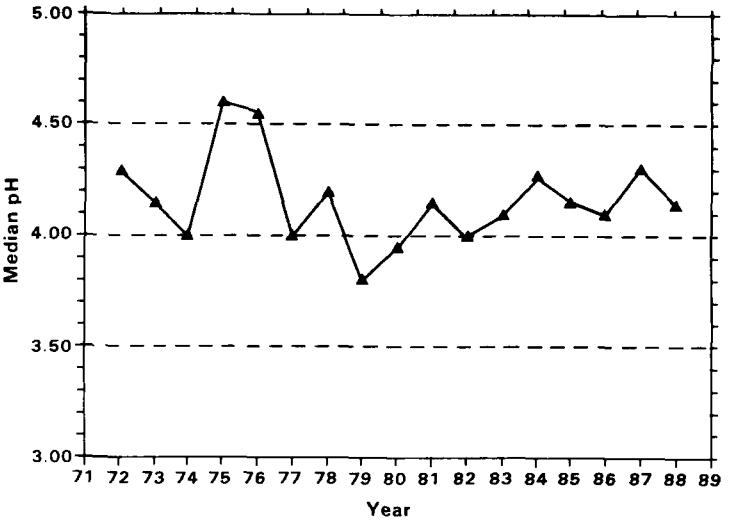


Figure S-1. Annual median precipitation pH values for New Hampshire from 1972 through 1988.

designed to document the impacts of acidic deposition. It has a continuous record of pH measurements for precipitation beginning in 1972. An updated summary by sensitivity category shows the acidic rain status of New Hampshire lakes and ponds (Table S-1). Figure s-1 is a graph depicting the annual median precipitation pH values from 1972 through 1988.

The Department recently published a report entitlec "Acidity Status of Remote High Altitude Trout Ponds in New Hampshire."

Address inquiries on above information to:

Mr. Robert H. Estabrook
State of New Hampshire
Water Supply and Pollution Control Commission
6 Hazen Drive
P.O. Box 95
Concord, New Hampshire 03301

Sensitivity Category	Range			Lake surveys Summer No.	Lake surveys Summer %	Lake surveys Winter No.	Lake surveys Winter %	Remote ponds Spring No.	Remote ponds Spring %
Alkalinity									
Acidified	≤ 0	mg/L	$CaCO_3$*	8	2	9	2	6	12
Critical	> 0-2	mg/L	$CaCO_3$*	68	14	77	17	25	49
Endangered	> 2-5	mg/L	$CaCO_3$*	163	33	142	32	9	18
Highly sensitive	> 5-10	mg/L	$CaCO_3$*	170	35	154	34	9	18
Sensitive	>10-20	mg/L	$CaCO_3$*	64	13	46	10	2	4
Not sensitive	> 20	mg/L	$CaCO_3$*	18	4	19	4	0	0
Total				491	101	447	99	51	101
pH									
Acidified	< 5	pH units		9	2	9	3	2	4
Critical	5.0-5.4	pH units		20	4	44	13	11	22
Endangered	5.5-6	pH units		66	13	102	31	19	37
Satisfactory	> 6	pH units		396	81	175	53	19	37
Total				491	100	330	100	51	100

** To convert to μ eq/L, multiply these values by 20.*
Table S-1. Acidic Rain Status of New Hampshire Lakes and Ponds 1976 - 1988

approaches have had limited success because of logistical difficulties associated with sampling unfamiliar systems. Therefore, a more intensive approach is being employed at 5 streams in Pennsylvania and 10 streams in New York. Biological and chemical characterization will be conducted during snowmelt and rainstorm events through means of automated and manual sampling techniques.

Eastern Episodes--Goals of the Episodic Response Project are to:

1. identify and quantify short-term acidic episodes in 4 to 5 streams in each of three regions--the Northern Appalachian Plateau in Pennsylvania and the Adirondack and Catskill mountains in New York State--and describe biological responses to episodes.

2. synthesize the results of the studies in these areas into regional models that will describe and predict both the chemical and biological effects of these short-term events.

Research at the ERP sites proceeded throughout the winter, although site access was limited due to extreme freezing conditions. In spite of this difficulty, a number of episodic events have been monitored and ERP scientists are beginning to characterize the duration and chemical components of acidic episodes in these eastern regions. Consecutive spring storms in Pennsylvania have resulted in the highest flows ever recorded on these ERP study streams. Mortality was observed in radio-tagged fish; those that survived moved erratically and appeared to be very sick. Bioassay experiments with trout had to be restarted on three streams when more than 90% mortality occurred. Bioassay mortality was also observed in the Catskills region of New York, although the episodes there were not as extreme as in Pennsylvania.

Address inquiries concerning the ERP to:

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Regional Episodic and Acidic Manipulations Project (REAM)--REAM is designed to provide data on the effects of increased acidic deposition on surface water quality following whole catchment manipulation. At the Fernow Experimental Forest (administered by the U.S. Department of Agriculture's Forest Service), near Parsons, West Virginia, scientists are monitoring the response of surface waters to acidification on both chronic and episodic time scales.

Plans for acidic manipulation of the watershed are on schedule. The first catchment manipulation was completed in January via helicopter additions of dry ammonium sulfate. Application rates are tailored to the ambient wet deposition rate for the season and are approximately three times the actual rate. In January 7.06 kg S/ha were added, in May 21.17 kg S/ha, and in September the researchers expect to add 7.06 kg S/ha.

Address inquiries concerning REAM to:

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Temporally Integrated Monitoring of Ecosystems (TIME) Project

A major TIME objective is to identify trends in surface water chemistry that may be related to acidic deposition. An internal report, "Biological Monitoring for Acidification Effects: Results of a U.S.-Canadian Workshop," is complete and available for review. This summary of the workshop and the eight papers prepared for the workshop demonstrate that biomonitoring can be cost effective for characterizing subtle changes in acidification or recovery. Compositional data on phytoplankton, periphyton, zooplankton, benthic macroinvertebrates, and fish can be used to construct response variables. Specific combinations of variables will be recommended to serve as (1) early warning signals of acidification or recovery and (2) indicators of longer term chronic ecological effects.

Several scientists are working on site selection and classification. Other major directions include the draft research plan and the draft data analysis plan, both of which will specifically address biological aspects of the project including issues related to geographical representativeness.

Address inquiries concerning the TIME project to:

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Corvallis, Oregon 97333
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SYNTHESIS AND INTEGRATION ACTIVITIES

Regional Case Studies--Since acidic deposition was identified in the 1970s as an important issue relative to aquatic effects, much research has been conducted by a variety of agencies, institutions, and universities. This large body of information has not been analyzed on an integrated, regional-scale basis. The Regional Case Studies (RCS) Project synthesizes previously existing information and newly acquired information from the AERP to provide regional comparisons of surface water quality (including chemistry and biology) in areas of the United States identified as being potentially sensitive to, changed by, or at risk because of acidic deposition.

The major product of the RCS project is a book entitled *Acidic Deposition and Aquatic Ecosystems: Regional Case Studies*. Most of the book is devoted to chapters that synthesize and integrate our knowledge about the current and potential effects of acidic deposition on lakes and streams in selected regions of the United States where large percentages of the surface waters have low acid neutralizing capacity. Regions included in the analyses are the Adirondack Mountains, Maine, the Catskill Mountains, western Virginia, the Southern Blue Ridge, northern Florida, the Upper Midwest (northern Minnesota, Wisconsin, and Michigan), the Rocky Mountains, the Sierra Nevada, and the Cascade Mountains. The chapters discuss regional limnology, particularly the current status of low-ANC lakes and streams, and the relative importance of processes that control the acid-base chemistry of surface water. The chapters are being written by scientists currently doing research in the regions. The National Surface Water Survey data and other regional data sets are being analyzed.

Five introductory chapters provide background information on processes that affect water chemistry and how to assess their importance, a description of methods for assessing long-term trends in water chemistry, an analysis of effects on fish and other biota, and the relevant geography of the case study regions. Two concluding chapters provide a synthesis, integration, and summary of information presented in the case study chapters.

A major conclusion of the book is that the important factors and processes controlling acid-base chemistry of surface waters vary considerably among regions of the United States.

Final versions of most chapter manuscripts were completed near the end of March. With a publication date set for early 1990, this document will support the Aquatics State-of-Science reports for the National Acid Precipitation Assessment Program.

Address inquiries concerning the RCS project to:

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1990 Report Activities--Scientists in the Aquatic Effects Research Program are playing a major role in the preparation of the State of Science/Technology (SOS/T) and Integrated Assessment (IA) for NAPAP. The 1980 Congressional mandate that established NAPAP, an interagency program, required periodic assessments of the effects of acidic deposition on the environment, including evaluations of the extent and severity of the effects on lakes and streams. The 1990 IA, based on the information presented in the SOS/T, fulfills this final obligation and represents the conclusion of NAPAP.

The SOS/T is comprised of 28 reports that summarize current knowledge and present state-of-the-art analytical techniques for evaluating the relationship between atmospheric emissions and acidic deposition; the effects of acidic deposition on aquatic, terrestrial, material, and cultural resources and on human health and visibility; and the economics associated with these effects. Seven of the 28 reports are specifically related to the effects of acidic deposition on aquatic resources and, collectively, are being authored by scientists sponsored by the U.S. EPA, the U.S. Fish and Wildlife Service, and the U.S. Department of Energy.

The IA is structured around five principal questions:

1. What are the effects of concern and what is the relationship between acidic deposition/air pollutant concentrations and these effects?

2. What is the relationship between emissions of precursor pollutants and acidic deposition/air concentrations of pollutants?

3. What is the sensitivity to change (i.e., change in effects with incremental deposition changes)?

4. What are the estimates of future conditions with and without new emissions reduction strategies?

5. What differences emerge from comparative evaluations of future illustrative scenarios?

The NAPAP Aquatic Effects Task Group, led by EPA, with major efforts by the Aquatic Effects Research Program, will contribute answers principally to Questions 1, 3, 4, and 5.

The Aquatics Task Group will address Question 1 by providing an integrated assessment of the current and historical status of the effects of acidic deposition on aquatic systems (including regional patterns in the chemistry of surface waters and associated fish populations) and the processes important in controlling surface water acidification and recovery.

For Question 3, the various types of models used to project future status of aquatic resources will examine the sensitivity to changes in sulfur deposition inputs, i.e., how different are model outputs (projections) given incremental changes in sulfur deposition ranging from an increase of 20% over current deposition levels to a decrease of 50%?

Question 4 will be addressed by projecting the future conditions of aquatic resources under two assumptions: (1) current policy on emissions control is maintained and (2) reductions occur in emissions of sulfur dioxide (a principal precursor to acidic deposition). For the second assumption, various illustrative strategies for emissions reduction will be evaluated.

Question 5, an integrated evaluation of the results of Question 4, will compare and contrast the outcomes of projected changes in aquatic resources under different deposition scenarios. Examples of the types of responses currently under consideration for the analyses include changes in fish populations and extent, magnitude, and rate of changes in pH and acid neutralizing capacity in lakes in the East and Upper Midwest and streams in the Middle Atlantic and Southeast.

The SOS/T, as presently planned, will be presented for review at an International Conference in February 1990. The final reports are scheduled for publication in mid-1990. The production schedule for the IA is concurrent with that for the SOS/T, with publication of the final document scheduled for September 1990.

For information on the SOS/T and IA, contact:

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Technical Information Project--The efforts of the Technical Information Project, as part of the AERP synthesis and integration activities, are discussed in detail in the feature article beginning on page 2.

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MAJOR REPORT/COMPANION DOCUMENTS

Eastern Lake Survey - Phase I

Major Report - Characteristics of Lakes in the Eastern United States

- Volumes I-III ..... 4007 ____
- Volume I ..... 4007a ____
- Volume II ..... 4007b ____
- Volume III ..... 4007c ____

Quality Assurance Plan ..... 4008 ____

Analytical Methods Manual ..... 4009 ____

Field Operations Report ..... 4010 ____

Quality Assurance Report ..... 4011 ____

Western Lake Survey - Phase I

Major Report - Characteristics of Lakes in the Western United States

- Volumes I-II ..... 3054 ____
- Volume I (out of print) ..... 3054a ____
- Volume II ..... 3054b ____

Quality Assurance Plan ..... 8026 ____

Analytical Methods Manual ..... 8038 ____

Field Operations Report ..... 8018 ____

Quality Assurance Report ..... 4037 ____

National Stream Survey - Phase I

Major Report - Characteristics of Streams in the Mid-Atlantic and Southeastern United States

- Volumes I-II ..... 3021 ____
- Volume I ..... 3021a ____
- Volume II ..... 3021b ____

Pilot Survey Major Report ..... 4026 ____

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*Publications listed for the first time.

Direct/Delayed Response Project

**Quality Assurance Report*

Southern Blue Ridge Province ..... 8100 -----

DATA BASES

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Base (Special order form will be sent) ..... 4027 -----

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Base (Special order form will be sent) ..... 4032 -----

HANDBOOKS

Handbook of Methods for Acid Deposition Studies, Laboratory Analyses for Surface Water Chemistry ..... 3026 -----

PROJECT DESCRIPTORS

Research Activity Descriptors, FY 1988 ..... 9006 -----

**Research Activity Descriptors, FY 1989 ..... 9059 -----

ABSTRACTS

Biennial Publications and Presentations

Journal, 1985-86 ..... 9007 -----

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