United States
Environmental Protection
Agency

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

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Research and Development

EPA AERP status

The Aquatic Effects Research Program (AERP) *status* provides information on AERP projects dealing with the effects of acidic deposition on U.S. surface waters. Our objectives 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 the Environmental Protection Agency, state agencies, and organizations involved in acidic deposition monitoring activities; and
- provide a mechanism to distribute available AERP information.

AQUATIC EFFECTS RESEARCH PROGRAM

Concern over the effects of acidic deposition on the nation's surface water resources led the U.S. Environmental Protection Agency (EPA) to initiate research in this field in the late 1970s. Early research, focusing on a diversity of potential effects, provided insight into those research areas which were considered central to key policy questions. Recognizing the need for an integrated, stepwise approach to resolve the issues, EPA implemented the Aquatic Effects Research Program (AERP) in 1983 with its present structure, focus, and approach. The Program, a part of EPA's Office of Research and Development, is administered by the Acid Deposition and Atmospheric Research Division in the Office of Acid Deposition, Environmental Monitoring, and Quality Assurance. The AERP is also a major component of the National Acid Precipitation Assessment Program's (NAPAP) Aquatic Effects Research Task Group 6, a cooperative effort of nine federal agencies tasked with addressing important policy and assessment questions relating to the acidic deposition phenomenon and its effects.

Initially, AERP studies focused on process-oriented research at a few study sites to generate hypotheses for further testing and to identify key parameters associated with the effects of acidic deposition on aquatic ecosystems. In 1983, after it was determined that regional assessments of the effects of acidic deposition could not be made with known confidence on the basis of available historical data, the AERP redirected its focus to provide that information. Weaknesses of available data included possible inconsistencies in the selection of study sites, lack of data for certain important parameters, inconsistent sampling and analytical methods, and little or no information on quality assurance.

The AERP addresses four major policy questions relating to the effects of acidic deposition on aquatic ecosystems:

1. the extent and magnitude of change,
2. the change to be expected in the future under various rates of acidic deposition,
3. the maximum rates of deposition below which further change is not expected, and
4. the rate of change or recovery of aquatic ecosystems if deposition rates are decreased.

An integrated, stepwise approach is used within the AERP to provide the necessary data for assessment and policy decisions related to the effects of acidic deposition on aquatic resources. The approach employs statistically-based site selection, standardized sampling procedures and analytical methods, and rigorous quality assurance protocols. At present, the AERP includes five major research component projects that have been initiated or are being planned: the National Surface Water Survey (NSWS), the Direct/Delayed Response Project (DDRP), the Episodic Response Project (ERP), the Watershed Manipulation Project (WMP), and the Temporal Integrated Monitoring of Ecosystems (TIME) Project. Two additional projects, Biologically Relevant Chemistry (BRC) and Indirect Human Health Effects (IHHE),

have been incorporated into the AERP research design. These projects form an integrated program to quantify the chemical status of surface waters, to predict the response of biologically relevant water chemistry to variable rates of acidic deposition, and to verify and validate the predictions (Figure 1).

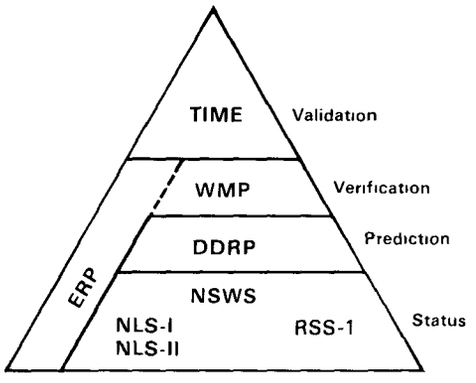


Figure 1. AERP Component Projects.

The AERP projects are concerned primarily with assessing chronic, or long-term, acidification of surface waters as affected by sulfur deposition, although the Episodic Response Project will assess the importance of acute, or short-term, acidification and nitrate deposition. Components of the Biologically Relevant Chemistry Project address issues of both chronic and acute acidification.

National Surface Water Survey (NSWS)—The NSWS is divided into two components: the National Lake Survey (NLS) and the Regional Stream Survey (RSS). Phase I activities of the NSWS provide information to assess the current chemical status of lakes and streams. Phase II activities of these surveys describe seasonal variability in regional surface water chemistry. Because of the statistical basis of the sampling design, data from the NSWS can be used to classify estimated populations of lakes and streams so that selected subsets can be identified for more detailed studies during other components of the AERP. Results of these more detailed studies can be interpreted then at a regional scale with greater confidence.

Direct/Delayed Response Project (DDRP)—The DDRP provides data on watersheds and soils to complement the surface water data of the NSWS. These data will be used in three existing watershed acidification models to predict the time scales over which surface waters are expected to become chronically acidified, given different levels of acidic inputs.

Episodic Response Project (ERP)—The ERP has similar objectives as the NSWS, but focuses on the magnitude, frequency, and duration of episodic acidification on regional water chemistry and watershed processes. Data from intensive experimental studies on hydrochemical and biological processes, along with limited surveys of chemist and fish (including bioassay data), will form the basis for developing regionally-applicable models of chemical and biological response. After calibration and verification, the models will be applied to the statistical frame of the NSWS to provide estimates of biologically relevant chemical data, as well as estimates of the effects on fish on a regional basis. At a small number of catchments, the ERP will be conducted in conjunction with the WMP. Approximately 1: streams in the eastern United States will be monitored intensively during major hydrologic events.

Watershed Manipulation Project (WMP)—The WMP, involving process-oriented research at a small number of watersheds, will assess the quantitative and qualitative response of watershed soil and surface waters to altered levels of deposition. Designed primarily to verify the model: used for prediction in the DDRP, the WMP also will determine the interactions among biogeochemical mechanisms controlling the response of surface waters to acidic inputs at various scales within watersheds.

Temporal Integrated Monitoring of Ecosystems (TIME) Project—The TIME Project, a long-term monitoring activity, will evolve from existing projects within EPA and NAPAP. The TIME sites will be selected by evaluating data from currently monitored systems and from the NSWS results. These sites, which will be established throughout the United States by 1990, will be monitored to quantify the rate, direction, and magnitude of changes in surface water chemistry possibly due to increased and decreased levels o acidic deposition. The TIME sites also will provide information on surface water chemistry that can be used to validate the conclusions of the DDRP, the ERP, and the WMP.

Biologically Relevant Chemistry (BRC) Project—The BRC Project will provide assessment data on the risk that acidic deposition poses to aquatic biota. Several complementary studies will be incorporated as components of the BRC. One study will determine the present status of fish populations in a subset of lakes sampled during the eastern component of the NLS and will quantify the chemical characteristics of these lakes. Another study, planned in conjunction with the ERP, will determine the effects of episodic acidification on fish populations.

Indirect Human Health Effects (IHHE)—The IHHE Project concentrates on two areas: (1) the alteration of drinking water supplies in response to acidic inputs and (2) the accumulation of mercury and other potentially toxic metals in the muscle tissues of edible fish. Emphasizing research on precipitation-dominated surface water systems as well as research on shallow water aquifers, drinking water studies include the examination of existing data to determine the potential modification of drinking water quality by acidic deposition. In addition, existing process-oriented and survey data are being examined to evaluate the relationship

between mercury bioaccumulation in sport fish and surface water chemistry in areas receiving high levels of acidic deposition.

1990 AERP Report—Scheduled for completion in the spring of 1990, the AERP Report will include discussions of biologically relevant chemistry, status of aquatic ecosystems, historical changes, forecasts of acidification and recovery, and an evaluation of region-specific dose-response scenarios. The AERP results will serve as a foundation for a 1990 NAPAP assessment.

Status of AERP Activities—Phase I field activities (Synoptic Chemistry) of the NLS and the RSS and Phase II field activities (Seasonal Chemistry) of the NLS are complete. Initial DDRP soil surveys have been completed in the northeastern United States and in the Southern Blue Ridge Province. Initial BRC sampling activities have been completed in the Upper Peninsula of Michigan and northwestern Wisconsin. The WMP was implemented in the spring of 1987; field studies for the ERP are scheduled to begin in the fall of 1987. The TIME Project conceptual design will be finalized by the end of 1987, and field activities will be initiated in the fall of 1988. Table 1 summarizes the present status of the various 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 (Chemistry, NE)	Complete	Complete	Summer 1988
Regional Stream Survey, Phase I	Complete	Complete	Winter 1987-88
Direct/Delayed Response Project			
NE and SBRP Soil Surveys	Complete	Complete	Winter 1987-88
Mid-Apalachian Soil Survey	Ongoing	Ongoing	Fall 1990
Biologically Relevant Chemistry	Ongoing	Ongoing	Winter 1988-89
Watershed Manipulation Project	Complete	Spring 1987	Annually
Episodic Response Project	Fall 1987	Fall 1987	Winter 1989-90
Temporal Integrated Monitoring of Ecosystems	Ongoing	Fall 1988	Biennially
Indirect Human Health Effects	Ongoing	Ongoing	Spring 1990

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

AERP FEATURE ARTICLE

Subregion	pH ≤ 6.0	ANC ≤ 200 μeq/liter
1A	343 (418)	909 (995)
1B	116 (179)	572 (719)
1C	191 (254)	1,002 (1,100)
1D	192 (260)	755 (882)
1E	74 (111)	1,020 (1,121)
Northeast*	916 (1,056)	4,258 (4,513)
2A	20 (43)	830 (938)
2B	185 (252)	438 (536)
2C	411 (489)	839 (936)
2D	202 (393)	1,411 (1,842)
Midwest*	818 (1,577)	3,518 (3,982)
3A	1 (2)	88 (108)
3B	687 (878)	1,156 (1,413)
Southeast*	688 (880)	1,244 (1,521)
4A	32 (84)	2,076 (2,233)
4B	41 (73)	1,222 (1,333)
4C	0 (-)	1,205 (1,411)
4D	30 (63)	1,788 (1,929)
4E	0 (-)	634 (787)
West**	103 (172)	6,926 (7,276)

* Estimated number of target population lakes in the ELS with pH and ANC values equal to or less than those identified. The value in parentheses is the 95 percent upper confidence limit on the estimated number.

** Estimated number of target population lakes in the WLS with pH and ANC values equal to or less than those identified. The value in parentheses is the 95 percent upper confidence limit on the estimated number.

Table 2. Estimated number of lakes with specific values of pH and ANC.

National Lake Survey, Phase I —The initial phase of the National Lake Survey (NLS) consisted of the Eastern Lake Survey (ELS) and the Western Lake Survey (WLS). The surveys, conducted in 1984 in the northeastern, midwestern, and southeastern United States (ELS) and in 1985 in mountainous areas of the western United States (WLS), provided baseline information about the current chemical status of our nation's lakes (Figure 2). To accomplish the survey objectives, a single sample was collected from each NLS lake during fall turnover, a period of minimum within-lake chemical variability. This index sample represented the integration of chemical inputs and lake transformation processes which occur during other seasons.

During the ELS, scientists used helicopters to access and sample 1,798 lakes (with surface areas between 4 and 2,000 hectares). Samples from 757 lakes (with surface areas between 1 and 2,000 hectares) were collected during the WLS . Approximately one-half of the WLS lakes were located within designated wilderness areas. Forest Service personnel accessed these lakes by foot or pack animal.

In the eastern region, the Adirondacks (11%), the Upper Peninsula of Michigan (10%), and Florida (22%) had the largest number and highest percentage of acidic lakes, i.e., acid neutralizing capacity (ANC) ≤ 0 μeq per liter. In the low alkalinity regions surveyed in the West, only one lake, which was associated with a naturally acidic hot spring in Yellow-Stone National Park, was found to be acidic. The California

Subregions

1	Northeast	2	Upper Midwest	3	Southeast	4	West
1A	Adirondacks	2A	Northeastern Minnesota	3A	Southern Blue Ridge Province	4A	California
1B	Poconos/ Catskills	2B	Upper Peninsula of Michigan	3B	Florida	4B	Pacific
1C	Central New England	2C	Northcentral Wisconsin			4C	Northern Rockies
1D	Southern New England	2D	Upper Great Lakes Area			4D	Central Rockies
1E	Maine					4E	Southern Rockies

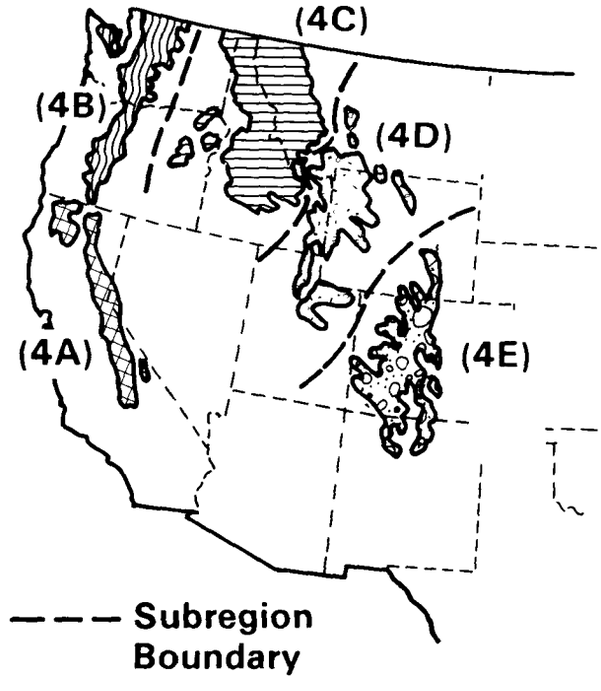
Objective

- Estimate number and area, and determine location of acidic lakes
- Estimate number and area, and determine location of low ANC lakes
- Characterize present chemical status, develop classification scheme

Design

- Collect one sample during fall
- Statistically select lakes so extrapolation to obtain regional estimates can be done
- Standardize methods for data comparability
- Determine data quality to allow confidence in estimates

Western Study Area



Eastern Study Area

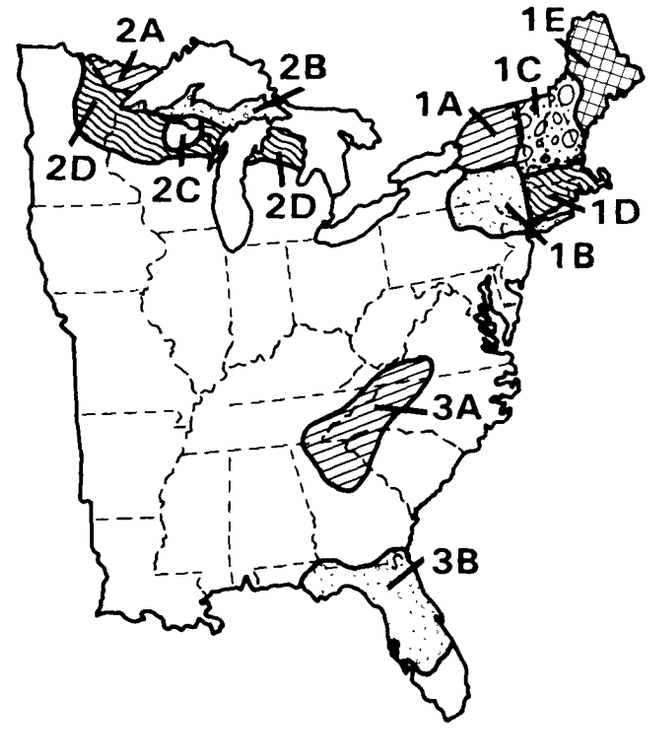


Figure 2. National Lake Survey - Phase I.

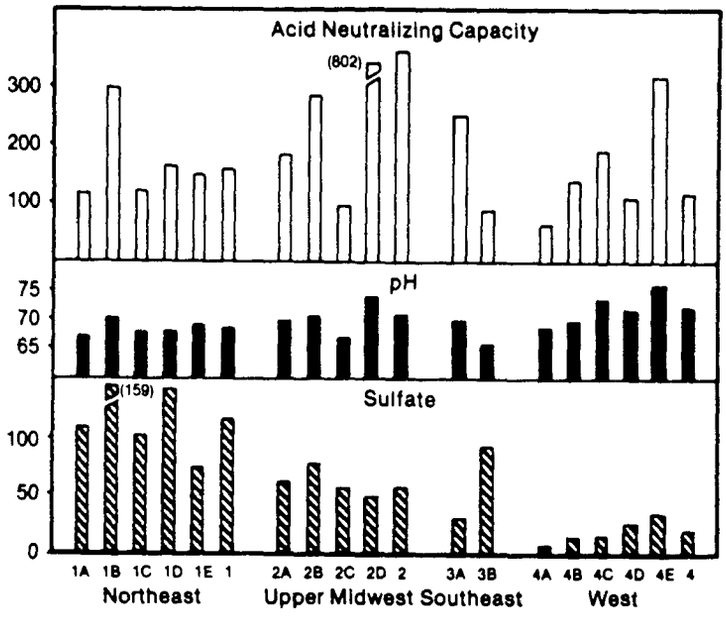


Figure 3. Comparison of median values for NLS subregions.

subregion had the lowest median ANC (62.6 μeq per liter) of all 15 subregions sampled in the NLS. With the exception of one upper midwestern subregion, the highest estimated median ANC for the NLS was observed in the Southern Rockies (317 μeq per liter). Wilderness area lakes in the West had much lower ANC values than did lakes located outside the wilderness areas. Table 2 shows the estimated number of NLS target lakes with pH $\leq$ 6.0 and ANC $\leq$ 200 μeq per liter.

Sulfate concentrations in the West were markedly lower than sulfate concentrations in the East. Median pH values were generally lower in the Northeast (Figure 3).

The ELS estimated the present chemical status of 17,954 lakes. The chemical characteristics of an estimated 10,393 lakes were calculated from data gathered during the WLS. The results indicate a large number of potentially sensitive lakes in each study area.

Results of ELS-I have been published in a three-volume major report. The report is available through the mail order form attached to the *status*. The availability of the WLS-I major report will be announced in the next edition of the *status*.

COMPLETED AERP ACTIVITIES

National Lake Survey

Phase II Activities (Seasonal Chemistry)—Phase II was initiated in the northeastern United States in 1986 and included three seasonal chemistry surveys. Each of 147 lakes, selected from lakes sampled during Phase I of the ELS, was sampled during spring, summer, and fall at approximately the same location on the lake sampled during Phase I. These surveys will provide data necessary to characterize seasonal patterns in water chemistry and to relate these patterns to the fall "index" conditions of Phase I. The surveys also will provide estimates of the number of lakes that were found not to be acidic during the Phase I fall sampling period but are acidic at other times of the year. The Phase II fall survey included an additional study to assess the variability associated with fall sampling.

Data from Phase II of the ELS are being verified, validated, and analyzed. A published report will follow this review process and will be available by the summer of 1988.

Regional Stream Survey

The Regional Stream Survey (RSS) was conducted in the Southern Blue Ridge Province, the Mid-Atlantic states, and the Southeast. The RSS included three components: a feasibility study (1985); the Mid-Atlantic Survey (1986), designed to meet NSWS Phase I objectives; and the Southeastern Screening Survey (1986), initiated in concert with Mid-Atlantic sampling to provide information to prioritize other RSS sites for future survey activities.

Feasibility Study—The RSS Pilot Study was conducted in the Southern Blue Ridge Province in 1985 to test and evaluate sample site selection research designs, sampling and analytical methods, field base operations, sample shipping and tracking procedures, quality assurance and quality control programs, and data base management. Each of sixty-one streams was sampled four times.

Reports on the pilot study will be announced in the next issue of the *status*.

Phase I Activities (Synoptic Chemistry)—During Phase I activities, 267 stream reaches (defined as the length of stream between two points of confluence with tributaries, or as the headwater if there was no upstream point of confluence) were sampled twice at upstream nodes and twice at downstream nodes. One sample for full chemical analysis was collected on each visit.

Screening Survey—The Southeastern Screening Survey covered areas of the Southern Appalachian Mountains, the Piedmont, the Ouachita Mountains, and parts of the Florida Panhandle and Florida Peninsula that were identified in the NLS to have a large number of acidic lakes. Each of 180

streams was sampled once at the upstream node and once at the downstream node. The same chemical measurements were made as in the Phase I survey. Results of the Screening Survey may target one or more of these areas for further study.

Final reports on the Mid-Atlantic Survey and the Southeastern Screening Survey will be available by early in the 1988 EPA fiscal year (the EPA fiscal year is October-September).

Direct/Delayed Response Project

The northeastern United States and the Southern Blue Ridge Province were studied during the Direct/Delayed Response Project (DDRP). Because these areas contain contrasting soils and watershed characteristics, their responses to acidic inputs are likely to differ. Watersheds in the Northeast were selected for mapping and soil sampling based on measurements of lake chemistry that were taken in Phase I of the NLS. About 90 percent of the sites selected for the northeastern portion of the soil surveys are within watersheds sampled during Phase II of the NLS. Stream water chemistry data generated from the pilot study of the RSS were used as the basis from which to select watersheds for mapping and soil sampling in the Southern Blue Ridge Province.

DDRP Soil Surveys—Soil Conservation Service scientists mapped the watersheds of 145 lakes in the Northeast in the spring of 1985 and mapped 35 sites in the Southern Blue Ridge Province in the fall of 1985. Sampling at all sites was completed by the winter of 1986.

Results of the soil surveys in the Northeast and the Southern Blue Ridge Province will be available by the winter of 1988.

Biologically Relevant Chemistry (BRC)—NSWS subregion 2B (the Upper Peninsula of Michigan and northwestern Wisconsin) was selected for surveys of fish communities and fish mercury content because it: (1) contains a high proportion of acidic lakes, therfore, is likely to have a high proportion of "fishless" lakes; (2) is anticipated to have relatively high levels of mercury in fish; (3) has little existing data on fish community status or on mercury levels in fish; and (4) has diverse geologic and hydrologic conditions.

BRC Field Activities—A cooperative effort among EPA, the Electric Power Research Institute, and the University of Michigan at Lansing, initial BRC sampling was conducted from June to September, 1987. Water samples from 49 Phase I lakes were collected and analyzed for a variety of aquatic chemistry parameters. From a subset of lakes, a separate set of samples was analyzed for levels of mercury. In addition, personnel from the University of Michigan at Lansing collected a variety of species and sizes of fish. Fillets of fish muscle were removed at Cornell University and are being analyzed for levels of mercury at Syracuse University.

CURRENT AERP ACTIVITIES

Current AERP activities include acidic deposition research projects either in progress or scheduled to commence by spring 1988.

Direct/Delayed Response Project (DDRP)—The DDRP data are being evaluated at three levels. Level I analyses include multivariate statistical procedures and steady-state calculations such as sulfur input-output budgets. The results of these analyses are being integrated with data from the NSWS to provide correlations between watershed characteristics and surface water chemistry. Level II analyses are order-of-magnitude time estimates. They will be used to estimate changes in individual system components (i.e., sulfate adsorption and base cation supply) considered to be important in controlling surface water acidification. Dynamic models are being used in Level III analyses to integrate key mechanisms controlling surface water chemistry in order to simulate changes in water chemistry over a long period of acidic deposition. The predicted responses to continued deposition are being used to classify watersheds and to estimate the number and geographic distribution of each class of watersheds.

To apply DDRP analyses to the Mid-Appalachian Region, a soil survey similar to the surveys conducted in the Northeast and the Southern Blue Ridge Province is being planned for implementation in 1988. Watershed mapping is underway in Pennsylvania, West Virginia, and Virginia. Geology, soils vegetation, and hydrologic characteristics are distinct in this region, and present levels of deposition are among the highest in the United States. The Mid-Appalachian Region probably represents a transition zone between the Northeast and the Southern Blue Ridge Province.

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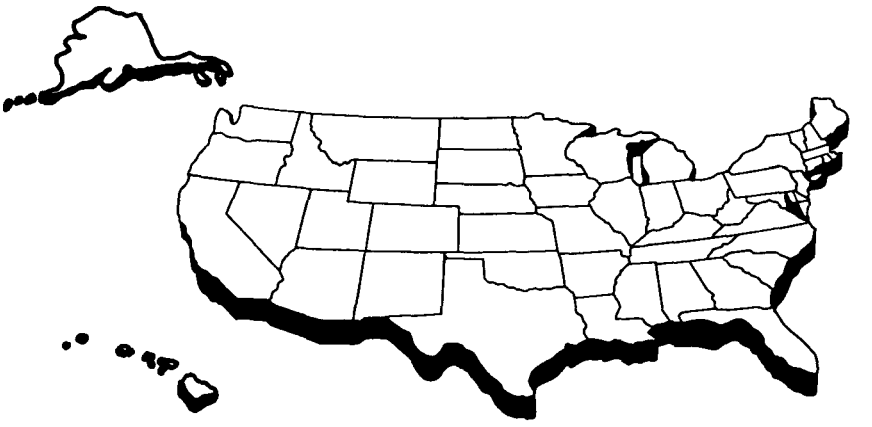
Episodic Response Project—The Fernow Experimental Forest, a U.S.D.A. Forest Service research site in West Virginia, has been selected as the site for the first ERP intensive experimental studies. Because this site has been the focus of ongoing studies, empirical data needed to begin model development and verification are already available. Field studies are expected to begin immediately, and fish studies and episodes monitoring will begin early next year.

Local Forest Service researchers will be responsible for data collection, chemical analyses, and data interpretation. These researchers will collect continuous and semi-continuous stream water chemical data so that the magnitude, duration, and frequency of episodic acidification at each site can be determined.

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

The California Air Resources Board is sponsoring a project on modeling acidification processes. The study targets high elevation watersheds in the Sierra Nevada and will include a compartment model of the Emerald Lake Watershed in Sequoia National Park and a regional assessment of the sensitivity of lakes in the Sierra Nevada to acidic deposition.

Connecticut

The U.S. Geological Survey and the Connecticut Department of Environmental Protection are involved in a cooperative project to determine the effects of atmospheric deposition on the surface water quality of streams in the Salmon River Basin. Short-term changes in water quality associated with storm events and snowmelt are central to this study.

Georgia

Georgia's Task Force on Acidic Deposition is conducting a research project to determine the effects of acidic deposition on smallmouth bass populations in several lakes in northern Georgia.

Maryland

Aquatic effects studies in Maryland include: stream chemistry surveys, an episodic response project near Chesapeake Bay, bioassay experiments using bluebarb herring, american shad, and yellow perch, detailed evaluations of stream acidification mitigation techniques, and an examination of the influences of acidic deposition on the quality of a major groundwater aquifer on Maryland's eastern shore. The Maryland Power Plant Research Program is charged with coordinating these research and monitoring activities.

Minnesota

Minnesota activities include:

Deposition Monitoring - Weekly precipitation samples are collected at five sites in the state and analyzed for major cations and anions. Low volume filterpack collectors are operated

at six sites to measure ambient concentrations of sulfur dioxide and to obtain estimates of dry deposition.

Seasonal Lake Chemisty - Seasonal lake monitoring has been conducted on 35 lakes since 1981. Fisheries assessments have been made on these lakes, and fish tissue has been analyzed for heavy metals and mercury. Reports are available for data collected from 1981-1985.

Intensive Lake Monitoring - Two seepage lakes and three headwater lakes were selected for study from October, 1983, through December, 1985, as part of the Watershed Acidification Study. Monitoring on two of the headwater lakes will continue under a mercury study to be initiated this summer. The additional hydrology and chemistry data collected from the two lakes will be used to extend the established data bases. In addition, mercury concentrations in various parts of the food chain and in various lake and watershed compartments will be assessed.

Streams/Snowmelt - A study to investigate snowmelt impacts on head water trout streams in northern Minnesota is in the planning stages. Stream studies recently conducted in Maryland and Wisconsin are being evaluated for their applicability to Minnesota.

Utah

The Acid Deposition Technical Advisory Committee (ADTAC) has implemented a 1987 agenda that includes: (1) sampling surface waters in 10 identified sensitive areas; (2) creating a map of ANC; and (3) forming a state acidic deposition policy.

Virginia

The State Air Pollution Control Board funds the following studies: (1) an investigation of the long-term transport of air pollution into Virginia, and (2) a study of the potential resources of Virginia at risk due to the effects of acidic deposition and ozone. In the spring of 1987, the Virginia Commission on Game and Inland Fisheries sponsored a study of 400 streams in the western portion of the state. This survey provided baseline information about the effects of acidic deposition on the stream habitat of the eastern brook trout in the mountains of Virginia.

Washington

Since 1984, the Washington Department of Ecology has examined source/receptor relationships and sensitive ecosystems to determine the effects of acidic deposition on the state's lakes and forests. Conclusions from these studies include: (1) precipitation is acidified to the greatest degree in the western part of the state; (2) levels of acidity are significant but not as high as in other affected areas of the country; (3) acidity is due largely to the emissions of sulfur dioxide and nitrogen oxides from pulp mills, smelters, refineries, and power plants in the region; and (4) automobiles are also a large source of nitrogen oxides.

Current studies focus on long-term monitoring activities.

West Virginia

In 1983, the West Virgina Wildlife Resources Division sampled 82 streams in the Allegheny Plateau Region. Indicating a trend toward declining water quality, these studies led to state involvement in the Acid Precipitation Mitigation Program sponsored by the U.S. Fish and

Wildlife Service. Currently, the state is constructing a station on Cranberry River to determine the site-specific responses to liming and to compare responses among sites in different geographic locations.

Wisconsin

The Water Resources Research Section in the Department of Natural Resources (DNR) has been conducting acidic deposition research since 1981. The Section has been involved in the following interdisciplinary studies:

Regional Integrated Lake-Watershed Acidification Study (RILWAS), with principal investigators from the Department of Natural Resources, University of Wisconsin, U.S. Geological Survey, University of Manitoba, Canadian Department of Fisheries and Oceans, Tetra Tech, Inc., Systech, Inc., and Wisconsin Power and Light.

Little Rock Lake - Whole-Lake Acidification Experiment, with principal investigators fro ⁻ DNR, University of Wisconsin - Madison, University of Wisconsin - Superior, University of Minnesota, Iowa State University, U.S. Geological Survey, and U.S. Environmental Protection Agency.

Historical Reconstruction of Acidic Lakes in Northern Wisconsin, with principal investigators from DNR and the University of Minnesota - Duluth.

Long-term Acid Sensitive Lakes Monitoring Program (Cluster Lakes), with principal investigators from DNR and the University of Minnesota.

The Department's Water Resources Research Section has maintained a philosophy that supports an interdisciplinary scientific team approach toward conducting holistic ecological research. In conducting acidic deposition research, specific scientific teams have been formed with specialists form DNR, midwestern and Canadian universities, federal government agencies from the U.S. and Canada, and private industry. Funding for the research projects has been provided by the U.S. Environmental Protection Agency, the Electric Power Research Institute, and DNR.

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Watershed Manipulation Project—Investigators are studying the response of watershed systems to artificial acidification at Bear Brook in Maine and at the Fernow Experimental Forest. At the Bear Brook site, near Orono, the University of Maine (Stephen Norton, Principle Investigator) provides scientific leadership and is responsible for testing watershed-level hypotheses. In addition, a number of other research institutions complement the activities of the University of Maine by testing specific hypotheses related to watershed acidification processes or by testing DDRP models. These studies are as follows:

- The University of Virginia (George Hornberger, PI) is testing hypotheses relating to subsurface flow processes important in understanding the long-term hydrochemical response of catchments to acidic deposition. This research will verify whether or not the models used in the DDRP are consistent with observed hydrological behavior in forested watersheds.

- The University of Iowa (Jerald Schnoor, PI) is working to determine the rate of base cation resupply to exchange sites and the kinetics of chemical weathering. This information will be used in the WMP to improve mathematical model formulations and to predict and explain the results of the watershed manipulation.

- Syracuse University (Charles Driscoll, PI) is evaluating watershed processes regulating the transfer of aluminum (Al) and the release of base cations prior to and following acid applications to a watershed. Quantitative relationships will be used in representations of Al chemistry and transfer of Al and base cations. These representations will aid in the conceptual structuring, parameterization, and validation of the DDRP models. It also will enhance the accuracy of the models in predicting the effects of acidic deposition on forested ecosystems.

- The State University of New York (Myron J. Mitchell, PI) is evaluating sulfur mobility as regulated by adsorption/desorption processes. The University is also assessing biochemical sulfur transformations affecting sulfate flux through the watershed and the resulting effects on surface water acidification.

- The University of Wisconsin at Madison (Dr. John Aber, PI) is addressing the effect of elevated levels of sulfate deposition on organic matter decay, nitrogen mineralization, nitrification, nitrogen retention on exchange sites, and nitrogen leaching losses, and the ability of vegetation to take up and retain nitrogen in the ecosystem.

- The University of Illinois (Mark B. David, PI) is examining organic acids and their role in the acidification of soil solutions and surface waters. This research will determine the role of organic acids in regulating cation leaching and soil solution organic chemistry (including ANC) in forested ecosystems. Subsequently, influence of organic acids in the DDRP models will be examined and refined.

- The Pacific Northwest Laboratory (Everett Jenne, PI) is testing, comparing, and verifying the DDRP models to evaluate their sensitivity when addressing specific assessment and policy questions. In addition, modeling studies will be conducted with other WMP cooperators to design, analyze, and interpret watershed manipulation experiments, to compare model outputs and experimental results, and to provide information to address policy and assessment questions.

- At the Fernow Experimental Forest, the U.S.D.A. Forest Service (David Helvey, PI) will conduct an artificial acidification experiment in which research will be concentrated at the watershed level with a small amount of supplemental process research. This research activity site is a component of both the WMP and the ERP.

Address inquiries concerning the WMP to:
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FTS: 420-4666

Temporal Integrated Monitoring of Ecosystems (TIME) Project—The TIME Project is in the preliminary design phase. The following tasks have been initiated:

- Model-based Population Estimates - Existing NSWS data will be used to identify the potential target population for the TIME project. A statistical sample will be drawn from the target population, representing lakes to be monitored during the TIME Project. Various relational models (e.g., cluster analyses) are being evaluated to classify lakes based on their physiochemical characteristics. Such a classification will aid in optimizing the statistical sampling design in terms of providing the necessary data to meet the objectives of the TIME Project.

- Variance Estimates - Statistical tests are being applied to historical data to estimate the number of lakes and streams needed to detect significant chemical variation (at various levels of precision and confidence). These analyses also will help evaluate the time required to detect a significant trend.

- Candidate Sites - Long-term monitoring is being conducted at a number of sites by private, state, and federal organizations. A preliminary survey identified over 700 watersheds in which research is being conducted by other agencies.

This preliminary survey is being expanded and coordinated with a recent NAPAP survey in order to identify potential candidate sites for the TIME Project.

- Statistical Analysis Approaches - For long-term monitoring data to be of maximum use, they must be analyzed and reviewed annually; therefore, needs of the data user must be incorporated into the design. This task will focus on the user and the anticipated analytical procedures. The design criteria and attributes of candidate TIME Project sites will be reviewed, and several statistical analysis procedures that may be appropriate will be identified. In conjunction with this work, the information expectations of the data users, including EPA and NAPAP personnel and Congress, are being evaluated. Proposed statistical and analytical procedures will be included in the TIME Research Plan.

The TIME Project is scheduled for implementation in the fall of 1988. Plans for data quality objectives, research, implementation, quality assurance, and data analysis will be developed and peer-reviewed. Coordination meetings with private, state, and federal agencies will be conducted during the next six months to identify candidate sites in regions sampled in the NSWS.

Address inquiries concerning the TIME Project to:
Dixon H. Landers, Aquatic Effects Team Leader
EPA/Environmental Research Laboratory-Corvallis
200 S.W. 35th Street
Corvallis, Oregon 97333
(503) 757-4695
FTS: 420-4695

Two other projects, the Southeastern Acidification Project and the Surface Water Recovery Project, are being incorporated into the AERP research design.

Southeastern Acidification Project—The "F-factor", a measure in the change of base cations due to change in sulfate concentration, is the greatest uncertainty in acidification models. One of the objectives of the Southeastern Acidification Project is to calculate watershed-specific values of the F-factor. Other objectives are: (1) develop a regional index of hydrologic inputs; (2) improve estimates of wet and dry sulfate deposition inputs; (3) refine projected timeframes for reaching sulfate steady-state and depleting base cation supplies; (4) examine the relationships among F-factors and various watershed characteristics for specific subsets of systems; (5) perform detailed analyses of RSS data from the Southern Blue Ridge Province and, (6) refine the estimated values for input parameters to reduce the error propagated through dynamic acidification models.

Possible study locations include sites sampled in the Southern Blue Ridge Province during the RSS and the DDRP, and watersheds currently studied by the U.S. Geological Survey, the U.S.D.A. Forest Service, and the National Park Service. Research is expected to begin earl next year, and integration of results is targeted for late 19

Address inquiries concerning the Southeastern Acidificati Project to:
Kent Thornton
Ford, Thornton, Norton & Assoc., Ltd.
3 Innwood Circle, Suite 220
Little Rock, Arkansas 72211
(501) 225-7779

Surface Water Recovery Project—The rate and extent of surface water recovery in response to decreased acidic deposition (relative to current levels) is presently unknown. The AERP plans to implement research that w provide information regarding the recovery issue in time fo the 1990 AERP Report.

The Surface Water Recovery Project will draw on the findings of nearly every other AERP component project, as well as case histories from Canada and Europe that have documented surface water response to decreased levels of acidic deposition. Field and laboratory studies will focus on sulfur sorption dynamics as a means to predict future sulfa steady-state in regions identified in the NSWS to contain acidic and low ANC lakes and streams. These studies may be conducted as part of the field manipulation studies in th Bear Brook Watershed and in the Fernow Experimental Forest. Plot studies, in which various portions of watershe are monitored after sulfate inputs are terminated, might be conducted at existing research sites or at watersheds associated with acidic systems sampled during the NSWS and the DDRP. All of these studies will monitor changes in base cation supply as well as sulfur sorption dynamics.

Laboratory studies will examine sulfate sorption processes i soil columns. Soils collected from various field sites can be loaded with sulfate and desorption dynamics monitored under various experimental conditions. Archived DDRP soil collected from the Northeast and the Southern Blue Ridge Province will be evaluated for use in these experiments.

Case history evaluations will focus on sites in Sudbury, Ontario, Nova Scotia, and western Sweden. A literature review will examine the extent to which sulfate "breakthrough" (i.e., sulfate transport from watersheds to surface waters) continues after sulfate inputs are removed. Field work will be conducted at Clearwater Lake in Ontario where deposition of sulfur compounds has been reduced significantly.

Address inquiries regarding the Surface Water Recovery Project to:
Dan McKenzie
EPA/Environmental Research Laboratory-Corvallis
200 S.W. 35th Street
Corvallis, Oregon 97333
(503) 757-4600 FTS: 757-4600

AERP TECHNICAL INFORMATION PROJECT

The technical information project disseminates information on AERP activities to state agencies, organizations, and technical audiences. Distributed information icludes the following items:

status—In addition to providing information on current activities within the AERP, the *status* will highlight the activities of state agencies involved in projects related to aquatic effects of acidic deposition. The *status* will provide a mechanism for obtaining documents resulting from AERP research activities and from the Technical Information Project.

Project Overviews—Concise project descriptions will inform regional EPA offices, state agencies, and other interested organizations about AERP projects prior to their implementation. A similar document, summarizing project conclusions, will follow at the end of each project.

Biennial Publications and Presentations Journal—This document will be a compilation of abstracts describing presentations authored or coauthored by AERP-EPA and contractor support personnel. Issues are prepared biennially. The first issue, covering 1985 and 1986 abstracts, will be available through the mail order form in the next issue of the *status*.

Project Descriptors—This document will be a compilation of AERP project descriptions for activities to be performed in a given EPA fiscal year. The first issue will cover the October 1987-September 1988 EPA fiscal year projects; the current issue should be available at the beginning of the calendar year (January 1988).

Major Report with Companion Documents—These document sets will be a compilation of the manuals and reports used during or prepared as a result of a particular AERP project. Companion documents to each major data report include field operations and quality assurance reports, quality assurance plans, and analytical methods manuals. The first complete set (ELS-I) of documents is available through the mail order form in this issue of the *status*.

Data Bases—Each data base consists of two components: a computer diskette or tape containing the validated data base for a particular AERP project and a user's guide with instructions on how to use the disk and how the quality of the data was assessed. The WLS-I Data base is available through the mail order form in this issue of the *status*.

Handbooks—The handbooks are guidance documents that contain procedures for field operations, laboratory operations, and quality assurance for surface water and soil chemistry. They are beneficial to those organizations involved in designing and implementing monitoring activities related to acidic deposition. A loose-leaf format facilitates insertion of revisions. The *Handbook of Methods for Acid Deposition Studies, Laboratory Analyses for Surface Water Chemistry* is available through the mail order form in this issue of the *status*.

Computer Animation Presentations—Computer animation presentations will be created for each AERP component project. A "storyboard" format will provide scientific information to a wide range of technical and non-technical audiences. The first computer animation presentation will describe the objectives and underlying hypotheses of DDRP.

Address inquiries concerning the AERP Technical Information Project to:
Robert E. Crowe, Technical Director,
AERP Technical Information Project
EPA/Environmental Monitoring Systems Laboratory-Las Vegas
P.O. Box 93478
Las Vegas, Nevada 89193-3478
(702) 798-2273
FTS: 545-2273

AERP ANNOUNCEMENTS

AERP Supported Activities

WLS-I Data Base—Data from the WLS-I are available. The data base includes lake and watershed physical characteristics, in situ measurements, and analytical laboratory results.

Address inquiries regarding the WLS-I Data Base to:
Dixon H. Landers
EPA/Environmental Research Laboratory-Corvallis
200 S.W. 35th Street
Corvallis, Oregon 97333

NAPAP Federal/State/Private Sector Research Coordination Workshop
November 3-5, 1987
Lake Geneva, Wisconsin

Contact:
Bob Downing, International Specialist
National Acid Precipitation Assessment Program
722 Jackson Place, N.W.
Washington, D.C. 20503
(202) 395-5771

If you would like to receive any of the following AERP products, please check the appropriate box(es).

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 ☐

Data Bases

Western Lake Survey - Phase I

- Data Base (Special order form will be sent) ..... 2027 ☐

Handbooks

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

Would you like to be included on the mailing list for future editions of AERP the *status*?

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Aquatic Effects Research Program

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