A REPORT

ASSESSMENT OF THE SCIENTIFIC QUALITY

OF THE

ECOLOGICAL RESEARCH PROGRAMS

OF THE

OFFICE OF RESEARCH AND DEVELOPMENT

BY THE

ECOLOGY ADVISORY COMMITTEE

SCIENCE ADVISORY BOARD
U. S. ENVIRONMENTAL PROTECTION AGENCY

July 26, 1976

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EXECUTIVE SUMMARY

At the request of Dr. Wilson Talley, the Committee reviewed the Corvallis, Duluth, Gulf Breeze, and Narragansett laboratories and several of their associated field stations.

In this review the Committee paid particular attention to the administration, quality and effectiveness of the scientific staff, the facilities, the research programs, the products of the research, and whether there was sufficient communication between the scientists of EPA and the scientific community.

Administration and Staff

The Committee found that the Directors of the laboratories were efficient, conscientious leaders, and that their methods of communication varied greatly. At the Duluth and Gulf Breeze laboratories the communication between the Director and staff was very effective in producing high morale and quality research of considerable quantity. At Corvallis a variety of reasons seemed to be the cause of lower morale. At Narragansett the Committee did not develop a position on morale. The reasons are discussed in the text.

In all cases better communications should be established between the laboratories and the Washington office. This applies to the movement of personnel, the development of policies about research, and assigning priorities for research programs.

The staff in general were well qualified for carrying out research programs. In some cases the credentials of the scientists did not match the research programs in which they served a major role. At all the laboratories well trained ecologists are needed in order that the planning and carrying out of experimental programs can more nearly simulate the real world.

At all except the Corvallis Laboratory greater use should be made of statisticians and/or modellers for designing programs so that the results have more reliability and predictability.

An aggressive effort should be made to secure scientists and technologists from minority groups and to assure that they are well trained and represented in the scientific work of the laboratories. An effective method for recruiting and training minorities is that employed by the USDA Soil Conservation Service.

In general, the capabilities of the scientific staff would be improved by more communication with scientists in academic institutions and industry, as well as in other government agencies. This may be achieved by inviting scientists to spend some time in residence at the laboratories; by seminars, and by visits of the staff to other laboratories. Such procedures should not only be followed with outside groups but also between laboratories of EPA and other federal agencies. The scientific community would benefit from such communications, and the research of EPA would become much better known by the scientific world.

Equipment

The laboratories were well equipped for carrying out bioassays, culturing of organisms, and chemical analyses. Considerably more equipment will be needed at most of the laboratories if community and ecosystem studies are to be carried out.

Library

The library facilities were adequate at most of the laboratories for the present programs. If ecological studies are undertaken some expansion in books and journals will be needed. In all cases library facilities could be improved by better exchange with local libraries.

Programs

The bioassay programs have reached a high degree of sophistication and the results are well respected by the scientific world. They could be improved in some cases by careful planning so that the results would have more applicability in natural ecosystems. For example, this could be accomplished by the use of local species and the incorporation of some of the more important ecological variables.

The EPA methodologies for culturing a large variety of organisms are widely used by the scientific world. Culturing programs should be encouraged and the methodologies made easily available.

It was in the consideration of community and ecosystem studies that the need for careful designing of experiments was most evident. Such planning must include the following: what are the questions the experiment is trying to answer? Is the

experimental design for sampling and analyses adequate to determine a sufficient degree of confidence in the results? Are the species and ecological variables incorporated in the experiment of the type necessary to produce predictable results in the natural world where the tested pollutant will occur? Because community and ecosystem studies are expensive and time consuming, it is essential that the most up-to-date ecological insights be brought to bear in designing and executing such studies. Talents from within and outside the Agency should be used.

Since ecosystem studies must extend over several years the EPA might develop an ongoing relationship with various academic institutions. They might use as a model the relationship between the U. S. Department of Agriculture and Land Grant Colleges which has been so successful for research programs concerned with food and fiber production.

Productivity

In general it was believed that the productivity of the scientific investigators should be improved and should be comparable to fellow scientists' at universities. Publication in refereed journals should be encouraged, and peer review (including outside reviewers) should be instigated for EPA reports. Some of the Committee members thought it wise to start an EPA scientific journal.

RECOMMENDATIONS

I. The Agency should emphasize community and ecosystem studies. These studies should be carefully planned with a theoretical base, making sure that the right questions are being asked and the design of the program is to answer these questions. The directors of the proposed programs as well as expertise outside of the Agency should be involved in the planning. A peer group of scientists inside and outside EPA -- probably those involved in the designing of the program -- should review the program at frequent intervals and be willing to advise as to the best execution of the program. Since such studies require a team of scientists, it is important that each scientist be well trained for the segment of the work he is to carry out. The need to include ecologists in such teams is self-evident. Statisticians and mathematicians capable of setting forth modeling principles

should be involved in the overall design and in setting up procedures for such programs.

Whereas the facilities for bioassay work and culturing of organisms were excellent, special facilities must be added if community and ecosystem studies are undertaken. For example, experimental watersheds, streams, and estuaries should be established in selected natural environments. Great care and forethought should be given to the selection of these ecosystems, and the advice of numerous experts should be sought.

There is a strong research program in aquatic ecological studies in the laboratories we visited. More emphasis should be placed on terrestrial studies, particularly on how changes in the use and management of watersheds affect not only the fauna and flora of the watershed but also of the entire drainage basin.

II. The Agency should determine in what ways it should change its means of operation so that leaders in the scientific fields pertinent to EPA research would not only be attracted but would wish to remain and build their reputations in EPA laboratories. Such permanent scientists would attract bright young people and thus highly respected centers of research would evolve.

III. Communications of several sorts within and outside of the Agency need to be improved. Scientists in the laboratories should communicate freely about their programs with each other as to design and progress of work. The EPA scientists should be encouraged to communicate with scientists in academic institutions and in industry by visiting other institutions and by inviting scientists from outside groups to visit their laboratories. Such communication can also be enhanced by seminars, symposia, more frequent use of consultants, and staff attendance and participation in scientific meetings.

Communications can also be improved by publications. In-house reports should be given wider distribution, perhaps by the establishment of an EPA journal. All such reports should be subject to peer review of scientists within and outside of the Agency such as is the custom in scientific journals. EPA scientists should be encouraged to publish in the open scientific literature.

IV. The bioassay program could be made more effective by studying species that are characteristic of various types of ecological conditions; by studying the interaction of commonly occurring pollutants; and by including naturally occurring

environmental variables in the design of the bioassays, i.e., variations in day length, diet, and seasonal variations in temperature.

In the case of special projects and/or crisis situations, qualified ecologists should participate in the planning phase to assure that the research produces the best essential information for the needs of the Agency.

The Agency has a wealth of good data from bioassay tests. This should be carefully reviewed to determine if predictions can be made as to how specific classes of chemicals will affect various groups or organisms.

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PREFACE

In a letter of April 8, 1975, to Dr. Ruth Patrick, Chairman of the Ecology Advisory Committee of the Science Advisory Board (SAB), from Dr. Wilson K. Talley, Assistant Administrator for Research and Development, Dr. Talley states as follows:

> "It is essential that this Agency be assured that the scientific support for its regulatory actions is sound. The scientists who compose our laboratories and the research they conduct are key aspects of this support. In recognition of this, the National Academy of Sciences and other sources have suggested that the Agency, in addition to conducting administrative review, independently appraise the quality of its scientific programs. For some time I have intended to follow through on this by seeking a Science Advisory Board critique of the quality of EPA scientific programs, but I have delayed due to the impending reorganization of my Office. However, your Committee's visit to Gulf Breeze creates an opportunity in this regard that should not be passed by."

Dr. Talley goes on to say:

> "Thus, as the Committee conducts its study of the Gulf Breeze program, I would like to have them do so with the anticipation of eventually preparing for my use a critique of the scientific quality of all my ecological research programs. In order that this critique be consistent with the broader study which will be conducted under SAB auspices, I would like to suggest that the Committee use the same value criteria in preparing its critique as are projected for the rest of the Board."

The following are the value criteria that Dr. Talley suggested the Committee include in writing the report:

- Products of research

Are publications and reports significant, adequate in quantity, of scientific value? Are research products meaningful to EPA's role and of suitable scientific impact?

- Research Scientists

  Are the backgrounds and disciplinary mix of staff appropriate to the need?

- Scientific environment

  How adequate are both scientific and reference resources? Is there appropriate cross-fertilization among the on-site scientists? Within the scientific community?

Dr. Talley noted that, although there have been numerous administrative reviews of the Office of Research and Development, no comprehensive scientific review of this type has been conducted since the formation of the Environmental Protection Agency. He also pointed out that the Committee's work will be helpful to him "if the Committee confines its evaluations to its study of the current activities and past products of the laboratories rather than addressing programmatic gaps or problems in research priorities not truly relevant to the scientific quality of the program." (APPENDIX A)

In order to respond to this request, the Ecology Advisory Committee decided that these evaluations should be made by the full Committee and that each laboratory with major program emphasis on ecological research should be visited by Committee members as a group. Field Stations of each Laboratory would be visited. Should any field stations not be visited, an opportunity would be provided for presentation of their respective programs. The visits should include briefings by the Laboratory Directors and key personnel and by the Chief or Director of the respective Field Station. These briefings would be followed by individual conversations and discussions with the staff in their laboratories. Background and informational materials were provided to all Committee members including 132 individual biographies prepared by individual staff members, publications selected by the staff member and other publications, laboratory reports, laboratory publication lists, staffing information. Material provided to the Committee is listed in APPENDIX B and APPENDIX C.

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Visits were made in conjunction with announced meetings of the Ecology Advisory Committee to the Environmental Research Laboratory, Corvallis, Oregon; Environmental Research Laboratory, Duluth, Minnesota; Environmental Research Laboratory, Gulf Breeze, Florida; and Environmental Research Laboratory, Narragansett, Rhode Island. The following Field Stations were visited: Bears Bluff Field Station, Wadmalaw Island, South Carolina; Monticello Field Station, Monticello, Minnesota; Newport Field Station, Newport, Oregon; Western Fish Toxicology Station, Corvallis, Oregon. Presentations were made by staff from the Newtown Fish Toxicology Station, the Arctic Field Station, and the Large Lakes Research Station. It should be noted that the Western Fish Toxicology Station, which had been a field station of the Environmental Research Laboratory -- Duluth, was transferred to the Environmental Research Laboratory -- Corvallis, effective July 1, 1975. The Large Lakes Research Station (Grosse Ile Laboratory), formerly responsible to Corvallis, became a responsibility of the Duluth Laboratory, effective July 1, 1975. See APPENDIX D.

Not included as a part of this evaluation are the visits of one Committee member to the Environmental Research Laboratory in Athens, Georgia, and one member to the Environmental Monitoring and Support Laboratory in Las Vegas, Nevada. The purpose of these two visits was to assure the Committee's awareness of the ecological related research being conducted by these Laboratories.

The final report includes an evaluation of EPA's four major ecological research laboratories, Environmental Research Laboratories -- Corvallis, Duluth, Gulf Breeze, Narragansett, and the majority of their Field Stations. The first part of the Report presents a general evaluation of the administration and staff, facilities, programs, and products of research, and includes recommendations. The second part presents specific evaluation of each Laboratory.

INTRODUCTION

Since this Report was written by the Ecology Advisory Committee of the Science Advisory Board, it is therefore appropriate to outline the ecological framework that provided the perspective for the Report.

Since the environmental crisis has emerged as a major, global problem, man's attitude toward ecology has changed. He is now forced to make compromises between his desire to exploit the earth's resources and his desire to maintain his quality of life. To be rational, these compromises must be grounded on scientific fact and prediction.

Study of ecosystem structure and functioning can guide scientists to those organisms or processes of an ecosystem that are most vital as well as most vulnerable to changes in environmental quality. Such studies may enable the scientist to recognize the degree of change that can serve to predict the consequences of various types of perturbation. These results are basic to define and maintain environmental quality in natural ecosystems.

Ecology is the scientific discipline that devotes itself to understanding the abiotic and biotic components of natural and perturbed environments and how they function. A major objective of ecological research is to provide an understanding of the multitude of components involved in the structure and functioning of ecosystems. Such knowledge provides a basis to predict the effects of various impacts on these systems. Ecology is, therefore, partly a system science and deals with many levels of organization. Ecosystems, communities, energy flow, nutrient cycling, population dynamics, adaptation -- these phrases all denote complex interactions between abiotic and biotic parts of the environment. To understand these processes, man must consider both synthetic and analytic aspects of ecology. Ecologists use analytical techniques to dissect and expose critical parts of a system, and synthetic techniques to learn how the system works as a whole. Like organismic biologists who believe that an organism is not simply the sum of its parts, ecologists believe that the functioning of ecosystems may be different from that expected simply by knowing the reactions of individual species to their environment.

To achieve an understanding of ecosystem complexities, ecologists employ several approaches involving studies of single species, populations, communities, and ecosystems. The single species

approach, where effects of environmental factors on single species are explored, has reached a high degree of sophistication. This is exemplified by the ecological research of EPA laboratories on lethal and sublethal concentrations of heavy metals or pesticides on brook trout and largemouth bass. Research of this kind is yielding valuable and dependable results.

The next level of complexity is the study of communities, assemblages of plants and animals. Environmental alterations may produce changes in communities, such as shifts in abundance, kinds of species, and number of species. Such shifts may be used as indices of community changes. This approach has been useful in studying effects of water pollution on aquatic organisms and effects of air pollution on plant communities. Community responses, however, have not been exploited as much as single species approaches and deserve more attention. EPA, although knowledgeable of the important research concerning composition and abundance of species as indicators of pollution, has not used this kind of research in proportion to its proven value.

Ecosystem research strongly emphasizes interactions between living and non-living parts of the environment. The characteristics of ecosystems that have received considerable attention are efficiency of energy flows; indirect effects of the functioning of one group of organisms on another; and the cycling of nutrient and toxic materials. If these functions are altered by pollution, then changes in species interaction and ecosystem properties inevitably occur. A chemical such as dieldrin in minute amounts affects vision of fish and prevents schooling, which is dependent upon sight recognition. An individual fish may be far more susceptible to predation than is a school of fish so that a minor behavioral effect may have a major consequence.

A second example is the effect of a physical condition, such as temperature, on the food of a desirable species. Many herbivores in streams prefer diatoms. These dominate natural communities in most streams that have not been severely perturbed. However, if the temperature is raised to and maintained at about 33 degrees centigrade, or if abnormal concentrations of trace metals are present, often algal populations will change from those dominated by diatoms to blue-greens. Since many species of blue-greens may be toxic and for most organisms constitute a less preferred food, herbivores will starve or produce runts with lower fecundity.

A third example is the change in toxicity of a chemical due to shifts in pH. This change in pH may be brought about by altering

the chemical composition of water or by activity of organisms. It is easier to correlate the shift in pH with change in chemical composition with biological activity. For example, ammonia becomes toxic as the un-ionized form increases. It is well established that the un-ionized form increases as the pH rises above 7. In naturally healthy streams that are somewhat eutrophic, there will be extensive plant growth during the spring, summer, and fall. Often photosynthesis is so rapid, particularly in algae, that pH of the water rises rapidly from about 7.0 to about 9.0 during midday. Thus ammonia during night and early morning will be in an ionized state and a nutrient rather than a toxic substance. However, in midday, because of phytosynthesis, it may become toxic. Thus, algae may produce toxic conditions for fishes under concentrations of ammonia that would be harmless if algal photosynthesis were less. The problem of un-ionized ammonia in midday is not nearly so great in streams where there is high turbidity and less algal production.

A fourth example is generation of oxidants, of which NOx and hydrocarbons are precursors, that have undesirable effects on plant and animal life in ecosystems. These oxidants, either gaseous or carried on airborne particulates, may be transported by wind and rain long distances from the point of origin and enter many kinds of biotic communities. Acid aerosols may change pH, altering the leaching quality of a soil and affecting plant micro-environments; they interfere with photosynthesis, produce deleterious cell compounds, change water balance in cells, and injure delicate cellular structure such as membranes, stomata, seed producing organs, and pollen. One result is crop damage, or to put it more broadly, reduced primary production. Another result, potentially even more serious, is the deleterious effects on herbivores, carnivores, predators, and decomposers. Finally, they can affect aquatic ecosystems through contamination by soil erosion, surface water runoff, and underground water flow.

The study of ecosystems is a complex undertaking. It not only requires a thorough familiarity with the science of ecology, but also demands natural history knowledge of organisms making up the system; physical and chemical properties of the system; and ability to express mathematically interactions among biological, chemical, and physical elements.

In conclusion, ecological approaches offer EPA several ways to measure pollution effects. There are many parameters by which the effects of perturbation can be measured; i.e., biogeochemical cycling of nutrients and toxicants, interaction of populations, predator-prey relationships, effects of one ecosystem on another,

and the effect of individual ecosystems on the biosphere. Ecosystems are open with respect to energy and nutrient flows. Thus changes in outputs from one ecosystem will affect adjacent ecosystems. There are also different methods of analyzing effects on single species population, community, and ecosystem studies. Knowledge of the value of various approaches enables the Agency to choose the appropriate ones in order to evaluate specific kinds of man-made environmental change.

This report is largely a consensus of the Committee's observations. More detailed study requires follow-up visits to the laboratories.

I. GENERAL FINDINGS AND RECOMMENDATIONS

Evaluation of EPA's Environmental Research Laboratories -- Corvallis, Duluth, Gulf Breeze, Narragansett, and their Field Stations -- was performed with the objective of determining the quality and quantity of research as it relates to short-term and long-term objectives of EPA. It was also directed toward determining the quality of the staff carrying out this research. The Committee feels that high standards are attainable and maintainable to the extent that the Agency addresses itself to long-range fundamental environmental pollution problems with capable people; strong, carefully planned and integrated programs; outstanding facilities; adequate resources; and a stable organization unfettered by too frequent reorganizations. Of special importance is a healthy administrative climate that fosters and stimulates an intellectual environment characterized by an opportunity for personal reflection; group interaction; active participation in at least initial decision-making and goal-setting processes; and freedom from unreasonable simultaneous demands in multiple directions. If the Agency with a stable administration conducts well planned, long-term, base-line research along with fire-fighting operations it can achieve greater stature in the scientific and public worlds. A healthy administration and stability of organization can attract talented scientists and supporting staff.

I. A. ADMINISTRATION

1. LABORATORY DIRECTORS

All Laboratory Directors are able, articulate persons with a deep dedication to meeting goals of EPA. Each of them is a lucid salesman and a credit to the Agency. They do, however, vary in their ability as administrators that in turn affects productivity at the Laboratory.

There seems to be excessive centralized direction from EPA Headquarters, particularly with regard to placement of individuals, shifting of personnel groups, reacting to pressures from Congress and the public, reordering of emphases, and reassignment of areas of investigation, sometimes with little regard for geographic location or distance from parent laboratory. There also appears to be insufficient coordination of activities resulting in unnecessary duplication of effort among the Laboratories visited and other agencies with similar scientific programs. Through communication with Headquarters and direct discussions with each other, Directors could help to minimize unnecessary duplication of research and development. They need to make a major effort toward long-term planning and development of goals.

Some assignments of responsibilities by Headquarters seem arbitrary, unwieldy, and costly. For example, assigning the problems of the New York Bight to the Corvallis Laboratory instead of the Narragansett Laboratory increases travel time and costs and makes coordination more difficult.

It is also evident that Laboratories, and some of the Field Stations, do not participate sufficiently in formulation of decisions concerning their scientific work. Such participation would contribute to the quality of investigations, morale of the investigators, and would be helpful to directors of Field Stations. The scientific staff in company with the Directors of the parent laboratories share a concern for the future of EPA.

One cannot over-emphasize the importance of the Agency's fostering and stimulating an intellectual environment appropriately conducive to creditable achievements. The Committee recognizes the primary responsibility within EPA to respond to crises and to answer immediate questions relative to the Agency's legislative mandates. The Committee,

however, believes that it is practicable to do the necessary applied research while also supporting basic ecological research. In addition, the Committee believes that better scientific insight will provide more efficient means of responding to EPA's short-term goals. Obviously these suggestions indicate the necessity of long-term planning, importance of continuing basic research by ecologists, and the value of stimulating an intellectual environment developed by better communication with outside scientists. Over the years if such research is not allowed, a debilitating atmosphere may result in attrition of the best scientists, leaving a cadre of civil servants of less than mediocre quality -- a certain way to degrade the quality of research programs.

2. LABORATORY STAFFS

A large part of the success of a laboratory is dependent upon interaction between the Laboratory Director and his Staff. The Committee evaluated effectiveness of Directors by looking critically at facilities, productivity and qualifications of the staff, morale, and creativity of researchers.

Ability and performance among laboratory personnel varied very widely, from a relatively few outstanding scientists to a large group of average workers, to a scattering of mediocre persons.

Morale and enthusiasm also varied widely, from very high to very low. The low morale undoubtedly reflects, in part, insecurity and uncertainty resulting from frequent organizational changes, resource constraints, and perceived loss of status from reorganizations. Morale, and thus productivity, could be greatly improved by better communications in planning and collaborative decision-making involving Headquarters, site-directors, and their staffs.

The practice, common in the laboratories for some time, of hiring temporary employees who must leave at the end of the year, should be used sparingly and only for special purposes. The Committee is aware of position ceiling constraints on the Agency. Intensive effort on the part of the Agency to minimize this practice that is so scientifically costly to the productivity of the Agency's research programs, would improve operational as well as scientific effectiveness.

The ratio of back-up staff to Ph.D's was variable among the laboratories visited ranging from approximately 1.3 to 4.0. However, a staff to Ph.D. ratio for the laboratories is a somewhat meaningless statistic unless the type of work being done is also taken into consideration. In general microbiological laboratory work requires fewer back-up technicians than does ecosystem field work; deepwater ecosystem research activity requires more extensive logistic support in terms of both field and laboratory back-up than does a terrestrial ecosystem study. In general, the quantity of back-up support appeared to be adequate but in some cases quality was not.

The most serious and conspicuous deficiency among the laboratories was the extremely limited number of Ph.D. ecologists. In contrast, physical sciences and engineering appeared to be adequately represented. Chemistry, especially analytical chemistry, is of high quality and has contributed significantly to research and development of methodology.

It is also necessary that each laboratory have at least one person expert in the statistical aspects of program design. The Corvallis Laboratory was adequately staffed in this regard; others were not.

Staff members are dedicated to their research, and in some instances, are well trained for specific assignments. In other situations because of the ceiling on positions and freezes on hiring, certain program leaders supervised research for which their training and experience are inappropriate. Because of reorganizations, for example, younger staff find themselves under the leadership of senior scientists who are good technically, but not especially imaginative. Understandably, this situation creates low morale and causes friction. Occasionally situations develop where scientists and their assistants no longer function as effectively as they might because of a lack of familiarity with newer techniques. Remedial options should be available. Opportunities to participate in refresher courses or new course areas, "sabbatical" leaves to gain further knowledge and experience should be routinely provided.

Effectiveness of the staff relative to accomplishment of assigned work would be improved if researchers had an opportunity to complete projects underway before being reassigned to another program. Completing a project involves

finishing experimental work, analysis and interpretation of data, and preparation of draft reports.

Another factor that lowers morale is employment of many technical assistants as temporary appointees. The situation also requires continual re-training and is thus wasteful to research.

There is excellent communication up, down, and laterally in the staffs of Gulf Breeze and Duluth. This was not so evident at Corvallis. At Narragansett the Committee had a chance to talk with only a few of the staff, most of them younger people, and therefore could not determine the effectiveness of communication.

Communication with academic institutions and other EPA laboratories is variable. Such communication seems poorly developed at Corvallis, fairly well developed at Gulf Breeze and Narragansett, and best developed at Duluth.

3. RECOMMENDATIONS

- Much greater effort should be devoted to development of long-term goals and research plans. Environmental impacts on entire ecosystems (e.g., watersheds) should be considered. It would be desirable to have informal discussions between cognizant EPA researchers and representatives of the scientific community during formulative stages of such plans, referring plans to the appropriate committee when draft plans are available for external review.

- Much more coordination of programs between EPA, other Federal agencies, and/or academia at the worker level should be developed. The U.S. Department of Agriculture (Agricultural Research Service and Cooperative State Research Service) cooperates with the Land Grant College System and other Universities and agencies capable of conducting agricultural research. This cooperative system could serve as a model for EPA.

- Greater communication with nearby universities and other academic institutions should be established; staff should be encouraged to visit other laboratories engaged in similar or related work; and seminars involving outside persons knowledgeable in the program areas of the respective laboratories should be introduced or increased.

- An effort should be made to reallocate positions ("lift the ceiling on hiring scientists") in order to employ particularly well-trained ecologists, statisticians, and individuals familiar with computer techniques. An alternative -- although certainly less desirable -- is to utilize vacancies for this purpose as they occur.

- Temporary appointments of scientific staff should be kept at a minimum for technical personnel and alternatives sought, except for well-trained people from universities and other appropriate organizations who come in for a year or two -- a catalytic activity the Committee strongly endorses.

- An aggressive effort should be made to secure scientists and technologists from minority groups and to assure that they are represented in the scientific work of the Laboratories. An effective method for recruiting minorities is that employed by the USDA Soil Conservation Service.

I. B. FACILITIES

1. LABORATORIES AND FIELD STATIONS

It is important to realize that the Laboratories and Field Stations visited by the Ecology Advisory Committee were established for varied and rather specific purposes. Each one should be evaluated relative to the purpose for which it was established, its suitability for its current responsibility, appropriateness of equipment and staffing, and its future potential. One should not expect to find the same equipment or an equally wide spectrum of staff interest and capability at a field station as one would find at a major research laboratory.

EPA's ecological research laboratories and field stations are located on very good to excellent sites for their missions. Three of the four major laboratories have the capacity for both marine and freshwater studies; all could undertake terrestrial ecosystem studies. Satellite field stations expand the capabilities of each major laboratory in important areas.

While there is a natural tendency to expand to fill available space, most of the laboratories are designed to accommodate a larger staff than is now provided. No major space problems were encountered, except at Narragansett where this situation is being corrected. This availability of space provides the opportunity for visiting scientists to work in the laboratory and contribute to better communication with the scientific community.

An example of a location not adequately used is the Newport Field Station. It is ideally suited for studying the marine biota of the cool Northwestern area. Existing studies do not justify the need for the Station, but considering the larger requirements of EPA, it could fill a valuable role. The Station has the advantage of sharing a common site with the Oregon State University Marine Laboratory that could offer expert advice on local fauna. The Western Fish Toxicology Station, could perhaps profitably transfer some of its operations to Newport. If Newport is to be retained and made a viable entity, it would best be associated with the Western Fish Toxicology Station and their research programs coordinated.

Monticello Field Station was carefully planned, construction is completed, and it is a potentially very valuable facility. The experimental stream channels are exactly the kind of a facility that EPA should use effectively. Since the research program is in the planning stage, advantage should be taken of the opportunity to subject program plans to peer review so as to utilize the full potential of this facility.

Bears Bluff is properly associated as a field station of the Gulf Breeze Laboratory, and is ideally situated for this purpose. The completion of much needed improvements will contribute to its versatility for research.

The diversity of field stations affiliated with the four major ecological research laboratories and other field situations offer opportunities for field testing of laboratory derived information and related ecosystem studies. Provision to utilize these field stations and laboratories for such studies in natural environments should be included when program plans are being developed. It is unlikely that these facilities will always suffice for implementing population and ecosystem studies in the field.

These facilities could also serve as a source of training and experience for qualified graduate students. Such training could be geared to a period of time compatible with the graduate student's school. Duluth, Corvallis, Gulf Breeze, and Narragansett all have some informal efforts along this line. EPA should be much more aggressive in this regard, especially at Corvallis.

2. EQUIPMENT

EPA laboratories and field stations visited are, without exception, supplied with high quality equipment for the work they are now doing. In-house shop facilities for design, maintenance and construction and/or modification of equipment are excellent and the associated staff is very competent for the job that they could be expected to perform. Although the equipment is good for laboratory studies, it is not good for field studies. Field studies require different equipment.

3. LIBRARIES

On-site libraries range from good to less than adequate. There is a strong reliance on nearby universities, colleges,

and medical centers library facilities that range from good to excellent.

The objective of on-site EPA libraries is not to maintain or build large, independent collections, but to serve members of the local group with important books and journals of specialized interest; to act as a contact between EPA personnel and local or regional libraries; and to serve as the local contact for the highly progressive Federal library system; i.e., the EPA Headquarters Library.

EPA Headquarters Library acts as a back-up for library services not available at local libraries and provides guidance to, and promotes coordination among the 28 Agency-wide libraries. It provides all services that can be expected of a first-class, all-service, sophisticated library system: interlibrary loans, foreign language translations, literature searches from 25 (at present) computerized data bases. It also is responsible for the U.S. participation in the United Nations Environment Program International Retrieval System.

These library services are available to everyone in EPA needing them, but at some cost in certain instances. The library service is excellent and there should be no literature deficiency among scientists in EPA, but the Committee's discussion indicated that workers were often unaware of critical literature.

Library services, as well as laboratory space and equipment, are well provided within EPA and cannot be considered limiting factors to the quality and quantity of EPA research.

4. RECOMMENDATIONS

Priority should be given to providing facilities necessary to implement population and ecosystem studies in the field. Consideration should be given to utilizing existing field sites, stations and other Agency laboratories. Experimental watersheds, lakes, streams, and estuaries should be established in selected natural environments.

I. C. ECOLOGICAL RESEARCH PROGRAMS

Scientific programs carried out at major ecological research laboratories and their satellite field stations fall into the following categories: bioassay, culturing of organisms, ecological studies, and various special programs such as the Lake Eutrophication Survey, the Grosse Ile Laboratory Studies, and the Sludge Disposal Program. In evaluating these categories of research, the Committee considered, among its criteria, quality of research, quantity of research, relevance to the Agency's immediate needs as expressed by EPA researchers, and relevance to understanding ecosystems. Research planning, implementation of the research plan, and results of respective programs are discussed.

1. BIOASSAY PROGRAMS

Bioassay research in EPA laboratories is stimulated to a large extent by the regulatory needs of the Agency and is one of few sources of numerical data upon which the regulatory arm of the Agency can depend. For this reason the Agency has to conduct bioassay tests using many kinds of chemicals, a great variety of organisms, and various environmental parameters. In addition, bioassay data provide a basis for effluent standard setting. From the point of view of understanding ecosystems, it is also important to understand tolerance levels of organisms for various perturbations, whether they are natural or introduced.

The extent to which laboratory-conducted bioassays can be extrapolated to field conditions is unknown. Field tests of laboratory results are badly needed. To date the EPA ecological research laboratories have responded well to the complex questions posed by bioassays, and have thoroughly explored application of data gained through the technique.

Bioassay tests were being carried out at all laboratories and each recognizes the importance of using appropriate test organisms and the necessity for conducting studies covering the entire life histories of organisms. Greater attention to this area was observed at Duluth, Gulf Breeze, and Narragansett.

a. Planning

It was evident to the Committee from visits to the Laboratories that considerable thinking at a

sophisticated level had directed much of the bioassay research. This was particularly true with aquatic bioassays and to some extent with assays of terrestrial organisms. The EPA scientists are currently considering the problems related to the expansion of laboratory bioassay data to field situations to include possible synergism of various toxicants and ecological factors; and reproductive, developmental, growth, and behavioral responses. They are also questioning whether such bioassay work should be validated in tanks, microcosms, or in larger community modules.

EPA's regulatory needs for numbers from bioassay data also influence the planning of bioassay research. The Committee gained the impression that immediate regulatory needs are, of necessity, influential on planning of bioassay activities. Sound, basic bioassay research capable of yielding greater generality of results is sometimes sacrificed for obtaining quick answers.

Since assay of the environmental toxicity of a potential hazard varies because of different ecological conditions characteristic of various parts of the country, it is desirable that all laboratories participate in this aspect of the program. However, the staff carrying out the studies at the laboratories should meet at frequent intervals and make an overall plan of important questions to answer as well as critiquing program plans of the individual laboratories. Undoubtedly this is done to some extent, but more of this activity is desirable.

b. Implementation of Plan

The bioassay programs at each of the laboratories visited involve both acute and chronic tests. In these chronic tests, morphological, histological, physiological, and behavioral effects are examined. Generally, chronic studies cannot be conducted without data at hand from acute studies.

Bioassay experiments are generally well designed, and are often conducted with the most sophisticated of equipment. Scientists involved in this work appeared to be aware of the quality of their data and their application. Given the uniqueness of each Laboratory's set of responsibilities, the demands for specific types of bioassay, and knowing the problems associated with

successful laboratory culturing of various species overtime, it is not difficult to understand why the numbers of species used are limited. Species are selected because they are economically important or readily available and more easily cultured. However, there is no rationale in selecting test organisms -- a set of research organisms at one laboratory was not used at the field station. Little bioassay work appears to concern algae and aquatic plants in general; a limited amount involves terrestrial plants and animals; and only a modest amount concerns invertebrates. Projects on invertebrates were scattered among Laboratories. Laboratory reports, lists of scientific publications, and other background material, however, show that the Laboratories have completed or have research underway on a greater diversity of species and life forms than observed during the Committee's visit. More attention needs to be given to the selection of assay organisms to provide test species adapted to general conditions in the target environment yet provide a reasonably small list of species to permit reproducibility and comparison of results.

One feature lacking in most bioassay research is testing for chemical characterization of the receiving media and determing concentration of the test chemical during the tests. Investigators usually knew what was in tests at the beginning of the experiment and often at the end, but did not know rates of change during tests. This, of course, can easily be corrected.

c. Results of Research

Bioassay tests result in generation of useful data for the regulatory purposes of EPA. When interpreted by scientists whose research produced them, the data are solid but limited. These data, nevertheless, provide a basis for EPA's regulations. Acute bioassay tests have some utility for comparative purposes, but chronic tests using sublethal concentrations of the toxicant are much more valuable. In addition, it is important to determine the effects of toxicants on all stages of the life history of test animals and plants and to determine sensitivities of test organisms under other than optimal conditions. In most bioassay work, test organisms are reared under optimal conditions of food and physical environments and no predators are present. In most real

environments, conditions of temperature, moisture, food, and predators are less than ideal and organisms can be expected to be more sensitive to toxicants under these conditions than under the ideal ones of the laboratory. Slight debilitation due to a toxicant might greatly affect the ability of an animal to avoid its predators, thereby producing a major populational effect when laboratory tests indicated no significant response. Thus, current laboratory bioassay procedures are biased against showing significant negative effects, and ecologically important changes may result from levels which now appear to be trivial.

It is a concern of the Committee that a great deal of data was being generated but not thoroughly analyzed, especially at Narragansett. The Committee understands that under the Science and Technical Assessment Reports (STAR documents) a literature review has been initiated to determine the state of the art of bioassay work for specific toxicants. Once these data are brought together, great care should be taken to analyze them to determine if any predictive statements can be made concerning the action of various groups of chemicals under different ecological conditions. In other words, is it possible to develop generalizations that can be used to predict the effects of an untested chemical based on its structural similarities to other chemicals. A commitment of resources and manpower to explore and develop this capability would be a promising approach potentially capable of yielding great savings of time and energy. Such studies may reveal short-cut methods, or may show gaps in existing knowledge using present techniques that ought to be filled.

2. CULTURE PROGRAMS

Species that can be reared in the laboratory are important tools for research. Furthermore, utilizing all stages in the life histories of species is essential to production of reliable information on long-term effects of perturbations. To yield at least limited generality of bioassay results, it is also important that ecological concerns be involved in the selection of species for which to develop culture techniques. In nearly all receiving environments there are rapidly growing species that attain reproductive maturity quickly and others that have long pre-reproductive periods. Some species feed low on food chains and others higher up. Some are

naturally tolerant of wide variations in physical conditions and others survive under only a narrow range of conditions. There are strong reasons for believing that these different types of species will respond differently to various toxicants and that this variability of response is central to understanding the effects of these toxicants in natural ecosystems. Therefore, it is important to seek out species of differing ecological characteristics and to develop culturing techniques for them. These species can at least provisionally be regarded as representative of a class of species for which the results are likely to be applicable. This approach offers the best possibility of detecting unexpected effects of toxicants and for being able to generalize from one environment to another and across species lines.

Culture programs are being carried out at all of the Laboratories. A high degree of success in culturing a number of species through their life cycles has been accomplished and others are being demonstrated. Methods of culture are modern, including attention to pathology and nutrition. Test organisms for bioassay may be important aids in ecosystem studies in the field where there is no control over nutritional requirements or disease. The Committee regards culture of native species as very important in evaluating the effects of pollutants on local receiving environments. By employing genetically homogeneous stocks, bioassay tests will become more sensitive and more dependable. Although repeatable, they may not be as representative of the environments.

The search for more representative species of fish to culture than the hardy, tolerant goldfish (Carassius auratus) has resulted in the rearing of several other species from egg to egg in the Laboratory. An inbred strain of the warm-water fathead minnow, Pimephales promelas Rafinesque, which is widely distributed in the eastern and midwestern United States, is now available for testing on a year-around basis. A species of the southeastern United States, the sheepshead minnow, Cyprinodon variegatus Lacepede, is also under intensive laboratory culture. The sensitivity of all stages of the life history of these species to diverse conditions of stress can be tested, a great advantage over older techniques employing only adults.

The fathead minnow has not been adopted in EPA laboratories as a standard test animal, but in practice it is used as

such. Other fishes are now cultured to serve as supplementary material. By controlling food intake, light, temperature, space, and toxic metabolic waste products, the bluegill, Lepomis macrochirus Rafinesque, can be reared from egg to maturity in approximately four months. This capability was undreamed of ten years ago. At least five additional freshwater species have been spawned in laboratory holding tanks. More developments of this kind can be expected as the Laboratories gain experience with their newly found techniques.

The Committee noted that work on the culturing of algae was being done only at the Narragansett Laboratory. Although algae are widely used elsewhere in bioassay work, such tests were not observed at the Laboratories visited.

The success in rearing species in the laboratory is a major and creditable achievement for the Agency, and one that has not received the publicity that it merits. This work should be continued to develop a broader more useful spectrum of sensitive species for more effective bioassay methods for potential toxicants, to provide genetic information on variability of test species, and to form the basis for intercomparison of experiments and results.

An outcome of an international symposium, Cultivation of Marine Organisms and Its Importance for Marine Biology was a publication, edited by O. Kinne and H. P. Bulnheim, in Helgolander Weiss. Meeresunters., Volume 20, pages 1-721, in 1970. This may be the time for EPA culturists in collaboration with other culturists from appropriate organizations and institutions to organize a symposium on laboratory culture, particularly on organisms of freshwaters, and updating information since 1970 on marine forms with a view to publishing the papers -- carefully reviewed and edited.

3. COMMUNITY STUDIES

EPA laboratories are just now initiating studies of communities, assemblages of interacting species of organisms. A great deal of attention must be paid to the conditions under which these assemblages are studied and the species selected for the assemblages. Natural communities are subjected to regular seasonal patterns of temperature, moisture, and day lengths that have profound effects on the physiology and behavior of the constituent species. They

affect timing of reproduction, social behavior, foraging, and fat deposition, hibernation and estivation. Violation of these conditions, knowingly or unknowingly, can cause experimental results that are difficult to interpret or are meaningless in the context of the ecological communities in which we are really interested. In addition, the densities under which organisms are held may also affect such central ecological processes as growth rates, reproductive rates, mortality rates, migration and other movements. Under laboratory conditions these responses may be altered (reproductive rates) or entirely prevented (migration). Also, there is increasing understanding among ecologists that many of the stability features of natural ecosystems are the result of temporal and spatial heterogeneity, the patchiness of nature; and, of course, laboratory conditions minimize all forms of patchiness. For these reasons studies of ecological communities are difficult to carry out and interpret and require careful planning. This effort is, nonetheless, worth it because effects of perturbations on communities are the ultimate level of concern in preservation of environmental quality.

One approach now being used by EPA is to carry out community studies in microcosms, artificial streams, and bathtubs or containers that simulate lake, stream, or estuarine conditions. In artificial streams or ponds all environmental factors can be controlled and variations in quality and quantity of density independent factors made to match the natural environment as closely as possible.

Another approach is to study an aquatic community confined in a plastic bag and immersed in a natural body of water. These types of studies are the nearest to natural conditions of any studies encountered, but they are more closely representative of community systems rather than ecosystems. In these kinds of studies it is necessary to assure that the communities contained in plastic bags are as similar as possible to natural communities. Artificial streams and microcosms may also be established under as natural conditions as possible, using natural changes in light and temperature. In these community studies a great deal of monitoring is necessary in order to know the variations to which these experiments are subjected. The first approach is much more expensive in equipment; the second approach is more costly for sufficient research assistance to analyze the environmental conditions.

It is preferable that communities of organisms under study be those that occur naturally together because natural communities have evolved over time and consist of species that have adapted to each other. Results of forced interaction among arbitrarily assembled communities may not be similar to those obtained with natural assemblages.

The Committee observed community studies of three species at Gulf Breeze; plankton communities at Bears Bluff; and terrestrial studies at Corvallis; discussed microcosm and large bag studies planned at Narragansett; and visited the semi-natural stream facility at Monticello. The Committee is aware of the artificial streams at the Environmental Research Laboratory, Athens.

These EPA studies have only recently been implemented or are being implemented. In general, the experimental design for many of these experiments appears questionable, for example, the big bag experiment at Narragansett.

4. ECOSYSTEM STUDIES

The purpose of ecosystem studies is to understand movement of energy and materials through systems and to understand the processes that govern and control this movement. Through such studies the principles that provide the basis for stability and flexibility of the system under change are determined. As pointed out in the Introduction, the study of ecosystems is a complex undertaking and can not be effectively carried out unless accompanied by field studies of similar ecosystems. It not only requires a thorough familiarity with the science of ecology, but also requires natural history knowledge of organisms making up the system, the physical and chemical properties of the system, and the mathematical analyses of interactions among biological, chemical, and physical elements. The study of ecosystems is important for defining and maintaining environmental quality, for it can guide scientists to those organisms or processes that are both most vital and most vulnerable to changes in environmental quality. Potentially it can serve as a prediction of the consequences of environmental change or pollutant incursions and thus serve as a guide to environmental managers.

a. Planning

Scientists at all of the laboratories are interested in ecosystem research and are at least partly cognizant of the kinds of problems it poses. They also understand the relevance of ecosystem problems to the Laboratories' missions. Thus, the first step in the planning process has been implemented: the problem is recognized, and the importance of ecosystem approaches is acknowledged. Planning for ecosystem studies, however, is inadequate, and it is not up to the capability of the discipline. Effective planning requires closer interface with ecologists in other agencies and institutions.

b. Implementation of Plan

Implementation of plans has suffered from inadequate modeling, insufficient expertise in systematics, ignoring whole sets of organisms such as bacteria, inadequate physical and chemical interpretation of processes, and failure to exercise statistical approaches and analyses. On subsequent visits to the Laboratories, the Committee will develop these problems more specifically.

c. Results of Research

It is important to EPA to acquire powerful ecosystem tools. Some studies are providing more sophisticated insight to the complexity of ecosystems and thus to the danger of offering simplistic solutions to environmental problems. Because of the failure to conduct studies under natural conditions much has been learned about methodology but little beyond interpretive guidance has resulted.

Since the Committee observed no true ecosystem research, considerations that should be included in design of ecosystem investigations are disucssed in Appendix P.

5. SPECIAL PROGRAMS

Special programs are defined here as programs initiated to answer specific questions about environmental quality that are outside the routine activities of EPA laboratories. These programs can be small, short-lived efforts to yield quick answers, or they can be large-scale efforts mounted to attack a problem on a broad scale. The first category is

trouble-shooting to which the Committee will give only little attention. The second category is significant to formulating environmental policy, and, therefore, the Committee will concentrate here on large projects requiring a team effort.

a. Examples of Special Programs

The Committee observed a number of special programs of the Agency; comments are limited to three referred to as: the Shagawa Lake Project, the National Lake Survey (APPENDICES E AND F), and the Reserve Mining Case -- Technical Support. Each has in common the following characteristics: (1) a significant complex environmental problem was raised to which there was no simple, pre-formulated answer, (2) a large-scale team effort was required to bring many facets of the problem into focus, (3) each program combines both physical-chemical and biological inputs to solve the problem. These projects also have their individual characteristics to which reference is made in other parts of this report.

The Committee feels that, in general, large-scale projects have not been planned carefully and that this fact has been a major drawback to their overall success. The presence of well-trained ecologists on the staff would have mitigated this poor planning. Special programs have sometimes been initiated with goals that are too limited in terms of the investment in time and money. Because of time-pressure to finalize the program plan, planning is inadequate. The quality of planning should not be sacrificed by undue time constraints. Of the programs the Committee has chosen to cite, the Shagawa Lake Project is the best example. The project has suffered from a lack of peer review at the time of planning. The short-range goal of producing a low phosphate effluent and observing immediate effects on eutrophication should, in the Committee's view, have been a part of a larger plan to explore the long-term effects of various levels of phosphate in the Lake. The potential scientific contribution of the experimental facility that was built would be enhanced many times with a rather modest cost. The phosphate problem is enormously important over the long run, and EPA should have recognized much earlier that the Shagawa Lake facility has potential far beyond proving that a sewage treatment plant can be built to produce a low level phosphate effluent.

Sampling is a part of planning, but it is presented as a separate item in order to emphasize the problem, as illustrated by the National Lake Survey. Successful sampling depends on a clear definition of objectives for which the samples are being taken and on a continued input during the planning stages. In the case of the National Lake Survey, these two basic requirements were violated. See APPENDIX F. Lakes were selected on a different basis from one section of the country to another. At least some sampling was done in consultation with State agencies. Thus the problem recognized political units rather than natural units based on geological, climatological or some other categorization.

EPA has generated a large mass of information which has limited utility. In some cases generalizations have been attempted that are based on inadequate numbers or non-representative selection or samples. The Committee recognizes that some "quick and dirty" limnology of the National Lake Survey type has a place in the EPA program, but it deplores the sampling methods used to carry it out. In the future, the objectives of similar large-scale projects should be given more careful attention and the sampling should be adequately designed to accomplish these objectives.

The team effort among scientists in attacking large-scale programs is highly developed in EPA. The Committee was gratified to see chemists and biologists working side by side. It has been recognized for a long time that broad ecological problems must be handled in this way. No individual or small group of individuals can have the skills or equipment required to tackle large projects such as Shagawa Lake or the Reserve Mining Case. Biology and chemistry had to be developed simultaneously to evaluate the effects of phosphate on eutrophication and the effects of taconite tailings on Lake Superior. The fine display of team effort should be recognized as a major contribution of EPA to resolving ecological problems. Administrators in both the laboratories and in Headquarters should identify team effort as a major strength and encourage its growth.

b. Cooperation with Other Governmental Agencies

The Committee's investigations were not directed specifically to this type of cooperation, but the few

instances that were observed looked promising. The Committee learned, for example, that EPA activities in Alaska, particularly along the pipeline, are limited and that EPA ecologists rely heavily on the findings of other agencies for their regulatory activities. In this case, the EPA staff should certainly be augmented in order to cope with major environmental alterations. On the other hand, what small effort that could be brought together by the State of Alaska, U. S. Fish and Wildlife Service, and EPA demonstrated an effective cooperation among these agencies.

The Western Fish Toxicology Station has cooperated with several governmental agencies to investigate gas bubble disease in fishes that occurs below high dams in major Pacific Northwest rivers. The Committee's observations indicate that communication is very good among the National Marine Fisheries Service, Washington Department of Fisheries, U. S. Corps of Army Engineers, Bureau of Reclamation, Bonneville Power Administration, and the Western Fish Toxicology Station. It appears that research was divided among several (not all of the above) laboratories and that findings were shared as research progressed. Such cooperative effort between governmental agencies concerned with a common problem should be encouraged.

c. Cooperation among the EPA Laboratories

Efforts are being made for different laboratories to cooperate on large-scale projects. This is an encouraging sign, but such cooperation needs to be extended and increased throughout the laboratory system. For example, the Lake Survey program is shared between Corvallis and Las Vegas. According to the Committee's observations, communication is flowing in both directions.

d. Response to Crises

The reaction to major environmental crises is quick, as it should be to fulfill a part of EPA's mission. The Committee is impressed by the rapidity and intensity with which the talents of the Duluth Laboratory were mobilized for the Reserve Mining Case Technical Support effort. Rapid response to problems on PCB's, heavy metals, and insecticide pollution was evident in other Laboratories,

as well. The Committee recognizes the need to respond to urgent problems. Caution should be exercised in selecting problems for immediate attack. Response should not be at the expense of failing to think the problem through before making such a selection. Otherwise, the laboratories are distracted from other important functions and will become little more than trouble-shooting units. The Committee urges that quick response time and laboratory long-range objectives be preserved in EPA research planning.

e. Communication

In carrying out community and ecosystem research much more communication needs to be established between EPA and the community of research scientists in academia and in industry. Large-scale projects need close coordination and cooperation to achieve success, and this can best be accomplished if the various groups have input during planning stages.

f. Conclusions

Most of the positive aspects of EPA research on special programs lie on the side of technical capability. The ability to collect accurate data on a massive scale is unmatched and the quality of the data is good. The negative aspects of the special programs all point to the lack of participation of qualified ecologists in the planning phase of the process. This lack has resulted in poor definition of objectives and consequently poorly designed systems of collecting information. Inadequate planning has also resulted in short-term goals not oriented to broad scientific problem to which the program might contribute.

6. RECOMMENDATIONS

- Results from the aquatic bioassay studies should be reviewed by EPA scientists to determine if predictions can be made as to how specific classes of chemicals will affect various groups of organisms so that predictions can be made on the effects of chemicals that have not been bioassayed.

- More care should be taken in selecting kinds of organisms for bioassay by selecting those that live under diverse

ecological conditions and have different life history properties, rather than basing the selection solely on availability, suitability for culturing, or economic importance.

- Sound planning, on a theoretical base and including site selection, is essential for all studies and especially for the newer community and ecosystem programs.

- In the planning process, one of the most important parts of any scientific program is to make sure that the right questions are being asked. Greater use should be made of knowledgeable consultants and scientists in the laboratories. The use of models and bioassays are important in evaluating effects of perturbations on ecosystems and should be given adequate attention. Sufficient time is necessary for quality planning.

- Each of the laboratories should have at least one person experienced in the statistical aspects of program design.

- To validate laboratory conducted bioassay information for field situations, resources should be expended for field studies, including ecosystem studies. Biological stations could be used when field sites are needed on a temporary basis only. Priority should be given to providing facilities to implement studies in the field.

- Aquatic and terrestrial community and ecosystem studies should be undertaken on carefully selected sites (APPENDIX P). These sites should be maintained on a long-term basis. Initiating a periodic study on lakes in context of their watersheds or drainage areas would be advantageous to the Agency. Several lake-watersned areas could be selected in different parts of the country with different geologic substrates and developed into experimental basins. It is critically important that a highly trained team of EPA scientists with sufficient resources be available to carry out each of the programs. Serious consideration should be given to the responsibility of tne Agency toward the terrestrial environment, to determine whether the level of resource allocations for terrestrial studies is in keeping with the Agency's mission.

- Communication relative to community and ecosystem research needs to be established between EPA, the academic community of scientists, and the industrial community.

This exchange could be accomplished by greater emphasis on sabbatical leaves, participation of visiting scientists, seminars, symposia, more frequent use of consultants, and staff at scientific meetings.

- Serious consideration should be given to the organization of an international symposium in the laboratory culture of aquatic organisms, particularly those of freshwaters, and updating information on marine forms since the 1970 symposium in Helgoland, with a view to publishing the papers in a carefully reviewed and edited book.

- Team effort in carrying out large projects should be encouraged.

I. D. PRODUCTS OF RESEARCH

1. PUBLICATIONS AND REPORTS

The primary goal of research programs funded by EPA is generation of data useful from a short-term and long-term perspective for setting environmental quality standards for toxicants and pollutants and that can also be used to sustain proposed regulations and enforcement activities in the face of legal challenges. Nevertheless, the general tax-paying public also has an interest in the widest possible dissemination and use of the results. Both of these objectives are enhanced by publication of the data in peer-reviwed journals (a) because the review process provides additional scientific input into manuscripts prior to publication, and (b) because of wide dissemination of scientific journals. The review process should also help detect weaknesses and errors in the research projects and their interpretation which will be useful in the design of future experiments. If a paper survives the review process, higher level administrators should have more confidence in the results of research and interpretation of findings than they have for unreviewed manuscripts.

Some projects should not be published in standard scientific journals either because of their restricted focus or because extensive details exceed the capacity of journals to accept them. It is nevertheless important that these results, if published in the form of in-house reports, be given wide circulation for reasons already cited above.

Another function performed by non-technical EPA publications is public education. Technical reports are often difficult for even informed lay persons to understand, but the general conclusions and why they have been reached can usually be communicated in non-technical language. These kinds of publications play a valuable role in general educational processes by which attitudes toward the environment are made.

2. THE EXTENT OF USE OF SCIENTIFIC JOURNALS BY EPA RESEARCHERS

Information contained in summaries of publications from the various EPA laboratories indicates that researchers at all of the Laboratories make extensive use of the refereed scientific journals as outlets for their work (Table 1).

These statistics must be interpreted with caution, however, because included (Table 1) are papers published by extramural researchers funded by the laboratories. For example, a large fraction of publications of the Corvallis laboratory appearing in scientific journals are the result of extramural research, and the number of in-house papers published in that manner is disappointingly low. In addition, since some of the laboratories are new and many staff members were added during the time period analyzed here, some of the publications represent theses or other work done by investigators before they actually joined the EPA laboratory. This appears to be most notable for the Corvallis Laboratory but to some extent affects all laboratories.

TABLE 1

Summary of publication patterns of the EPA laboratories doing ecological research. Data taken from publications lists provided by the laboratories.

Environmental Research Laboratory	Peer-reviewed journals			Non-refereed, in-house, and semi-popular publications			Total
	66-70	71-73	74-75	66-70	71-73	74-75	
Narragansett (NMWQL)	17	20	18	10	9	7	81
Gulf Breeze	20	34	25	10	18	10	115
Duluth (NWQL)	40	53	20	6	6	0	125
Corvallis	23	60	16	16	59	27	201
Athens	11	15	(3)	3	13	(2)	(47)

3. PRODUCTIVITY OF RESEARCHERS

In measuring laboratory productivity, the Committee sought some indication of publications per person per year per thousand dollars invested in research. The Committee finds it difficult to avoid the impression that productivity is not as high as it should be, given the excellence of research equipment, the number of supporting technical personnel available to each principal investigator, and the fact that the majority of the investigators are free to engage in research almost full-time. Some of this apparent low productivity probably results from reorganizations that took place during the period under consideration. In part, it also reflects the difficulty, reported by so many researchers, of completing a job before a new directive requires them to drop what they are doing to engage in a crash program to provide data for some new regulation or other regulatory activity.

Scientists have done considerable publishing, but not as much as would be expected. A rough tally of publications (all without regard to quality) indicate that on the average each EPA scientist produced approximately 0.6 articles per year during the 5-year perior (1970-1975). The Committee feels that one article per year is more nearly the norm in scientific circles. It must be remembered that a scientist at an EPA laboratory must carry out a large number of experiments not appropriate for publication, and that he must also testify in court, answer questions raised by the public, and produce in-house reports.

Average per person production increased during the years 1970 and 1971 with a peak production coming in 1973. Production fell off rather sharply in 1974 and even more in 1975. This was generally true for all the research laboratories, but was more pronounced for some laboratories. Corvallis, for example, produced 39 articles in 1971, 29 in 1972, 52 in 1973, 25 in 1974, and 19 in 1975.

The quality of research reports on the other hand, increased over that of previous years. For example, better than 45% of the articles published in 1975 appeared in national journals as opposed to only roughtly 25% in 1970. Some laboratories had a higher percentage of quality papers than others. The Duluth Laboratory appeared to be the leader here with approximately 67%.

4. AVAILABILITY OF IN-HOUSE PUBLICATIONS TO THE GENERAL TECHNICAL COMMUNITY

The major vehicle by which publications of the Office of Research and Development (ORD) of EPA are advertised is a quarterly, ORD PUBLICATIONS SUMMARY. This summary is currently sent to a mailing list of approximately 10,000 persons and institutions in the United States plus 1,000 foreign entities. Included on the list are other Federal Agencies, many State agencies concerned with environmental matters, a large number of universities, and individual investigators as well. This effort represents a substantial commitment to the dissemination of research results, but, unfortunately, the Committee's survey did not provide it with the information needed to offer an effective appraisal of the real extent to which research results are actually getting to the attention of persons most needing them. It was clearly apparent at some of the laboratories that workers are not aware of research taking place at other laboratories, but the extent to which this problem can be alleviated by publications summaries is questionable. Because of current delays in reviewing and publishing manuscripts, publications are necessarily two or more years out of date by the time they appear. Much of the overlap and duplication of effort seems to involve work started so recently that nothing is yet in print. Possibly a newsletter briefly describing research being initiated at different laboratories might serve to increase communication during these earlier stages when it is most difficult to know what other persons are doing or planning to do.

The ORD PUBLICATIONS SUMMARY provides a complete listing of all EPA publications and abstracts of new ones. In its present form, however, it is cumbersome. A useful classification of reports according to their general subject matter is provided by the nine Series Designations, but locating papers according to their Series classifications in the SUMMARY is very difficult. Also, the amount of potential overlap in contents of publications would require extensive cross-referencing which would defeat the purposes of the Series Designations. Nevertheless, some improvement could be realized by listing publications according to their Series Designations as this would provide the most valuable clues to potential users of the Publications Summaries. Sport Fisheries Abstracts is a good example of a readily usable document of this kind.

While papers published in scientific journals generally receive rigorous review, it is less obvious how decisions are made and quality control is exercised for in-house publications. Presumably some review is carried out within each laboratory before a paper is submitted to ORD, but the Committee is not aware of any subsequent review of papers by qualified scientists either elsewhere in the Agency or outside. Administrative persons are not necessarily qualified to perform this type of review, and, to the best of the Committee's knowledge, academic scientists have not been involved except insofar as individual investigators have sought their opinions.

The Committee believes that a more formal review procedure for in-house publications is needed for better quality control. Such a procedure should increase the credibility of EPA research in the scientific community as a whole and should reduce court costs since results used in the establishment of standards will have been subjected to more careful scrutiny before such decisions are made. One possible means of accomplishing this review might be to establish a panel of experts in the various fields encompassed by EPA research who indicate a willingness to serve in this capacity. This system would require a highly qualified EPA scientist to serve as Editor-in-Chief, sending manuscripts out for review, communicating the opinions of the reviewers to authors, and making decisions concerning acceptance or rejection of papers in much the same manner as these decisions are made by editors of scientific journals.

At a still higher level there is a need for some centralization of information dispensing operations of EPA and other Federal agencies. ORD is not the only source of EPA publications, and EPA is not the only Federal agency engaged in ecological research. At the present time an outsider is likely to experience considerable difficulty in determining the appropriate sources for information desired. It would be much easier if there were a single central office that all outsiders could contact directly with their needs for specific types of information. This one office could then direct inquiries to the appropriate source.

5. PUBLIC INFORMATION PUBLICATIONS

An important function of EPA is dissemination of results of research to the general public in non-technical language; for example, articles in environmental magazines. Whereas

individual investigators and laboratories have taken various steps to enhance this communication process in their local regions, the overall EPA effort is deficient in this regard. In the long run, this will reflect unfavorably in the strength of regulations that can be adopted by the Agency. Serious consideration should be given to developing this function. It is the Committee's impression that the EPA Journal, which does carry this type of information, is primarily designed as an intra-agency communication medium and does not serve this role for a broader constituency.

6. OTHER REPORTING SERVICES

a. Technical Assistance to Other Laboratories

All Laboratories reported rendering technical assistance in one form or another to a number of organizations and groups. Their reporting system is very generalized, and in most cases, the service provided is for another governmental regulatory agency. A notable exception to this statement is the report provided by the Duluth Laboratory. This report, which dates back to 1969, gives specifics on technical assistance provided to organizations, dates of participation, and the nature of the assistance. The assistance given by this laboratory, and presumably to a certain extent by the other laboratories as well, falls under the following headings:

1. Private enterprise or industrial complex
2. Regulatory agencies: State and Federal
3. Universities
4. Public Schools
5. Academic and lay groups
6. Professional organizations

b. Aid to Private Laboratories and Lay Groups

Most laboratory assistance is given to private enterprise, regulatory agencies, and professional organizations. For example, between December 1974 and June 1975, the Duluth Laboratory used 716.5 man-days for technical assistance. Ninety-five percent of the time was spent on these three groups. The remaining 5% was utilized in assisting public schools (0.5%), universities (2%), and lay groups (2%). Assistance given agencies and professional organizations included references on fish larvae collections, analysis of water supply, review of

manuscripts, provision of technical information to assist with adjudication of test cases in court, lectures, demonstrations, and bioassay techniques. Services to universities and public schools were in the form of lectures, career-day activities, research reviews, analytical procedures, testing systems, and mini-courses on various organisms. For lay groups, information was largely on health hazards of asbestiform fibers in drinking water. Comprehensive courses, however, are not provided for lay and academic groups. The mini-course mentioned above represents an allocation of approximately three days for high school students.

7. RECOMMENDATIONS

- To the maximum extent possible manuscripts reporting results of research should be submitted to standard refereed scientific journals. This practice should be followed by all laboratories.

- A peer review system, including qualified scientists from outside as well as within EPA, should be established for all in-house scientific and technical reports.

- For scientific and technical publications, a centralized office capable of receiving and responding to all outside requests should be established.

- General communication of results of research in non-technical language should be greatly increased.

- Serious consideration should be given to the publication of an EPA scientific journal.

II. ENVIRONMENTAL RESEARCH LABORATORIES AND FIELD STATIONS

A. ENVIRONMENTAL RESEARCH LABORATORY -- CORVALLIS

The Committee is aware that the Corvallis Laboratory is structurally the most complex of all the Laboratories it has visited. It is also the largest in terms of personnel as well as in complexity of missions. It is characterized by a diversity of widely scattered programs.

1. LABORATORY DIRECTOR

The Director is a competent, experienced administrator and respected scientist. He knows in considerable detail the type and extent of research programs underway at the Laboratory and its Field Stations. Although he seems to have a well-organized Laboratory from an administrative point of view, there is noticeable lack of communication between him and program leaders. The Committee suggests that he meet with program leaders at frequent intervals to discuss the programs and to determine which ones are suitable for Corvallis (parent laboratory) and which, if any, should be moved to other laboratories or field stations.

The Committee is led to conclude that communication between the Director and EPA Headquarters has been ineffective. Improved communication would facilitate integration and direction of programs at Corvallis and decisions on transfer of programs.

2. LABORATORY STAFF

Morale of the staff at Corvallis ranged from extremely low to high. In some groups it was the poorest of any of the laboratories visited. The group at the Western Fish Toxicology Station demonstrated the highest morale.

The staff includes a substantial number of older scientists who have survived shifts from one agency to another when pollution control was trying to find a home. These individuals are technically skilled, but some lack imagination. Despite reorientation of the Laboratory's objectives during its evolution from FWPCA to FWQA, to EPA, some of the work retains outdated conceptions of problems.

In some cases the training and experience of staff are not oriented toward their present responsibilities.

Young people and new people, some of whom are quite imaginative, are keenly interested in their work. Undoubtedly all would be more creative if they had the opportunity to work together as a unit to plan the programs. The Committee believes that insufficient communication between the Director and the various working groups is a major cause of a considerable part of the low morale. It may also result, in part, from the scatter of field stations at some distance from the parent laboratory, a situation that impedes communication.

Because of its concern with the factors noted above, the Committee forwarded an ADVISORY STATEMENT -- ADMINISTRATIVE FACTORS INFLUENCING THE QUALITY OF SCIENTIFIC PROGRAMS AT THE CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY, October 23, 1975, (APPENDIX I) to the Assistant Administrator for Research and Development.

3. TERRESTRIAL RESEARCH PROGRAMS

a. Effects of Gaseous Air Pollutants

The program at the Hyslop Farm site involves work on ozone (O_3) interaction studies with SO_2, and programming of experimental exposures of plants to studies of gaseous pollutants using a stochastic model. The project appeared to be well designed to some, but not to others.

The main points raised by the Committee were:

Is looking at only one organ of the plant -- root of one, leaf of another -- (even though the organ is of economic importance) likely to provide enough critical information to determine the targets of and the explanation for the effects of a pollutant? Leaves play a common role in the photosynthetic process of all plants and would thus seem to be extremely important in pollutant studies of any species.

How important are physiological-genetic parameters? Some of the Committee questioned whether non-hardy and winter-hardy alfalfa varieties would have similar responses. Can the results of testing a non-hardy alfalfa at

Corvallis be assumed to apply to a winter-hardy (i.e. winter dormant) alfalfa in Montana?

The Committee was pleased to learn that the experiments on the Hyslop Farm site are being supplemented by the Zonal Air Pollution Study at Colstrip, Montana. This project entails controlled SO_2 exposures of native grasslands and ecological effects in an open field setting.

b. Acid Precipitation

The major questions being asked are the effects of acid rain on: 1) nutrient cycling, 2) forest productivity and community structure, and 3) particular ecosystem processes such as litter-decomposition, mycorrhizal interactions, nitrogen fixation, and soil water leaching, and implications of these effects for multiple uses of forests.

In addition to short term "pot studies", data will be obtained from the main plots on regular basis through analyses of water, plants, litter, and soil. Measurements taken will be based on the conceptual model of an ecosystem used in the experiment.

In response to questions raised by the Committee it was stated that the experiment is designed to study chronic effects on a system containing plants (trees, ferns, herbs, microflora), animals (arthropods, tree frogs), and a reconstructed forest soil (litter and mineral horizons). Studies should involve different types of buffered soils with different vegetation types.

The Committee notes that the ecological effects of acid precipitation are probably more obvious and severe in freshwater ecosystems than on land and should not be ignored. Thus, the Committee is pleased to learn from the No. 5 Newsletter of the Natural Resource Ecology Laboratory of Colorado State University that it has undertaken a multi-agency, multidisciplinary study of the direct and indirect effects of strip mining on aquatic ecosystems in Montana and Colorado, funded by the Environmental Research Laboratory, Duluth. It is not clear to the Committee whether this effort is being coordinated with the Corvallis program.

c. Plant Pathology Greenhouse Studies

Plant pathology studies in the greenhouse impressed Committee members, particularly the dialysis membrane developed at the Laboratory for inducing water stress levels in experimental plants. Its potential for a wide range of experiments appears promising. More attention needs to be given to what is to be measured on plants and why. Investigations need to evaluate performance of plants in environments where they are exposed to competition, predation, and climatic fluctuations. As any of these conditions deviates from optimal, the effects of pollutants and stresses can be expected to become greater. The experiments now being conducted will reveal almost nothing about these parameters, but will provide a basis to proceed.

The scientists working on this program seem imaginative and some valuable work can be anticipated. Since greenhouse experiments, however, do not duplicate conditions in natural environments, further work will be required to determine applicability of results of these studies to the field.

d. Pesticide Effects on Terrestrial Environments

This field of research is extremely important and should be given a high priority. The program, however, has such limited support that it is unlikely it can make contributions of any substance.

4. AQUATIC STUDIES

a. Lake Eutrophication Survey

The Lake Eutrophication Survey involved characterization of 800 lakes and reservoirs by means of a helicopter and taking very few samples at each lake or reservoir. Some parts of the Survey (National Lake Survey) were very poorly designed, and it is questionable that the Survey will yield reliable results. A program designed to yield the maximum amount of information about a series of lakes from a few samples should have begun by a detailed analysis of lakes already intensively studied. By pretending to sample these lakes at infrequent intervals it would have been possible to determine (a) the best times to take samples, and (b) the extent of information

loss resulting from the low level of sampling effort. From this information the potential value of the Survey could have been estimated and decisions made about the kinds of data most worth gathering. Failure to do this means that the characterization of the lakes is subject to biases that are unknown and cannot be reliably estimated. There is no way to judge the quality of the samples or their analyses, but the Committee can say positively that the lakes selected for sampling are not representative. One way to make this program more credible would be for individuals studying these various lakes to consult with scientists who have previous data on the same lakes to correlate their findings. The Committee was concerned that there would be a considerable effort to generalize from this Survey and that its admonitions to consult with limnologists to compare old and new data on the same lake would not be taken very seriously unless the Committee's objections were recognized at the Laboratory Director level or above. The Committee agreed that EPA should be very cautious about publication of results of this study. As an outcome of the Committee's concern, ECOLOGY ADVISORY STATEMENT -- THE NATIONAL LAKE SURVEY, October 23, 1975, (APPENDIX F) was forwarded to the attention of the Assistant Administrator for Research and Development.

Members of the Committee discussed the possibility of EPA's initiating a periodic study on lakes in the context of their watersheds or drainage areas. Several lake-watershed areas could be selected in various parts of the country with different geologic substrates and developed into experimental basins. Testing of hypotheses by experimentation is clearly the best and most efficient way to develop sound management plans. As it stands, EPA's approach appears to be entirely piecemeal, or to try something and see what happens, instead of designing studies to test previously developed hypotheses.

b. <u>The Shagawa Lake Project</u>

The Shagawa Lake Project provides an excellent opportunity for experimental work at the ecosystem level. For example, the results of phosphorus removal from the effluent could be followed for several years in order to observe (1) the effects of varying amounts of treatment of sewage on the lake ecosystem and (2) the rates of recovery of the Lake from pollution. The ECOLOGY

ADVISORY COMMITTEE ADVISORY STATEMENT -- THE SHAGAWA LAKE PROJECT, October 23, 1975, (APPENDIX E) resulted from the Committee's briefings and deliberation. The STATEMENT was forwarded to the Assistant Administrator for Research and Development.

c. Newport Field Station

It is generally agreed by those who visited the marine station at Newport that, although the facilities are very good, they are not well utilized. Vessels under EPA control are inshore coast type, small, opendecked affairs that provide rapid transportation short distances offshore. Any heavy work done in locations further offshore should apparently have been contracted with the Oregon State University oceanographic vessel or through other Federal vessel active in the area. The Oregon State University vessels are used for coastal circulation studies.

The Station provides a logistic base for access to the sea and equipment necessary to conduct pluming and pollution dispersal type work in marine environments. The in-laboratory facilities are limited. Several offices are provided for on-site personnel as well as one relatively spacious chemistry analysis laboratory. Some space in the building is provided for wet lab work. No great evidence exists that much is underway in the wet laboratory facilities. Some chemical analyses being performed on sewage sludge were observed, but these tests could be done any place once the samples are collected.

Perhaps the greatest benefit for EPA personnel working at that site is the communication possible with Oregon State University personnel located in the facility. This provides an environment for cross fertilization and easy, rapid, informal communication. It is believed that a far greater espirit de corps could be worked out between the University and EPA.

However, any expansion of EPA effort in the area, unless it is done through extramural contracting, would require more space. Since space is unlikely to be forthcoming from Oregon State University, temporary or trailer-type space might be necessary for expansion of efforts.

Newport is the only EPA outlet to the sea in the Northwest, an area distinctive because of its cold seawater and upwelling. Considering its future potential, the Committee, in general, believes the Station should be retained, but it should be developed with a broad responsibility for emerging problems involving domestic and industrial pollution, sewer outfalls, ocean dumping, oil impacts, and toxicology. A real need exists to study coastal organisms in the Pacific Northwest from the standpoint of man's alteration of coastal environments through diverse sources of pollution. Newport is well suited for such a study.

This entire program does not appear to have been given proper attention. The present program at Newport does not justify its existence. There are, however, real problems basic to EPA's rationale to be investigated on coastal food organisms of the Northwest. The Director at Corvallis should look at new goals for the facility and associate with it those aspects of the Western Fish Toxicology Station involved with salt water.

d. The Sludge Program

Inclusion of the New York Bight sludge research in Corvallis programs seems inappropriate. Ecologists are accustomed to traveling long distances to conduct research, but a nation-wide organization such as EPA with laboratories throughout the country should avoid unnecessary expenses of travel, scientists' time, and transporting of New York sludge across the continent. Far better alternatives would be to conduct these studies at the Narragansett Laboratory or to contract them to a neighboring academic institution.

e. Western Fish Toxicology Station

The Western Fish Toxicology Station, until recently an entity of the Duluth Laboratory, has a clear and restricted focus and a good esprit de corps. The laboratory facilities are excellent including both its analytical equipment and its water system. Presentations of the staff were brief and to the point, and on the whole covered the fields well.

The Station is concerned with species of fishes of great importance to the Pacific Northwest. The reason for the

Station being at its location, besides appropriate quality of water, was to be near the salmonid fishes, suitable and usable as test species, and to be able to work on anadromous species important to the Pacific Northwest. The Station fulfills a need for a facility that represents a typical environment necessary to anadromous fishes.

The Committee questioned the advisability of continuing the program on gas bubble disease especially since laboratories of other agencies are working in this field and further study seemed unlikely to produce new information that would alter the basis for EPA regulatory policy. As a result of its concern, study, and deliberations, the ECOLOGY ADVISORY COMMITTEE ADVISORY STATEMENT -- GAS BUBBLE DISEASE IN FISHES, October 23, 1975, (APPENDIX G), was forwarded to the attention of the Assistant Administrator for Research and Development. See APPENDIX O.

The Station has two exploratory programs that hold some promise. One intends to expose stressed fish to pathogens in order to quantify their susceptibility to disease. The rationale is that stresses may be sublethal but still may be important to the health and ultimate survival of fish. The other project intends to use the blood concentration of an enzyme from the Lysosome, LAN, as a criterion of fish health. If conditions of stress cause cellular breakdown, the blood titre of LAN then should rise. Both projects are imaginative and have a high potential for yielding useful results.

Some members were of the opinion that both programs should be continued. Others considered this part of the program to be weak, particularly that dealing with micro-organisms.

f. Arctic Field Station

Although the Committee has not yet visited the Arctic Field Station, three of its staff members discussed their programs with the Committee during its visit to Corvallis. Much more stream gravel was moved by the pipe-line construction than was originally estimated. This has created a number of problems for phytoplankton, benthos, and fishes. These problems apparently are being

attacked by the most elementary methods, so elementary that only the grossest changes might be detected. Recognizing the great difficulties imposed by the severe climate, some members are disturbed because little or no attention has been given to fish migration in these streams, not only where they might swim, but at what time of year. Altering the stream channel would surely have an effect on migration, and it is possible that such an effect, if it exists, could be eliminated before migration movements are completely blocked. It appears necessary to augment the Station considerably to meet the needs of EPA in Alaska. Perhaps EPA and other agencies could combine their efforts in undertaking such an investigation.

The Committee is of the opinion that the laboratory is grossly undermanned and underfunded for the problems that exist in Alaska. Most of Alaska has an Arctic climate where waste disposal and other environmental problems differ from the rest of the United States. A laboratory in this area is thoroughly justified in view of the pending environmental impact from oil and other resource development activities in Alaska. Cold climate ecology and cold climate disposal problems have to be located in cold climates. That criterion coupled with the importance of the natural resources in that area is sufficient to merit a substantial environmental research activity in Alaska. The EPA laboratory currently existing in Fairbanks, though staffed with dedicated people, does not approach the critical mass necessary to do sound ecological or pollutant disposal work. This could be alleviated with increase of staffing with personnel of complementary skills in addition to extending a substantial extramural effort in the area, coordinated by the laboratory services. Consideration should be given to this type of augmentation.

The Committee is of the opinion that a group of members should site-visit the laboratory if ecologically oriented research continues there. Furthermore, a site visit is necessary for an effective assessment of the Station.

5. MODELING

The Committee suggests that modeling, though it is incapable of producing magic results, should not be set off as a separate activity. Modelers should participate in all of the laboratory's programs and in all of the research of all four major laboratories. The modelers should discuss methods of modelers in industry and academia so that tne most appropriate methods are followed. The deficiency of this type of communication was noticeable in some of the discussion.

6. SOCIO-ECONOMIC PROGRAMS

The possibility of introducing socio-economic programs was broached to the Committee during discussions at Corvallis. Some members of the Committee would like to see a laboratory of EPA assume tne responsibility for this type of research. Problems such as that of the tussock moth, have far-reaching ramifications and its investigation should consider socio-economic as well as ecological aspects. Other members are strongly opposed to having such a program and question the Committee's appropriateness to make this judgement. Introduction of such a program might curtail resources of other programs.

7. PRODUCTIVITY OF RESEARCH

On the whole, publications at the Corvallis Laboratory may have fulfilled the mandate of EPA, but productivity of such a large center should be higher. The per capita number of articles published in national journals is less at this Laboratory than at the others visited. Many of the publications in the list from the Corvallis Laboratory are authored by investigators from outside organizations. As stated in the Committee's comments on other Laboratories, peer review for inhouse manuscripts tends to enhance the quality of scientific publications.

8. INTERACTIONS WITH OTHER GROUPS

The group at Corvallis does not appear to be interacting to any great degree with scientists of other laboratories nor in academic insitutions. In some cases there is a curious lack of knowledge of what is going on in other research groups in the outside world. In otners, there seems to be more

knowledge of work going on in Japan, for example, than of that in the United States.

9. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the Committee believes that productivity of the Corvallis laboratory would be greatly increased if there were less shifting of personnel; if scientists were allowed to complete projects; if there were a greater dialogue between program leaders and the upper administration in planning and making decisions; and likewise if there were more interaction between and among staffs of the various scientific programs.

The Committee recommends the following:

- Much needed discussion between EPA modelers and modelers in industry and academia in regard to modeler's methods.

- Initiation of periodic study of lakes in context of their watersheds and drainage areas.

- More effective utilization of the Newport Field Station by considering new goals for the Station and associated with the Station of those aspects of the Western Fish Toxicology Station involved with salt water.

- Augmentation of manpower and resources for research in Alaska either by additional support to the Arctic Field Station or extramurally or both.

- Greater use of peer review for in-house research reports.

- Better communication between the Director and program supervisors.

B. THE ENVIRONMENTAL RESEARCH LABORATORY -- DULUTH

1. DULUTH LABORATORY

The Environmental Research Laboratory -- Duluth, (formerly designated as the National Water Quality Laboratory) located on the shore of Lake Superior, is one of the finest laboratories concerned with quality of freshwater environments and problems of importance to the effects of pollution on aquatic life.

a. Laboratory Director

The Director is a recognized scientist and an able leader who has developed a fine rapport with his staff. He expects and is obtaining high quality research. He and his key staff have an established, sound, imaginative philosophy, especially in terms of future research needs, to gain a knowledge of water quality criteria problems. Of the laboratories visited by the Committee, the Duluth Laboratory has the best internal communication and cross-fertilization. Under the Director's leadership, this Laboratory is one of the top groups in the world studying the effects of pollutants on freshwater aquatic life.

b. Laboratory Staff

The staff includes many excellent scientists, with enthusiasm and good morale, pursuing, for the most part, carefully designed and executed research with a high degree of sophistication. The organization of the Laboratory is probably the best of any visited. The staff have a deep respect for the Director, and he, in turn, has great consideration for their research and personal needs. The Committee observed genuine enthusiasm and interest in work in progress and among the staff for each other. Researchers are making concerted effort to communicate with academic institutions and other agencies. Communication is accomplished primarily through the staff meetings and seminars. In a geographic area where the winter environment is harsh the fine morale in the laboratory is great tribute to the Director.

c. Facilities

Facilities at this Laboratory are excellent. The Committee is particularly impressed by the sophisticated chemical equipment and the work being carried out on subtle physiological and biochemical effects of pollutants on freshwater species. Biological facilities are good, but did not seem to be as sophisticated as the chemical. Biological work centered on testing a single species under varying conditions.

d. Research Program

It is essential to utilize all life history stages of species in order to produce reliable information on long-term effects. Species that can be reared in the laboratory are important tools for research, a prime use being for bioassay. The searches for more representative species of fish to culture than the hardy, tolerant goldfish (Carassius auratus) has resulted in the rearing of several other species from egg to egg. An inbred strain of the warm-water fathead minnow, Pimephales promelas Rafinesque, which is widely distributed in the eastern and midwestern United States, is now available for testing on a year-around basis. By controlling food intake, light, temperature, space, and toxic metabolic waste products, the bluegill, Lepomis macrochirus Rafinesque, can be reared from egg to maturity in approximately four months. Largemouth bass, Micropterus salmoides (Lacepede); walleye, Stizostedion vitreum (Mitchill); yellow perch, Perca flavescens (Mitchill); northern pike, Esox lucius Linneaus; the brook trout, Salvelinus fontinalis (Mitchill); and the black crappie, Pomoxis nigromaculatus (Lesueur) have been spawned in laboratory holding tanks. Additional developments of this kind can be expected as greater experience is acquired with the newly found techniques.

The Committee was particularly impressed with studies that involved the complete life cycle of species. The ability to couple exposure of various species to toxicants with complex analyses of physiological effects from such exposure produces important results in the field of toxicology. The staff achieved a high standard of work on bioassay of single species, both acute and chronic.

The Committee suggests several beneficial avenues for future investigations; for example, study of complex mixtures of effluents to determine synergistic and antagonistic effects should be continued and expanded. This approach, coupled with pulsating levels of toxicants, may give important information on chronic levels. Introduction of ecological stresses would provide useful information on the severity of effects of a toxicant, in relation to quantity and quality of food, crowding, sudden temperature changes or the presence of predators.

The evolutionary effects of exposure to toxicants are poorly known. If a species is exposed to a toxicant when it is very young, will it affect it when it is an adult or in future generations? Such tests should be done, not only on fishes, but on many different kinds of groups of organisms. This type of research, the Committee feels, would produce a great deal of precise information of value in understanding the effects of toxicants in real ecosystems.

e. Productivity of Researchers

The publications in national journals are good, sound, workmanlike products indicating a high degree of technical skill. A few authors have taken a broad view of their problems and thus can be regarded as pacesetters. A high standard of publication has been achieved at the Duluth Laboratory.

One of the activities for which the Duluth Laboratory should be particularly commended is the fine team approach utilized in researching the asbestos problem in Lake Superior. The format of the team effort, together with the ways in which the research was designed and carried out, is a model for this kind of investigation.

2. MONTICELLO FIELD STATION

The Monticello Field Station is an important arm of the Duluth Laboratory and its potential as a research facility is outstanding. The experimental channels are exactly the kind of facility that EPA should be using more generally.

The program is just getting underway and consequently the research potential could not be evaluated. Unpredictable and frequent shutdowns of the power plant makes effective long-term studies of thermal effects unrealistic. Questions relating to inter-active qualities with variable chemical and environmental parameters should be considered as an important function of the Laboratory. The program should not be restricted solely to thermal pollution problems but should be diversified and designed in such a way that useful ecological information can be gathered in addition to that on effects of temperature on aquatic life. Studies in the channels should focus on benthos and algae as well as on fishes.

There appears to be a critical need for additional manpower available to carry out the program. Unless a much larger staff is built up, care must be taken to assure frequent communication with the scientists of the Duluth Laboratory. Consultation with ecologists in the development of the research program is desirable.

Monticello offers facilities for conducting research in several fields of interest to ecologists such as cycling of many kinds of toxicants through an ecosystem. The program will attract the attention of many ecologists.

3. NEWTOWN FISH TOXICOLOGY STATION

Neither the Committee nor any of its members visited the Newtown Fish Toxicology Station. A staff member from Newtown described the study conducted on Shayler Run for the Committee. The purpose of that study was to test the validity of laboratory produced data in a natural stream situation. The final report on the study is not yet available, but it will be of interest to the Committee partly because this is the first time the Agency has undertaken an ecological study of this nature.

4. LARGE LAKES RESEARCH STATION

Neither the Committee nor any of its members visited this Large Lakes Research Station usually referred to as the Grosse Ile Laboratory. This Station, formerly an entity of the National Environmental Research Center, Corvallis, was assigned to the responsibility of the Duluth Laboratory approximately one month before the Committee's Duluth visit. The Chief of the Station, prior to the transfer of Grosse Ile Laboratory, and other staff described the Station's activity

that is closely related to the International Great Lakes Commission.

The Station seems to be playing a key position in the research of the Great Lakes. The models being used to study the phytoplankton in the Great Lakes, offer an approach that holds considerable promise.

5. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the Committee finds that the Duluth Laboratory is characterized by a very good administration, a fine scientific staff, and utilization of excellent physical facilities to their best potential. Projects of research are significant and of high quality. A need for more ecologists on the staff is recognized.

The Committee recommends the following:

- expansion of investigations on complex effluents
- optimum utilization of the experimental channels at the Monticello Field Station for diversified and carefully designed studies that, in conjunction with investigations on the effects of temperature on aquatic life, will produce other useful information on ecosystems
- strengthening the research staff of the Large Lakes Research Station, increasing and expanding the Station's programs.
- additional manpower for the Monticello Field Station

C. ENVIRONMENTAL RESEARCH LABORATORY -- GULF BREEZE

The Committee orginally planned to utilize the entire day to become acquainted with the research program at Gulf Breeze. However, the future plans for ecological research programs of the Office of Research and Development were discussed. This discussion was oriented toward the Committee's initial assessment of coverage and gaps in the ORD program. The Laboratory Directors or their representatives presented overviews of the programs of the four major ecological research laboratories. Thus, the time available for the Gulf Breeze Program was severly curtailed -- less than one-half day. The Committee's concern with the brevity of its consideration to the Gulf Breeze Program at the site has not been quelled especially in light of its experience on the visits to the other Laboratories.

1. GULF BREEZE LABORATORY

The Gulf Breeze Laboratory, well located on Santa Rosa Sound, on clean water with partial insular isolation, provides ample and well equipped facilities to conduct research on various ecological problems characteristic of the Gulf Coast.

a. Laboratory Director

The Director, highly respected and a recognized scientist, is developing a program responsive to EPA needs and of high scientific merit. His administrative style allows very good communication among workers in his laboratory as well as time for individuals to pursue peripheral personal professional research interests.

b. Laboratory Staff

The staff is a hardworking group with very high morale, undoubtedly because of the opportunity to pursue at least some research of their own interest and the effectiveness of the Director. The Director is to be complimented for developing a mix of investigators - physiologists, toxicologists, and microbiologists, as well as chemists interested in ecology and in the team approach to solving complex ecological problems.

The training and experience of the staff appears to be suitable to research programs in which they are engaged. Although a large part of the Laboratory research programs

require knowledge of ecology, only a few persons might be considered ecologically oriented. Nonetheless all investigators seemed sensitive to the need for an ecological approach. Their interest in working with ecosystems points to the need for increasing the number of well qualified and experienced ecologists to the staff.

c. Facilities

The facilities at the Laboratory are excellent. Much of the equipment, especially that relating to toxicological work, was developed or was modified at the Laboratory to accommodate the Laboratory's special circumstances. The Committee is impressed by the good use of space and the ingenuity expressed in many of the experimental designs and apparatus used in research. The proximity of Gulf Breeze to the coast makes it an ideal location to study estuarine and marine ecological problems. This aspect of the work should be strengthened. Abundance of available local organisms with which to carry out various scientific programs further enhaces this site for ecological research.

d. Research Program

The bioassay effort is interesting and sophisticated. The Laboratory investigators are conducting valuable long-term chronic bioassays. However, results of research obtained from Laboratory studies should be transferred to the natural ecosystem in order to determine if the degree of stress noted in the laboratory is similar to the corresponding stresses in natural environments. The capability of using three species systems is a major contribution and a significant step forward in the study of interactions of species in a community.

Of the three species to which the reference is made, the Laboratory has developed culture methods for two, Cyprinodon variegatus and Palaemonetes pugio. The Laboratory has also been quite successful in its culturing of algae and crustaceans.

Of considerable importance are investigations on pesticides, bacterial degradation of pesticides alone and combined with other materials, and investigations on the

physiological action of pesticides. Research on viruses of invertebrates is also of especial importance because of the proposed use of viruses of invertebrates to control pests.

This Laboratory should carry out many more experiments designed to observe the effects of toxicants in an ecosystem. Data obtained from chronic tests could be of great value in initiating such studies. Spending more time in the field in validation of results -- although a difficult undertaking -- should be encouraged.

It appears that criteria used in selection of research animals for chronic bioassays are based entirely on availability, economic importance of the species, and suitability for culturing. These are clearly important criteria; but if one seeks generality of results, additional criteria need to be included in the selection process. For example, it would be highly desirable to select research animals on the basis of key ecological characteristics so that results might be applicable to other organisms having those characteristics. Included in these criteria would be the tropnic level of the organism, its growth rates, reproductive rates, and habitat distributions. These criteria are important because fast growing organisms with nigh reproductive rates and high rates of population turnover usually share a constellation of physiological characteristics that should be correlated with similar responses to environmental pertubations. Similarly, slow growing species with low reproductive rates and low rates of turnover share another set of physiological traits that should be of great predictive value. Obviously, culturability and availability are necessary attributes, but by themselves they provide no basis for predicting the range of species for which a particular result might be generalized.

One of the needs of the Laboratory is more comprehensive designing of experiments. An ecologist, experienced in this field, would bring some badly needed insights to the planning of experiments.

e. Productivity of Researchers

Scientific productivity of this Laboratory is very good. Many of the papers appear in national journals with

critical review. The scientific staff is actively involved in meetings, conferences, and symposia that take them to other research laboratories and campuses. The ability to publish research, at least in part, of their own choosing has no doubt stimulated improvement in the quality of research.

f. Communication

There appeared to be more communication concerning the work at this Laboratory than other laboratories visited by the Committee, except Duluth. The Committee, however, is concerned that travel ceilings and budget restrictions may cause unfortunate constraints on the opportunity for visiting scientists to come to the laboratories as well as for staff to attend professional sessions.

g. Conclusions and Recommendations

In conclusion, the Committee is impressed by the Director and staff and the research that they are doing. The Committee's main suggestion is that one or more well-trained experienced ecologists be added to the staff. This would enable programs to be designed to more fully utilize the valuable ecological sites near the Laboratory. Such work would have special relevance and value to the Southeastern part of the United States, and the ecosystem work would have much broader, general implications.

The Committee recommends the following:

- Addition of one or more well-trained and experienced ecologists to the staff.

- Testing laboratory findings in the field -- an essential part of the program.

- Consideration in the selection of animals for chronic bioassay to characteristics such as ecological conditions under which they live, and life history properties, in addition to availability, economic importance, and suitability for culturing.

2. BEARS BLUFF FIELD STATION

The Bears Bluff Field Station, located on Wadmalaw Island, South Carolina, is a satellite station of the Gulf Breeze Environmental Research Laboratory of which it became a part July 1, 1974, prior to which it had been affiliated with the National Water Quality Laboratory, Narragansett. Situated on the intra-coastal waterway, it is in an ecologically interesting area. From a geographical and an ecological standpoint, its association with Gulf Breeze is highly advantageous.

a. Staff

The Chief of the Station is innovative and extremely interested in his work and in the potential of Bears Bluff. The staff is a dedicated group, enthusiastic about the work they are doing. They are pleased with their affiliation with the Gulf Breeze Laboratory. Of the eight technical staff members, one has a Ph.D., three have M.S. degrees, and three Bachelor degrees. Although they seem to be good persons, their training and experience seem limited for the work being pursued.

b. Facilities

Although not as extensive as those at Gulf Breeze, the facilities at this Field Station are very good. There are an abundance of organisms for study and a source of clean water. A good functional seawater system is in operation.

c. Research Program

Bears Bluff carries out a program in toxicology utilizing organisms indigenous to the mid-southern Atlantic area and emphasizes experiments designed to validate data on the effects of toxic organics obtained in the natural ecosystem and in the laboratory. There is considerable difference of opinion about the research of the station. Some members feel that it is well designed, others are critical of the "bathtub" (basin) experiments in which the effects of chlorine are being examined. Ecosystem studies, even those in small confined areas, are very complex, and they need more scientific input than was apparent in the Bears Bluff studies. Nonetheless, some general valuable facts can be obtained from these

investigations, and in the opinion of some of the Committee this is the purpose of these experiments. Some members feel that in the design of any ecosystem studies, outside scientists should comment on the design of the programs and keep in close communication to make constructive suggestions as to how the work should be carried out.

The Station has the potential for field testing of laboratory derived data.

d. Productivity of Researchers

The turnover in Chiefs of the Station, shifts in personnel and program, and indecision as the Station's place in the program during the last several years, plus lack of adequate electric power and a waste disposal system make it particularly difficult for a limited staff and have not been conducive to the productivity of scientific papers. Results of research have, however, been incorporated in Agency reports. Now that the stability of organization, of planning, and of staffing exists, and essential improvements completed, it is anticipated that researchers can be more productive.

e. Communication

Some concern was expressed that the Station might be sufficiently isolated to inhibit effective communication with outside scientists. Its proximity to Charleston, however, makes accessibility no more difficult that that of many other field stations and laboratories. A conscious effort to encourage stimulating exchange of information with other scientists should alleviate such a situation.

f. Conclusions and Recommendations

From a geographic and ecological viewpoint, the association of Bears Bluff Field Station with the Gulf Breeze Laboratory is highly advantageous and should be mutually beneficial. The improvement and availability of essential facilities now completed should reduce operational problems of the research program and augment the versatility of the research.

The Committee is cognizant of the fact that a small operation can not be expected to have a staff with expertise in all areas, but a source of expertise should be available as needed.

The Committee recommends the following:

- Counseling from specialists in the kinds of research undertaken at Bears Bluff.

- Guidance in experimental design of projects.

D. ENVIRONMENTAL RESEARCH LABORATORY -- NARRAGANSETT

The Environmental Research Laboratory -- Narragansett (formerly designated as the National Marine Water Quality Laboratory), is located in Narragansett Bay and has unusual marine facilities being situated in such close proximity to the University of Rhode Island's Graduate School of Oceanography and to a laboratory of the National Marine Fisheries Service (NOAA, U. S. Department of Commerce).

1. LABORATORY DIRECTOR

The Laboratory Director is very enthusiastic and persuasive and tends to oversell the accomplishments of the staff. His efforts to keep in close contact with the team leaders and pressing for better communication with their groups do not seem to have been as effective as desired. Although the Committee was attracted by his competent manner, some members found his descriptions of the Laboratory's activities overstated and in some cases, misleading. He apparently is trying to make the program supportive of EPA's regulatory functions and at the same time the Director is attempting to foster a program that will attract and hold high quality staff for which he should be commended.

At least some of the staff's presentations during the Committee's visit to the Laboratory did not live up to the promise expressed in the Director's presentation the previous evening. As the Laboratory develops, the Director will be unable to be familiar with all of the programs as he is now; he must, therefore, develop a group of associate program leaders upon whom he can depend and who understand the directions which the advisory staff and he recommends.

2. LABORATORY STAFF

Some members of the Committee felt that the morale of the staff is good and that the younger members appear to be on good terms with each other and with the Director. Others were of the impression that morale is low among the working group and that there is an undercurrent of dissatisfaction among the staff that was layered over by the enthusiasm expressed by the team leaders. Individual Committee members talked with different members of the staff, of course, which may well account for the different responses. The staff is predominately young, enthusiastic, and energetic. Several senior members were away or unavailable. Older members were

not conspicuous and there is some question whether their experience is being fully utilized. Many temporary assistants are employed for very short periods of time. The high turnover rate leads to inefficiency, as was noted in connection with the other laboratories. The need for these transients is imposed by EPA personnel rulings. Many URI graduate students are employed part time on research programs, and the Committee fully approves of this activity.

3. FACILITIES

The location of the Laboratory is advantageous in that Narragansett Bay has been the subject to many taxonomic studies over the years and considerable knowledge exists about the ecology of the Bay. It is thus an excellent place for a wide variety of research on brackish and marine organisms. In addition, a relatively extensive monitoring program on the physical and chemical features of the Bay has produced excellent background information.

A research barge located at Point Judith is utilized for experimental studies and culturing organisms. At the time of its acquisition, the National Marine Water Quality Laboratory was housed in a leased facility, ten miles from a direct source of sea water. Not until the Laboratory was moved to its current location was this situation remedied. At the present time research space is cramped, but new laboratories are under construction. These laboratories should greatly improve the efficiency of the research. Equipment is excellent, modern, and up-to-date. An outstanding example is a video-computer that is being established for quantitative studies of behavior of fish and crustaceans.

The Library, located in the West Kingston Building, is an excellent resource center. It is one of the best of the libraries in any of the laboratories visited.

4. RESEARCH PROGRAM

Attempts are being made to develop long-range as well as short-range programs directed toward understanding marine ecosystems. The culturing of marine organisms native to the area and the use of these organisms in bioassay tests are to be commended. The Committee is pleased to see that the effect of pollution on various life stages is being included in the bioassay work. A variety of species and life stages of marine organisms are studied for their responses to

various toxic materials. The responses varied by about two orders of magnitude. The concept that bioassays should be performed on the most sensitive life stage of the most sensitive organism in the ecosystem had been given lip service at the other laboratories but this was the first time that hard data were presented to indicate that something was really being done on this question. The data indicated clearly that the common species used in the past for bioassays, Artemia and Fundulus, are among the poorest bioassay organisms one could select because they are so tough and resistant. These studies will result in more knowledge concerning the physiology and sensitivity of the various age classes. Phycologists on the Committee were very much interested in the bioassay on algae. This work should be encouraged. At this Laboratory as at the other Laboratories, emphasis in bioassay studies is not on lethality but rather on chronic effects of low level effects of a pollutant upon organisms. Here they are using photosynthesis of various species of phytoplankton, and growth, reproduction, behavior and respiration of various planktonic species as their criteria for environmental impact. Food consumption of lobster larvae and flounders and short-term growth indications were also being evaluated as means of assessing toxicity effects.

Analyses of the cycling of toxicants in these ecosystems, although they are constant in many other environmental factors, should still produce considerable information for developing a model of how various pollutants effect estuarine organisms.

The Committee feels that scientists working on culture and bioassay programs should interact more fully with investigators in other laboratories working on similar problems. In nutrition they should continue to interact with persons at Cornell University, in the Fish and Wildlife Service laboratories in Washington, the Florida maricultural work. They should also consult with scientists at marine laboratories and facilities around the country, such as the Steinhart Aquarium in Chicago or the National Aquarium in Washington, D.C. In regard to diseases and pathology, often encountered in cultured organisms, they should have considerable contact with the work of the Fish and Wildlife Service's Eastern Fish Disease Laboratory. More emphasis should be placed on understanding the parasitology of organisms cultured in the Laboratory.

With reference to research projects on the effects of petroleum on marine organisms, the most talked-about effect was that of tumors, tentatively identified as cancer, found in some invertebrates. Chemical carcinogens such as oil and petroleum products can cause cancer in experimental animals, notably: vertebrates. Positive tests for cancerous growth are appropriately made in or on living tissue. Among criteria used in determining whether or not observed tissue or cell aberrations are cancerous is the test for metastasis. To achieve this, a portion of the suspected cancerous tissue is grafted into normal tissue of a living organism. If a tumor develops in the normal host tissue as a result of this graft, one can conclude that the implanted tissue is cancerous.

There are other demonstrated differences between normal and cancer cells when grown in culture: (1) Normal cells tend to proliferate rapidly for several months and die. In contrast, cancer cells proliferate in culture for many years without loss of vigor and vitality; (2) Normal and cancer cells respond differently when they become crowded in glass culture vessels. Normal cells in the process of growth and proliferation cease division upon coming in contact with one another. Cancer cells, on the other hand, when this occurs, continue to proliferate and tend to stack one upon the other.

The Committee is of the opinion that the designation of cancer for the growth aberrations found in certain clam tissues should be withheld until such time as the techniques are available for making tests with them in the living state as outlined above.

The "big bag" experiment (Facility for the Experimental Analysis of Coastal Marine Ecosystems, EPA grant R803902-01, University of Rhode Island Graduate School of Oceanography) caused concern among some of the Committee members. This study was introduced by the Laboratory Director when he presented Narragansett's program at the Gulf Breeze meeting (APPENDIX J). The Committee expected to have an opportunity to have input before the project was authorized and regretted that it was funded only a few days before the site visit.

This experiment is a very complex one and the scientific staff at Narragansett needs many kinds of advice if it is to be successful. A plan should be developed to add one or more trained ecologists to the Laboratory staff and to use outside expertise. The independent advisory board, which has been

appointed by the University of Rhode Island, consists of competent people, and their continuing advice on this program will be necessary for success.

The barge facility at Point Judith seems a potentially useful addition to their experimental approaches to many programs, but it had not yet been used to full advantage and it should be fully exploited. Plans for this facility include studies of benthic microcosms and, if properly exploited, this research could contribute to our understanding of the ecosystem impact of pollutants.

One of the general criticisms of the Laboratory's programs is that many projects were talked about but little appeared to be in progress. The Committee could thus not actually observe how experiments were carried out or examine how results were obtained.

5. PRODUCTIVITY OF RESEARCHERS

Although some very worthwhile publications are coming out of the Laboratory, and some of these are in refereed journals, the Committee observed considerable unpublished data that should be prepared for publication. Furthermore, rate of publication does not seem to be as high as indicated by the potential of the group.

6. COMMUNICATION

Several instances point up the necessity to improve communication among the Laboratory staff. Regular programs should be maintained whereby chemists and biologists interact and describe their research to each other. Communication failure was apparent, for example, in a discussion by Laboratory scientists of motion patterns by videotape and computer analysis. Biologists and computer analysts seemed to be out of touch.

There is also some question on the degree of communication among EPA Laboratories engaged in marine research. Reasonably good communication exists between Gulf Breeze and Narragansett, but that between Narragansett and Corvallis was less obvious. It was difficult to judge the degree of communication with the University of Rhode Island which is near at hand.

7. CONCLUSIONS AND RECOMMENDATIONS

The Committee concluded that innovative programs are being planned, initiated, or undertaken at the Laboratory, and that researchers are enthusiastic about them. These experiments, however, should be carefully designed, carried out with precision, and frequent use of advisory scientists should be made to guide researchers in their ecosystem investigations. One or more very competent ecologists specializing in marine ecosystems should be added to the staff.

Some members of the Committee feel that the program should be more clearly focused.

The Committee recommends the following:

- Frequent use of advisory scientists in the Laboratory's ecosystem studies.

- Addition of one or more very competent ecologists with particular expertise in marine ecosystems.

- Greater interaction between scientists working on culture and bioassay problems and those in other laboratories, particularly in regard to nutrition, diseases, and parasitalogy of organisms under culture.

- Exercise of caution until appropriate tests are completed before identifying observations in invertebrates as cancer.

- Improved communication among Laboratory staff.

- More effective use of the barge facility.

APPENDICES

APPENDICES

A. Letter of April 8, 1975, from Dr. Wilson K. Talley, Assistant Administrator for Research and Development, to Dr. Ruth Patrick, Chairman, Ecology Advisory Committee

B. Informational Materials Provided to the Ecology Advisory Committee

C. Publications and Reports Provided to the Ecology Advisory Committee

D. Ecology Advisory Committee, Site-Visits--Schedule

E. Ecology Advisory Committee Advisory Statement -- The Shagawa Lake Project, October 23, 1975

F. Ecology Advisory Committee Advisory Statement--The National Lake Survey, October 23, 1975

G. Ecology Advisory Committee Advisory Statement--Gas Bubble Disease of Fishes, October 23, 1975

H. Ecology Advisory Committee Advisory Statement--Acid Precipitation, October 23, 1975

I. Ecology Advisory Committee Advisory Statement--Administrative Factors Influencing the Scientific Programs at the Environmental Research Laboratory, Corvallis, Oregon, October 23, 1975

J. Agenda -- Ecology Advisory Committee Meeting, February 24-25, 1975

K. Agenda -- Ecology Advisory Committee Meeting, April 23, 1975

L. Agenda -- Ecology Advisory Committee Meeting, July 25, 1975

M. Agenda -- Ecology Advisory Committee Meeting, August 14, 1975

N. Agenda -- Ecology Advisory Committee Meeting, October 23, 1975

O. Letter of December 1, 1975, from Dr. Shelby D. Gerking to Dr. J Frances Allen

P. Comments on Design of Ecosystem Investigations

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 8 1975

OFFICE OF
RESEARCH AND DEVELOPMENT

Dr. Ruth Patrick, Chairman
Ecology Advisory Committee
Science Advisory Board

Dear Ruth:

I understand that the Ecology Advisory Committee will hold its next meeting April 22 at our Gulf Breeze laboratory, and that the Committee plans to use part of that time to develop a detailed familiarity with the scientific programs there. I strongly support this endeavor, because it provides the Committee with the basis to address one aspect of a problem of great concern to me.

It is essential that this Agency be assured that the scientific support for its regulatory actions is sound. The scientists who compose our laboratories and the research which they conduct are key aspects of this support. In recognition of this, the National Academy of Sciences and other sources have suggested that the Agency, in addition to conducting administrative review, independently appraise the quality of its scientific programs. For some time I have intended to follow through on this by seeking a Science Advisory Board critique of the quality of EPA scientific programs, but I have delayed due to the impending reorganization of my Office. However, your Committee's visit to Gulf Breeze creates an opportunity in this regard that should not be passed by.

Thus, as the Committee conducts its study of the Gulf Breeze program, I would like to have them do so with the anticipation of eventually preparing for my use a critique of the scientific quality of all my ecological research programs. In order that this critique be consistent with the broader study which will be conducted under SAB auspices, I would like to suggest that the Committee use the same "value criteria" in preparing its critique as are projected for the rest of the Board. These are:

- Products of research

  Are publications and reports significant, adequate in quantity, of scientific value? Are research products meaningful to EPA's role and of suitable scientific impact?

- Research scientists

  Are the backgrounds and disciplinary mix of staff appropriate to the need?

- Scientific environment

  How adequate are both scientific and reference resources? Is there appropriate cross-fertilization among the on-site scientists? Within the scientific community?

I recognize that your use of these "value criteria" must perforce be subjective and imprecise, but the assessments will be those of recognized experts in the field.

I feel I should emphasize that my request does not imply any lack of confidence on my part, either in the ecological research program or in other ORD scientific programs. However, it is an accepted premise that scientists benefit by "peer review", and although there have been numerous administrative reviews of the ORD, no comprehensive scientific review of this type has been conducted since the formation of EPA. This work will be most helpful to me if the Committee can confine its evaluations to its study of the current activities and past products of the laboratory, rather than addressing programmatic gaps or problems in research priorities not truly relevant to the scientific quality of the program.

Sincerely,

Wilson K. Talley
Assistant Administrator for
Research and Development

c/o Department of Limnology
Academy of Natural Sciences
of Philadelphia
19th Street and the Parkway
Philadelphia, Pennsylvania 19103

APPENDIX B

INFORMATIONAL MATERIALS PROVIDED TO THE
ECOLOGY ADVISORY COMMITTEE

Environmental Research Laboratory -- Corvallis

Environmental Research Laboratory -- Corvallis. A Summary of Missions, Needs, Resources, Accomplishments and Trends. August 1975.

List of Publications of the Staff of the National Ecological Research Laboratory and Reports without Author Attribution. April 1975.

List of National Eutrophication Survey Working Papers. Printed July 21, 1975.

Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon. Publications and Reports. Revised Spring 1974.

Pacific Northwest Environmental Research Laboratory. Publications and Reports Resulting from Research Grants Funded through the Coastal Zone Pollution Branch. Fall 1974.

Alaska Field Station
(Arctic Environmental Research Laboratory)

List of Publications: Laboratory Reports and Working Papers Series, Arctic Environmental Research Laboratory, College Alaska. April 1975.

Western Fish Toxicology Station

List of Publications, April 11, 1975.

Environmental Research Laboratory -- Duluth
(National Water Quality Laboratory)

List of Publications: July 1974, October 1975. List of Papers Presented and Formal Statements Made.

Quarterly Reports of Laboratory:

June 30, 1974
September 30, 1974
December 30, 1974
March 31, 1975
June 30, 1975
September 30, 1975
October-December 1975

Research Highlights:

Freshwater Aquatic Life
*NWQL Research on Waste Oil
*NWQL Undertakes Complex Effluent Monitoring Tests

Technical Assistance Reports to National Environmental Research Center -- Corvallis. December 1974; January, February, March, April, May, 1975.

National Water Quality Laboratory. The Search. 20 pp.

Large Lakes Research Station
(Grosse Isle Laboratory)

Grosse Ile Laboratory Annual Report. May 1975. National Environmental Research Center, Office of Research and Development, EPA. 53 pp.

List of Grant and Contract Technical Publications.

Monticello Field Station

Full-Scale Fish Studies at EPA.. Project Expected in Fall of 1976. Monticello (Minn.) Times. August 7, 1975. p. 5.

*Also contains other items.

Environmental Research Laboratory -- Gulf Breeze

List of Staff Publications, April 18, 1975.

List of Papers in Press or Accepted for Publication, March 11, 1975.

List of Scientific Meetings Attended by Staff and Papers Presented. January 1974 - December 31, 1974.

Quarterly Reports of Laboratory:

1 April 1974 - 30 June 1974
1 July 1974 - 30 September 1974
1 October 1974 - 31 December 1974
1 January 1975 - 31 March 1975
1 April 1975 - 30 June 1975

Bears Bluff Field Station

Quarterly Reports of Station:

1 April 1974 - 30 June 1974
September - December 1974

Marine Research Report -- Historical Background 1949-1974, (and other information).

Environmental Research Laboratory -- Narragansett
(National Marine Water Quality Laboratory)

List of Publications and Reports: Publications, Papers Submitted to Journals, Papers in Review by In-house Review Committee, Papers in Preparation at Author Review, Presentation to be Published as Planned. September 1975.

Semi-Annual Reports of Laboratory:

July - December 1974
January - July 1975

Research Proposal No. R803902-01, April 1, 1975, A Facility for the Experimental Analysis of Coastal Marine Ecosystems, University of Rhode Island to the National Marine Water Quality Laboratory, Narragansett.

General

Gamache, Rose Ann: Presentation given October 25, 1975 at the Environmental Research Laboratory, West Kingston, Rhode Island to EPA Science Advisory Board's Ecology Advisory Committee. 8 pp.

List of Evaluation Studies -- EPA Library Systems.

List: EPA Library Systems Video-Tapes.

List: Publications Issued in Conjunction with the Office of International Activities.

List: Publications of the EPA Library Systems Branch.

Office of Research and Development. Indexed Bibliography of Office of Research and Development Reports. September 1974. EPA-600/9-74-001.

Office of Research and Development. Indexed Bibliography of Office of Research and Development. Updated to January 1975. March 1975. EPA-600/9-74-002. 293 pp.

Office of Research and Development. ORD Publications Summary. EPA-600/9-75-001b. 160 pp.

Office of Research and Development. ORD Publications Summary. EPA-600/9-75-001c. 164 pp.

Office of Research and Development. ORD Publications Summary. EPA-600/9-75-001d. 156 pp.

Summaries of the Ecological Research Programs at: National Environmental Research Center, Corvallis, Oregon; National Water Quality Laboratory, Duluth Minnesota; National Marine Water Quality Laboratory, Narragansett, Rhode Island; Gulf Breeze Environmental Research Laboratory, Gulf Breeze, Florida. Prepared for the SAB Ecology Advisory Committee Meeting, Gulf Breeze, Florida, April 22, 1975.

The Institute of Ecology. Implementing the Ecology Theme. February 1975. EPA Contract 68-03-0354. Project Officer, Earl Kari. National Environmental Research Center, Corvallis. 62 pp.

U. S. Environmental Protection Agency. July 1973. State and Local Environmental Libraries: A Directory. 24 pp.

U. S. Environmental Protection Agency. October 1974. User's Guide to the Environmental Protection Agency Library System. Report EPA-LIB-74-05. 11 pp and Appendix.

U. S. Environmental Protection Agency. October 1975. U. S. National Focal Point for United Nation's Environment Program, International Reference System (UNEP/IRS) - Background Information. 14 pp.

U. S. Environmental Protection Agency, Focus: Library Services. 19 pp.

APPENDIX C

PUBLICATIONS AND REPORTS PROVIDED TO THE ECOLOGY ADVISORY COMMITTEE

Bannerman, R. T., D. E. Armstrong, R. F. Harris, and G. C. Holdren. 1975. Phosphorus uptake and release by Lake Ontario sediments. EPA-660/3-75-006. (Grant No. 800609.)

Barry, M. M., and P. P. Yevich. 1972. Incidence of gonadal cancer in the quahog Mercenaria mercenaria. Oncology 26: 87-96.

Baumgartner, D. J. 1969. Discussion of a paper entitled: The fate of intestinal bacteria in the sea, by R. Mitchell and J. Carell Morris. Pages 819-821 in S. H. Jenkins, ed. Advances in water pollution research. Proceedings of the 4th International Conference held in Prague, 1969. Pergamon, New York.

Baumgartner, D. J., and R. J. Callaway. 1970. State of the art for simulation of pollution problems and controls in estuaries. Pre-publication copy. 19 pp.

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Beck, Allan D., and Neal F. Lackie. n.d. Effects of passage of marine animals through power plant cooling systems. 36 pp.

Biesinger, Kenneth E., and Glenn M. Christensen. 1972. Effects of various metals on survival, growth, reproduction and metabolism of Daphnia magna. J. Fish. Res. Board Can. 29(12): 1691-1700.

Biesinger, Kenneth E., Robert W. Andrew, and John W. Arthur. 1974. Chronic toxicity to NTA (nitrilo-triacetate) and Metal-NTA complexes to Daphnia magna. J. Fish. Res. Board Can. 31(4): 486-490.

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Borthwick, P. W., T. W. Duke, A. J. Wilson, Jr., J. I. Love, J. M. Patrick, Jr., and J. C. Oberhew. 1973. Residues in fish, wildlife, and estuaries. Pestic. Monit. J. 7(1): 6-26.

Bouck, G. R., A. V. Nebeker, and D. G. Stevens. Mortality, saltwater adaptation, and reproduction of fish exposed to gas supersaturated water. Preliminary draft. 84 pp.

Bourquin, Al W., Donald G. Ahearn, and Samuel P. Myers, eds. 1975. The impact of the use of microorganisms on the aquatic environment. Proceedings of Symposium Workshop, April 1974. EPA-660/3-75-001.

Bourquin, Al W., and S. Cassidy. 1975. Effect of poly-chlorinated biphenyl formulations on the growth of estuarine bacteria. Appl. Microbiol. 29: 125-127.

Brooks, Norman H. 1973. Dispersion in hydrologic and coastal environments. EPA-660/3-73-010. (Grant No. 16070 DGY.)

Brungs, William A. 1973. Continuous-flow bioassays with aquatic organisms: Procedures and applications. Pages 117-126 in Biological methods for the assessment of water quality. Am. Soc. Test. Mater., Spec. Tech. Bull. 528.

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Bryam, K. V., F. A. Roberts, and L. A. Wilson. n.d. A data reduction system for an automatic colorimeter. Pages 226-233 in ORD ADP workshop proceedings, No. 1. Office of Program Management, ORD, EPA.

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Bydalek, T. J., J. E. Poldoski, and D. Bagenda John. 1970. Spectrophotometric determination based on the formation of tris-1,10-phenanthroline iron(II). Anal. Chem. 42: 929-930.

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Callaway, R. J. 1974. Subsurface horizontal dispersion of pollutants in open coastal waters. Proceedings of the International Symposium on Discharge of Sewage from Sea Outfalls. London, August 28, 1974. Paper No. 30. 10 pp.

Chapman, Gary A. June 1975. Interim Report. Toxicity of copper, cadmium, and zinc to Pacific Northwest salmonids. Western Fish Toxicology Station. 27 pp.

Chasse, James P. January 1974. Activities of EPA's Thermal Pollution Branch, past, present, future. 7 pp.

Cheer, Sue. Memorandum, preliminary cruise report, cruise number 75-05, July 27 to August 12, 1975. Narragansett, R.I. to Tampa, Fla. Project VI-2.1, U.S. and U.S.S.R. joint cruise. University of Moscow Research Vessel. Memo to E. Schneider (EPA, USA): A. Simonov (Instit. Oceanogr., USSR); and V. Federov (Marconi Univ., USSR). 6 pp.

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Committee on Methods for Toxicity Tests with Aquatic Organisms. April 1975. Methods of acute toxicity tests with fish, microinvertebrates, and amphibians. U. S. Environmental Protection Agency. EPA-660/3-75-009.

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APPENDIX D

ECOLOGY ADVISORY COMMITTEE

SITE VISITS -- SCHEDULE

ENVIRONMENTAL RESEARCH LABORATORY	FIELD STATION	DATE 1975	COMMITTEE / COMMITTEE REPRESENTATIVES	
Gulf Breeze		April 22	X	
	Bears Bluff Field Station	April 21		X (5)
Duluth		July 24-25	X	
	Monticello Field Station	July 26	X	
Corvallis		August 15-16	X	
	Western Fish Toxicology Station	August 16	X	
	Newport Field Station	August 16		X (5)
Narragansett		October 24-25	X	

APPENDIX E

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE
ADVISORY STATEMENT

THE SHAGAWA LAKE PROJECT

Background

Concern had been expressed for the effects of the effluent from the secondary wastewater treatment plant, Ely, Minnesota, on the eutrophic state of Shagawa Lake. In order to assist in defining the significance of the wastewater discharge, the hydrological, phosphorus, and nitrogen budgets of the Lake were determined from 1969 through 1972. The hydrological and nutrient budgets and the laboratory studies indicated that the high levels of phosphorus in the effluent were chiefly responsible for the Lake's eutrophied condition.

These studies, conducted by the U. S. Environmental Protection Agency and its predecessor agencies, led the Agency to construct a demonstration project tertiary wastewater treatment plant that was designed to remove 99% of the phosphorus from the secondary effluent. The purpose of this effort was to demonstrate that phosphorus removal would allow the limnological processes within the Lake to stabilize to a situation with less frequent and less intensive algal blooms. The treatment plant produces an effluent that is twenty times better than that which is required to meet minimum water quality standards.

The complete operation of the tertiary wastewater treatment plant is to be turned over to the village of Ely. EPA researchers would continue only water quality monitoring studies. This situation poses several potential problems of importance.

- It is questionable that the village of Ely can continue to operate the plant in the same way that EPA researchers have been doing, both economically and in terms of maintaining effluent quality.
- The village of Ely has the potential option of treating sewage and releasing the effluent with 20 times the amount of phosphorus as that presently released without violating minimum State water quality standards. Therefore, it seems likely that the phosphorus content of treated effluent will increase substantially.
- Any progress in arresting the acceleration of eutrophication would be offset because of the increased phosphorus content of the effluent discharged to the Lake.
- The issue as to whether the system has stabilized sufficiently so that the true algal bloom potential has been reduced is still

unresolved. It has been observed that on any very warm or unseasonable day, sudden and extensive blooms occur. It is believed that these blooms are related to thermal conditions. Further, periods of stabilization in water bodies following changes in the limnological processes often take as much as five years before it is assured that stabilization has truly occurred.

- There have been no scientific assessments on the role of zooplankton, fishes, and benthos, nor in mixing and diffusional processes in the Lake.

The Ecology Advisory Committee is in agreement that the funds for EPA's efforts are inadequate to follow through the program as originally conceived and allow for only a limited sampling program.

The Ecology Advisory Committee recommends that a new emphasis be placed on the Lake Shagawa Project in order to exploit the unique situation. The presence of a highly sophisticated tertiary plant on a highly studied water body is unique in the limnological experience.

The Committee recommends:

1. Continuation of full sewage treatment until the lake ecosystem has stabilized.

   a. A carefully designed biological sampling program should be carried out in order to determine the changes in the biota, habitat structure, water chemistry, and sediment processes of the Lake.

   b. The degree of sampling for the various groups of organisms should be sufficient to determine the nutrient transfer and production of various important species.

2. Following stabilization, the treatment might be modified to evaluate the effects of lesser treatment.

3. The Lake Shagawa biological study presents an extremely important opportunity to estimate and assess the comparative costs and benefits, in social, economic, and environmental terms, of various levels of sewage treatment. This opportunity for study should be called to the attention of analytical groups, such as The Institute of Ecology, concerned with the evaluation of benefits resulting from various approaches to resource management.

APPENDIX F

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE
ADVISORY STATEMENT

THE NATIONAL LAKE SURVEY PROJECT

The Ecology Advisory Committee of the Science Advisory Board recognizes that the National Lake Survey Project has served an admirable purpose in supplying characterization of some 800 lakes and reservoirs in the contiguous United States. The National Lake Survey Program was conceived originally as the Office of Research and Development's contribution to a policy paper being developed by the U. S. Environmental Protection Agency on possible requirements for municipal wastewater treatment plants to remove phosphate from sewage by processes beyond secondary treatment. The purpose of this requirement would be to prevent the accelerated eutrophication of water bodies related to the nutrient content of effluents discharged from those treatment plants. In order to carry out this program, data were collected from the States on lakes and reservoirs that have various types of eutrophication problems. The relationship between the locations of these lakes and reservoirs and the location of the discharge from the sewage treatment plants, either directly into the lakes and reservoirs or into feeder tributaries into the lakes and reservoirs, was a major factor in the selections for survey.

A crash program of sampling of water chemistry and plankton productivity in as many lakes and reservoirs as possible was undertaken in order to identify those that are limited in productivity by nutrients or abiotic factors. In addition, of those lakes associated with a sewage treatment plant as a sole point-source nutrient input, the degree of tertiary treatment (selective nutrient removal) necessary to "stabilize" the productivity of a water body and possibly lead to a reversal of the process symptomatic of cultural eutrophication might then be projected.

At approximately the same time, the Agency was required to respond to the Congress on certain initiatives in the restoration of eutrophied lakes and impoundments under other legislative mandates. Information gathered for the National Lake Survey program paralleled information needed for Congresionally mandated reports. The Lake Survey Program, therefore, acquired an additional purpose.

Initiated in 1972, this Survey of more than 800 bodies of water in the contiguous United States will be concluded in late 1975 upon the completion of the sampling of the western sector of lakes and reservoirs. Data analyses will require one more year. It is recognized that because the Survey is a crash program, conducted over a relatively short period of time and with a limited sampling program, the data obtained will be relatively crude.

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The Committee states further that because of the non-random selection of the lakes and reservoirs and the limited sampling program of limnological parameters, the results of the Survey must be viewed with some caution. The Committee has severe reservations about the suitability of the National Lake Survey data for extrapolation and generalization. There is a concern that premature evaluation of these data may lead to incorrect conclusions and result in bad management practices.

In order to strengthen the credibility of the study, the Committee recommends that:

- The National Lake Survey data should be compared with existing data on the many well-studied lakes of similar type.

- The comparisons of the results should be discussed in personal conference with limnologists who have collected and assessed data on the same or similar lakes and impoundments covered by the National Lake Survey.

- The National Lake Survey estimation techniques should be applied to data already available on additional well-studied lakes and impoundments and those results should be compared. This will enable one to test the degree of error one may expect to find and thus provide an evaluation of the reliability of the Survey itself.

- Only after such comparison should further efforts at extrapolation and generalization through the computer be carried out.

APPENDIX G

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE
ADVISORY STATEMENT

GAS BUBBLE DISEASE IN FISHES

Gas bubble disease in fishes is an important problem, particularly below the high dams in the large rivers of the Pacific Northwest. Considerable research has been done and is being done in EPA laboratories and by other agencies on the effects of gas supersaturation on fishes. The work has reached the stage where EPA can consider terminating its program.

The Ecology Advisory Committee recognizes that:

- Understanding of the pathology of this disease is essentially complete, and the causes are known. Further study in this field is unlikely to provide new information that would alter the basis for EPA regulatory policy.

- Many aspects of supersaturation are apparently controllable and further attention should be given by appropriate agencies to control methods to mitigate this problem through engineering and design changes.

The Committee, therefore, recommends that:

- The considerable body of information on this topic should be compiled and subjected to independent review within the next few months for the purpose of either concluding the work or planning future efforts.

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APPENDIX H

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE
ADVISORY STATEMENT

ACID PRECIPITATION

The Ecology Advisory Committee of the Science Advisory Board, after considering the scientific evidence, recognizes that the United States in certain regions has an acid precipitation problem that may have serious impacts on our natural--and possibly human--resources.

The Committee, therefore, intends to establish an Ad Hoc Study Panel, responsive to the Ecology Advisory Committee, to consider the complexities of the apparent acid precipitation problem and the associated environmental implications.

The Ad Hoc Study Panel is charged as follows:

- To consider in detail the research needs relative to this problem and their relative urgency.
- To assess, in the broadest sense, the present and anticipated future ecological impacts of this problem throughout the United States.
- To provide the Ecology Advisory Committee with a comprehensive report on the Panel's findings.

The Committee further recommends that the Environmental Protection Agency take the lead in formulating an inter-agency committee consisting of representatives of Federal agencies that are or may be concerned with acid precipitation. The inter-agency committee would be charged with:

1. Assessing the interests and responsibilities of the respective agencies.
2. Formulating a plan of action for the funding of the necessary research.

APPENDIX I

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE
ADVISORY STATEMENT

ADMINISTRATIVE FACTORS INFLUENCING THE QUALITY OF SCIENTIFIC PROGRAMS AT THE CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY

In its consideration of the ecological research programs at the EPA Corvallis Environmental Research Laboratory, the Committee felt that administrative factors were of special relevance to the scientific quality of these programs. In that regard the Committee has reached these conclusions and recommendations:

- The Committee felt that in the past there was not a clear line of communication between the various laboratory directors of EPA (including Corvallis) and the Washington office as to the priority of research programs and funding. It is hoped that under the new organization this will be substantially improved.

- The Committee concluded that at Corvallis there has not been sufficient communication between the research leaders and the Director and that every opportunity should be given to the program leaders to develop their own ideas as to how the research they carry out should be done. Better integration of the programs at the Laboratory is desirable.

- The Committee felt it was unfair to compare the management of this laboratory with Gulf Breeze or Duluth as the Corvallis programs are much more diverse. It is believed that once the mission of the Laboratory is better defined, the diversity of the programs can be better integrated and more effectively handled.

APPENDIX J

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE

Agenda
February 24-25, 1975

Room 1112, Building 2, Crystal Mall
1921 Jefferson Davis Highway, Arlington, Virginia

February 24	Dr. Ruth Patrick, Chairman	
9:00 a.m.	The Ecology Advisory Committee and Its Potential for the Environmental Protection Agency	Mr. Russell E. Train Administrator
	The Ecology Advisory Committee and its Potential for Specific Agency Areas of Responsibility	Dr. Wilson K. Talley Assistant Administrator for Research and Development
		Mr. Roger Strelow Assistant Administrator for Air and Waste Management
		Mr. James L. Agee Assistant Administrator for Water and Hazardous Materials
		Mr. Alvin L. Alm Assistant Administrator for Planning and Management
		Mr. Richard Johnson Acting Assistant Administrator for Enforcement
10:30 a.m.	Organization and Operation of the Agency's Science Advisory Board	Dr. Thomas D. Bath Staff Director Science Advisory Board
11:15 a.m.	Commentary	Dr. Ruth Patrick

12:00 M	Recess - LUNCH	
1:15 p.m.	Ecological Areas of Concern as viewed by Members, of the Ecology Advisory Committee	Dr. Patrick and Committee Members
3:30 p.m.	Adjournment	

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February 25

9:00 a.m.	Reorganization of the Agency's Research and Development Program	Mr. Carl Gerber Consultant
9:30 a.m.	Ecological Research in the Environmental Protection Agency	Dr. Andrew J. McErlean Director, Ecological Processes and Effects Division
		Dr. Paul Lefcourt Chief, Coastal Zone Ecosystem Branch
		Dr. Frank G. Wilkes Chief, Watershed Ecosystem Branch
		Dr. Kenneth J. Hood Terrestrial Ecologist, Atmospheric and Terrestrial Branch
		Dr. John Buckley Deputy Assistant Administrator for Program Integration

12:00 M	Recess - LUNCH	
1:00 p.m.	Identification of problems to be studied by the Ecology Advisory Committee and setting up procedures for immediate attack.	Dr. Patrick and Committee Members
3:00 p.m.	Adjournment	

APPENDIX K

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE

Agenda
April 22, 1975

Conference Building

Gulf Breeze Environmental Research Laboratory
Sabine Island, Gulf Breeze, Florida

8:30 a.m.	Opening Remarks	Dr. Ruth Patrick, Chairman
8:45 a.m.	Review of EPA's Ecological Research Program	
	Introduction	Dr. Andrew McErlean
	Research Programs of the Laboratories	
	Environmental Research Laboratory - Corvallis, Oregon	Dr. Norman Glass
	Environmental Research Laboratory - Duluth, Minnesota	Dr. Donald Mount
	Environmental Research Laboratory - Narragansett, Rhode Island	Dr. Eric Schneider
12:30 p.m.	Recess - Lunch	
1:30 p.m.	Environmental Research Laboratory - Gulf Breeze, Florida	Dr. Thomas Duke

2:30 p.m.	Concluding Remarks	Dr. John Buckley
2:45 p.m.	Review of Gulf Breeze On-Going Research Activities	Dr. Thomas Duke and Staff
5:00 p.m.	Comments: The Health of the Environment Project	Dr. Bostick Ketchum Dr. John Neuhold Dr. Gordon Orians
5:15 p.m.	Member Items of Interest	
5:45 p.m.	Adjournment	

APPENDIX L

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE

AGENDA

July 25, 1975

Conference Room
National Water Quality Laboratory
6201 Congdon Boulevard
Duluth, Minnesota

1:00 p.m.	Introductory Remarks	Dr. Ruth Patrick, Chairman
1:15 p.m.	Executive Committee Activities, Science Advisory Board	Dr. Thomas D. Bath
1:45 p.m.	Five Year Summary - Reserve Mining Case	Dr. Gary E. Glass
2:30 p.m.	Activities Lake Superior Basin Study Center, University of Minnesota, Duluth	Dr. Wayland R. Swain
3:15 p.m.	Activities Center for Lake Superior Environmental Studies, University of Wisconsin, Superior	Dr. Albert Dickas
3:45 p.m.	Sea Grant Program, University of Wisconsin, Superior	Dr. William A. Swenson
4:15 p.m.	Sea Grant Program, University of Minnesota, Duluth	Dr. Dale Baker
4:45 p.m.	Technical Assistance: Research in Action	Dr. Donald I. Mount
5:15 p.m.	Member Items of Interest	
5:30 p.m.	Adjournment	

APPENDIX M

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE

Agenda

August 15, 1975

Conference Room
Corvallis Environmental Research Laboratory
200 S.W. 35th Street
Corvallis, Oregon

1:30 p.m.	Opening Remarks	Dr. Ruth Patrick, Chairman
1:40 p.m.	Science Advisory Board Activities	Dr. Thomas D. Bath
1:55 p.m.	The Trans-Alaska Pipeline	Dr. O. E. Dickason
2:45 p.m.	Douglas Fir-Tussock Moth Research and Development Program	Mr. Kenneth Wright Dr. Max McFadden Mr. Gerald Dewey
3:35 p.m.	Review of the Acid Precipitation Problem	Dr. Gene E. Likens
4:30 p.m.	Status Report on Ad Hoc Study Group Evaluation of the Technical Bulletin on Acceptable Methods of Utilization or Disposal of Sludges	Dr. Bostwick Ketchum
4:40 p.m.	Commentary	Dr. Emil M. Mrak
5:05 p.m.	Concluding Remarks	Dr. Ruth Patrick
5:15 p.m.	Adjournment	

APPENDIX N

U. S. ENVIRONMENTAL PROTECTION AGENCY

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE

The Delft Room, Dutch Inn
Great Island Road - Galilee
Narragansett, Rhode Island

October 23, 1975

AGENDA

1:30 p.m.	Opening Remarks	Dr. Ruth Patrick, Chairman
1:45 p.m.	Report: September 18-19, 1975 Science Advisory Board Executive Committee Meeting	Dr. Thomas D. Bath
2:00 p.m.	Design of Bioassay Experiments for Non-Human Organisms	Dr. John Zapp
3:00 p.m.	Biological Indicators of Problems Related to Development of East Coast Offshore Oil Resources	Dr. C. Richard Robins
3:30 p.m.	Coffee Break	
3:45 p.m.	Progress Report: Ad Hoc Study Group on Municipal Sludge Disposal and Utilization	Dr. Bostwick Ketchum
4:00 p.m.	Consideration of Committee Advisory Statements on: Acid Precipitation The National Lake Survey Project The Shagawa Lake Project Gas Bubble Disease of Fishes Long-term Plans for Ecological Research	Dr. Ruth Patrick

5:30 p.m.	Member Items of Interest
5:45 p.m.	Concluding Remarks
6:00 p.m.	Adjournment

APPENDIX O

ARIZONA STATE
UNIVERSITY TEMPE, ARIZONA 85281

DEPARTMENT OF ZOOLOGY

December 1, 1975

Dr. J. Frances Allen
7507 23rd Avenue
Hyattsville, Maryland 20783

Dear Jayde:

I would like to modify my analysis of the status of gas bubble disease research. As you remember, I concluded that much of the data had not yet reached report form and therefore no evaluation of the material could be made in relation to possible EPA regulations on gas supersaturation in water. Two reports have been sent to me which put a different light on the matter.

Dr. Bouck recently sent me a report by him, Nebeker and Stevens on "Mortality, saltwater adaptation and reproduction of fish exposed to gas supersaturation". He was also instrumental in having sent to me a report from NOAA on research performed under contracts with Bonneville Power Administration, Bureau of Reclamation, and U.S. Army Corps of Engineers. This final report is titled "Studies on effects of supersaturation of dissolved gases on fish." It carries a September 1975 publication date (mimeographed).

These two reports add greatly to an overall evaluation of gas bubble disease and I believe that EPA regulations could be drawn from them, especially the NOAA report. It is thorough and treats continuous vs intermittent exposure effects, bioassays in the field and laboratory, avoidance, physiological effects (stamina, O_2 consumption, blood chemistry, effects of different O_2/N_2 ratios). The Bouck, et al. report deals with reproduction effects, adaptation to saltwater and bioassay results. Adding these studies to the number of reports already available, I believe sufficient work has been done for EPA purposes.

I hope you understand that I felt that my original appraisal was justified and that this modifying statement is based on new information. I now question whether an independent investigation of the status of gas bubble disease research is justified. Either the Western Fish Toxicology Laboratory or the Washington office should be able to arrive at a reasonable set of recommendations from information now available.

Sincerely yours,

Shelby D. Gerking

Shelby D. Gerking
Professor of Zoology

SDG:mgl

APPENDIX P

Comments on Design of Ecosystem Investigations

Only at Corvallis did the Committee observe any terrestrial research. Considering the limitations of personnel and budget a good start has been made.

Since the Committee observed no true aquatic ecosystem research, the following remarks are directed toward the kinds of research that should be included in the design of ecosystem investigations.

Careful study of aquatic ecosystems enables a scientist to recognize changes that may serve as early warning signals of more severe perturbation. Studies of aquatic ecosystems must include biological, chemical, geological, and physical components of the environment. The impact of shifts in water quality on the total ecosystem may differ from that expected from knowledge of the impacts on individual parts of the system. For example, eliminating or decreasing the abundance of a species or life stage that is an essential food of another species might disturb the entire pattern of energy flow throughout the system. It is essential to understand the inter-relationships among organisms and their environment in order to evaluate these subtle and secondary effects.

Studies of ecosystems must include analyses of chemical, physical, and biological imports and exports as well as analyses of these characteristics of the ecosystem that are generated within the ecosystem. They must also include knowledge of the species living in the ecosystem. Each local environment is somewhat different from all others, and species inhabiting any given environment have evolved over long periods of time relative to their interactions with other species. Any additional stress -- whether natural or man made -- will tend to eliminate some species, leaving only the more resistant and tolerant forms to survive. Stresses that are transient may permit the replenishing of the species by recruitment from adjacent unaffected areas. In such a case the impact may be reversible and the ecosystem can reestablish itself. A change that is chronic and permanent, such as excessive pollution in some of our streams and harbors, will never permit recovery of the original ecosystem until the source of unusual stress is removed.

In order to assess the impact of any new pollutant on a body of water, investigators must acquire information on conditions existing before, during, and after the addition, on the physical and chemical characteristics of the system, and on the

distribution and abundance of the species. Such data must be of long-term duration to characterize the normal variations of these attributes of the system over an annual cycle. Evaluation should include productivity, nutrient cycling, shifts in numbers, kinds, and relative abundance of species. The ability of the system to recover from various concentrations of pollutants needs to be studied also.

One of the problems that needs emphasis in the future is recovery of ecosystems and how man can manage them in geographic areas of severe stress in order to enable recovery to occur more easily. The potential for recovery must be evaluated in ecosystem experiments.

The Committee members feel that a great deal more emphasis in both money and scientific staff should be devoted to terrestrial programs relevant to EPA's mission. Personnel and funds to mount the kind of terrestrial program that EPA should be undertaking are insufficient. The Committee agrees that programs in the aquatic areas should not be curtailed in deference to the development of a major terrestrial effort.

The complexities of terrestrial ecosystems involve the interactions between the abiotic and biotic components. The latter run the gamut from the primary producers (the vegetation), to the herbivores, carnivores, and decomposers. The above-ground consumer communities consist of large and small herbivores, invertebrates, small mammals, and birds. Very little is known about the roles of invertebrate herbivores in terrestrial ecosystems. Even less is known of the roles of invertebrate predators. At the bottom of the scale is our woefully weak knowledge of the rhizosphere components in the ecosystem. And yet these contain a great biomass. They contribute greatly to the total energy flow in the ecosystem and they are vital to the cycling of nutrients.

Whether research is concerned with terrestrial ecosystems or aquatic ecosystems, in general, the same kinds of experimental parameters, principles, and concepts are applicable to planning and carrying out effective ecosystem investigations.