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THE QUALITY OF NOAA'S OCEAN RESEARCH AND DEVELOPMENT PROGRAM-- An Evaluation

NOAA Ocean R&D Review Steering Committee
Ocean Sciences Board
Assembly of Mathematical and Physical Sciences
National Research Council

NATIONAL ACADEMY OF SCIENCES
Washington, D.C. 1977

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine

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PART I

INTRODUCTION

In November 1974, the Administrator of the National Oceanic and Atmospheric Administration (NOAA) asked the Ocean Affairs Board (OAB) of the National Research Council (NRC) to review NOAA's ocean research and development (R&D) activities. Originally intended to cover non-fisheries ocean research programs, the review evolved to include NOAA's fisheries research program as well.

The Ocean Science Committee of the OAB, now succeeded by the Ocean Sciences Board, in collaboration with the Marine Board of the NRC Assembly of Engineering, organized a Steering Committee to direct the review. The steering committee planned the review, organized site visits to NOAA R&D laboratories, chose review teams for each site, and set forth priorities and standards for the overall review.

The Administrator of NOAA asked for a straightforward evaluation of the quality, vitality, and health of the ocean research and development being conducted by NOAA, particularly in comparison with the rest of the ocean-science community, not a program-by-program or scientist-by-scientist review. Furthermore, the question of the responsiveness of NOAA research to NOAA and other national needs was not to be assessed by this review. The original correspondence requesting the review and the purpose and procedures for the review as developed by the Steering Committee are reproduced as Appendixes A and B.

The Steering Committee decided to present the results of fisheries and nonfisheries reviews within a single report to emphasize the commonality of many of the strengths, as well as problems, throughout all of NOAA's ocean R&D program and to emphasize the Committee's conviction that NOAA can benefit by giving its ocean R&D programs greater coherence. This report thus begins with the main conclusions as they apply to the overall NOAA R&D organization. These are followed by individual reports on the various research units reviewed, which are presented in Part II of this report.

Some laboratories visited were engaged in both atmospheric and oceanic research. Only the ocean R&D component was reviewed at these laboratories. Therefore, our judgments apply only to their ocean programs.

Visits to laboratories took place from May 1975 to May 1976. Thirty-four laboratories or research units were visited during this period. Additional visits and interviews were held with NOAA headquarters personnel and with some directors of the Major Line Components of NOAA.

The Steering Committee selected a review team to match the program of each of the ocean R&D facilities reviewed. In all cases but one (the National Systematics Laboratory), at least one member of the Steering Committee was part of the review team. The Chairman of the Steering Committee visited all Laboratories and Centers except the National Systematics Laboratory. The judgment of the review team members, based on their expertise, is the principal basis for the quality evaluations contained in this report.

Each review team prepared the first draft of the review for the facility visited. These drafts were edited by the Steering Committee for format and to be in accord with the review guidelines. In spite of this editing, variations in style between reviews remain. No effort has been made to impose a uniformity on these styles, since they indicate the varying attitudes of the different review teams and an imposed uniformity of style would require deletion of content considered applicable to a particular laboratory.

The texts of the individual laboratory reviews do not contain all the source material to justify the conclusions in the summary section. It was difficult for individual laboratory review teams to identify NOAA-wide strengths and weaknesses on the basis of a single site visit. In some cases, it was only after a particular pattern had been noted at several laboratories, even though not specifically noted in the texts of the reviews, that the Steering Committee was able to agree that a phenomenon common to several laboratories had been identified.

Budget information for fiscal year 1975 is provided with each laboratory review to give some idea of the scope of the work going on at the laboratory. These numbers were provided by NOAA during briefings with the Steering Committee. They should not be regarded as authoritative budget figures. They are also not well suited to interlaboratory comparisons because in some laboratories oceanic and atmospheric research programs were so heavily intertwined that meaningful separate budget figures could not be established. In other cases, the ocean R&D component was easily separable from other work and the number represents only this component of the total laboratory effort. The "NOAA-defined function" given at the beginning at each laboratory review was taken from the *NOAA Organizational Handbook* current at the time of the review.

During the period of the review and during the preparation of this report, NOAA has been changing. The program reviewed in this report is that which existed during the year of site visits. Thus, some of the observations outlined in this report are no longer pertinent. We have tried to indicate those that may no longer apply.

NOAA'S OCEAN RESEARCH AND DEVELOPMENT PROGRAM

The ocean R&D program of NOAA that we reviewed was carried out within all the Major Line Components, as shown schematically in the organizational diagram presented as Appendix E. The bulk of NOAA's ocean research was carried out in the Environmental Research Laboratories and in the National Marine Fisheries Service. The Environmental Research Laboratories were carrying on basic and applied ocean research on the Atlantic and Pacific Coasts and on the Great Lakes. The work of these laboratories constituted the principal nonmilitary federal ocean research program. The National Marine Fisheries Service (NMFS) laboratories were strung along the U.S. coastline from Massachusetts to Alaska (although not on the Great Lakes). We visited 21 NMFS laboratories, grouped into ten organizational units. Here too, the research work ranged from basic to applied, with an emphasis on research work in support of maintaining and improving the use of national fishery resources.

The other Major Line Components (the National Ocean Survey, the National Weather Service, the Environmental Data Service, and the National Environmental Satellite Service) tended to emphasize developmental ocean work in support of their mission requirements. With the exception of the Oceanographic Division of the National Ocean Survey, these latter units were not concerned exclusively with ocean R&D. Most commonly, meteorological activities were also under way, and none of the leaders of these units were primarily ocean scientists or engineers.

The ocean R&D carried out within all the Major Line Components of NOAA is intended in part to meet statutory responsibilities. These statutory responsibilities cover a broad range, including fisheries, ocean dumping and marine protection, disasters and the environment, some marine mammals, coastal zone management, mapping and charting, energy, and ocean technology. Whenever there is a scientific or engineering limit to operations in support of these responsibilities, the R&D program in NOAA is looked to for assistance.

The Steering Committee was impressed with the potential within NOAA for making a positive contribution to the total national ocean R&D effort. NOAA brings many potential strengths to an ocean R&D program that cannot be matched elsewhere in the nation. These strengths and advantages support the conclusion that a healthy ocean R&D program should be maintained in NOAA as part of a balanced national oceanographic program. Among NOAA's potential ocean R&D strengths that should be recognized and used to build a more effective ocean R&D program are the following:

1. NOAA has the possibility to establish ocean R&D programs with long-term continuity on a scale that cannot be matched by universities or industry.
2. NOAA, with its various Major Line Components, has the resources to mount a multidisciplinary approach to ocean problems. For example, NOAA can develop a research program that calls for scientific and engineering capabilities in oceanography, fisheries, meteorology, geodesy, and remote sensing.

3. NOAA can direct an unduplicated concentration of resources to its ocean R&D mission.

4. NOAA is the only federal civilian agency with the tradition and capability of in-house comprehensive deep-sea scientific research.

5. NOAA includes research and operational elements and thus has a special opportunity to provide an effective transfer of technology from research to operations.

6. NOAA provides the single focus for national and international fishery research and development.

7. NOAA has already collected an impressive data bank, particularly in fisheries, which provides an unequaled information base for future research programs.

8. NOAA has statutory responsibilities in national ocean matters.

Although we recognized the important role of these strengths in building an effective NOAA ocean R&D program, we were asked not to address the responsiveness of NOAA's ocean R&D program to NOAA and national needs (see Appendix A). We did recognize, however, that the justification for much of NOAA's R&D work lies in fulfilling operational and other mission requirements. The success with which these requirements were being met by the ocean R&D work is indirectly addressed at several points in the summary of the review.

EVALUATION OF QUALITY

A single evaluation of the quality of NOAA's R&D work is inappropriate because the programs reviewed here were large, complex, and changing. The quality of research even within individual laboratories was variable (see Part II). However, our review revealed that there were factors affecting quality common to many or all of NOAA's ocean R&D programs.

To clarify the broad patterns of ocean R&D quality, we have grouped our summary conclusions into four parts: (a) general, (b) fisheries R&D, (c) Environmental Research Laboratories ocean R&D, and (d) other nonfisheries ocean R&D.

(a) General Factors Affecting Quality

Factors that affected the quality of ocean research and development included ability and training of staff, research facilities and services available, and management of the research program at all levels.

We cannot characterize the quality of the NOAA ocean R&D staff in comparison with researchers in the rest of the ocean-science community by a single generality. We found excellent quality and poor quality: some NOAA scientists were making major contributions to the understanding of the ocean; others were insufficiently trained, unfamiliar with the scientific literature, and were making little contribution either to research or to NOAA's mission. We tried to identify general patterns of strengths and weaknesses in staff research quality, particularly in

the individual laboratory reports in Part II, but our review specifically avoided assessments of the capabilities of individuals.

In general, we found that facilities, equipment, and services in support of ocean R&D were not major factors influencing research quality. The section of this summary on Services and Facilities in Support of Ocean Research and Development (see page 16) presents our findings on this subject.

Research management receives considerable attention in this summary (see pages 12 through 16) because we judged this to be a major factor influencing the quality of ocean R&D work within NOAA. At the laboratory level, the director and his staff had the greatest single influence. They initiate and guide staff recruitment, encourage research productivity, set an atmosphere that can be conducive to research creativity, and communicate a sense of purpose to motivate R&D work directed to specific NOAA goals. Often good local management was helped by a tradition of research excellence within a laboratory.

We had expected that the quality of ocean R&D work in many laboratories would be affected by proximity to universities or oceanographic institutions. There are research advantages to such proximity. However, we found excellent NOAA laboratories that are remote from universities. We also found that some laboratories did not gain the benefits expected of being co-located with university marine activities. In some instances, such as at the Miami ERL and Princeton, it was our opinion that the NOAA laboratories were demonstrating research leadership in their work without the degree of scientific stimulation from their university neighbors that had been expected when the laboratory sites were chosen.

In one sense, the entire R&D program in NOAA was intended to provide support to NOAA's mission responsibilities. Much of this work was indistinguishable in quality from R&D work in the rest of the ocean-science community. In some other cases, particularly when the research was directed to specific mission goals, we believed that the research suffered because there was not a clear conception at the project working level of the mission goals of the research. This resulted in research, sometimes of low quality, that did not even provide the mission support intended. Furthermore, often in an attempt to meet the urgent research needs of an externally imposed mission, staff with inadequate training or experience were recruited for the work. For example, we found a physical oceanographer running a marine mammal program and a biologist leading an engineering laboratory. (When this report was in draft form, we were challenged by a reviewer on this latter point. It was argued that a fisheries biologist, rather than an engineer, *should* be running a fisheries engineering laboratory. The argument was that fisheries priorities and perspectives should be determined in establishing the work of this laboratory. The counterargument was that the magnitude of the technical problems warrants the application of state-of-the-art technical solutions that can best be supplied by having an engineer as laboratory leader. The Steering Committee is divided on this point.)

(b) Fisheries Research and Development

The quality of the fisheries R&D work was variable. Excellent research was being carried out at La Jolla, Beaufort, Seattle, Galveston, and at the National Systematics Laboratory (NSL). We were particularly impressed with the quality of the staff at Beaufort, Seattle, NSL, and the Fisheries Engineering Laboratory (FEL). In most of these laboratories, and in some others, especially Sandy Hook, publication in refereed journals was encouraged and high. We noted problems, however, with the quality or quantity of such publications at Miami, Woods Hole, at the smaller laboratories reporting to the Galveston center.

Research management seemed noteworthy for its high quality at Beaufort, La Jolla, Seattle, and Galveston. This was reflected in good staff morale, motivation, and effectiveness. We found a problem in this area in Miami; also, we were concerned with the management structure, although not the leadership, at Woods Hole. Unlike the staff at the nonfisheries laboratories, the NMFS R&D staff generally was not concerned with NOAA's "ocean R&D mission." Most of the NMFS staff we met felt that they knew why they were engaged in ocean R&D.

We found excellent fisheries R&D programs nearly everywhere. Some of these were: menhaden work at Beaufort; shrimp studies at Galveston; shellfish work at the laboratories of the Sandy Hook Center; resource assessment programs at Woods Hole and Galveston; fish larval work at La Jolla, Woods Hole, and Miami; the coastal fisheries program at La Jolla; and the environmental conservation program at Seattle (this list is not exhaustive). The work of the Fisheries Engineering Laboratory at Bay St. Louis deserves special mention because it is a unique capability.

We were disappointed in the quality of research in some of the smaller laboratories in several of the Centers. There was in some cases a tendency for research isolation and consequent lowering of research quantity and quality. Examples of this were seen at Panama City, Pascagoula, Port Aransas, Honolulu, and Kodiak.

We were particularly impressed with the management, staff morale, and general interaction with the research community at the Beaufort Center. We would have liked to see stronger working ties with the nearby Duke University Marine Laboratory.

The problem of communication with outside groups was generally less marked at NMFS laboratories than at other NOAA ocean R&D laboratories. We did see possibilities for improvement at Sandy Hook, Miami, and the NSL, however. We noted the good relations with industry built up by the Miami center.

External pressures on research seemed more intense in the NMFS than in the other ocean R&D laboratories we reviewed. We noted this at La Jolla, with the tuna/porpoise problem, and at Woods Hole with respect to the International Commission for the Northwest Atlantic Fisheries. We do not imply that these external pressures are to be avoided or that they necessarily result in poor research; they are manifestations of responses to national needs. However, additional attention is required to ensure that a productive research program is maintained under such pressures.

General comments on the two Environmental Groups (AEG and PEG) are included in Section (d). We did observe that the role of fishery oceanography in NMFS R&D is not clearly understood. If a NMFS-wide policy does exist, it should be communicated to the fisheries R&D staff.

(c) Ocean Research and Development in the Environmental Research Laboratories

Several of the ERL laboratories have unique ocean research capabilities. Some examples are the world ocean model at Princeton, the broad-based limnological research program with field and analytical capabilities at Ann Arbor, and the Tsunami work at Honolulu. The quality of research in comparison with the rest of the ocean-science community is generally good in the ERL laboratories, with some laboratories of excellent quality but with some groups not reaching the quality of their colleagues, as described in more detail below. Research at the smaller units (Princeton, Honolulu, and Boulder) was remarkably high in overall quality and could hold its own with the best anywhere.

The ERL laboratories generally provided the best overall working conditions for scientific research of any group of NOAA laboratories that we visited. Morale was generally good. There seemed to be more likelihood within ERL for scientists to be promoted *as* scientists.

We were concerned with the need for better application of research results to operational programs within NOAA, for example, it was our impression that there was room for improvement in application of research results from Miami, Seattle, and Princeton. We recognized that there was some application of results at all these laboratories; our concern was based on interviews with NOAA people in other units who were unaware of work at these laboratories that they should have known about.

In a parallel vein, ties with universities and oceanographic institutions could have been improved. We noted this particularly at Princeton, Ann Arbor, Miami, and Boulder. In these cases, the value of the work would have been improved if closer ties were established with outside groups. At Princeton and Miami, the local universities did not seem to be holding up their end. At Ann Arbor, some excellent NOAA limnological research would have had more value if done in cooperation with regional universities. At Boulder, the technical abilities of the ocean research group would have been enhanced by closer working relationships with university oceanographers.

At the large laboratories (Miami, Seattle, and Ann Arbor), there was more variability in research quality. At these laboratories, we found greater concern by the staff as to what NOAA's ocean mission was. The staffs at these laboratories were concerned about the value of both the applied research and more basic research programs. We believe that a better overview of NOAA's research objectives should be developed and shared with the staffs. Generally, it was our impression that the smaller groups, at Princeton, Honolulu, and Boulder, had a clear idea of the purpose of their work.

At the larger laboratories, there was also a tendency for some groups to lag in quality or to be spread too thinly to be effective. Examples were the Lake Hydrology group at Ann Arbor, the Chemistry program at Miami, and the Marine Life Studies group at Seattle.

We noted excellence as well in these laboratories, including wave studies at Miami and Ann Arbor, air-sea interaction work at Seattle, and physical limnology at Ann Arbor.

(d) Other Nonfisheries Ocean Research and Development

The R&D units included in this section (including the AEG and PEG of the NMFS) are not homogeneous and have many individual research strengths and weaknesses. The morale and sense of mission at these laboratories was generally high. We believe that this may be related to in-house technical capabilities that provided the means to achieve significant results of value (OD/NOS, NDBO, CEDDA, PEG).

We found the most common problem to be a lack of sufficient ties with groups on the outside. At some units (EDL/NOS, NDBO, CEDDA, OR/NESS), ties with the outside ocean-science community would have improved the quality of R&D work.

A good sense of R&D mission was found at OD/NOS and at TDL. We thought this helped the quality of the research by increasing motivation and by encouraging a wise choice among program options. On the other hand, we found a problem with a sense of mission at OR/NESS. A common result of this appeared to be that the research staff was spread too thinly over too many projects. This was also found at AEG, TDL, and OD/NOS.

The quality of R&D was excellent at EDL/NOS and PEG. The scientific staff was excellent at TDL and PEG. Computer facilities significantly aided the work at CEDDA and PEG. Although the research was not yet of first rank, we noted a significant recent improvement at AEG.

The NDBO presented a situation that differed from the other units that we reviewed. Virtually no research or engineering development was being carried out at NDBO. Consequently, there was a lack of publication and a trial-and-error philosophy in program development. Extensive use was not made of outside engineering research talent. In view of the remarkable ability of NDBO to pool a large range of talents and facilities to buoy deployment and servicing, there is an opportunity for significant improvement in their R&D program.

Technical staff support was weak in some units (EDL, TDL, OR/NESS, AEG). In a period of personnel ceiling constraints, the balance between professional and support staff is always difficult to strike. We noted only that the research effectiveness of the professionals who were working in these units would have been enhanced by stronger technical support.

RESEARCH AND DEVELOPMENT MISSION AND PRIORITIES

Our review lays heavy stress on the need for clearly defined ocean R&D missions and priorities within NOAA. We do this primarily because the quality of much of the R&D program can be justified only to the extent that it contributes to NOAA's mission. We note that the budget for ocean R&D has been static for several years, and with inflation the net effect has been a decrease in resources. NOAA needs a clear set of priorities to make the best use of these resources during a period of rapidly changing mission responsibilities. A clearly defined set of missions and priorities should do the following:

- Provide protection against undue external pressures that would tend to disrupt the continuity of NOAA's program;
- Allow criteria to be established for judging whether and to what extent reimbursable funds from other agencies may be accepted without seriously altering NOAA R&D goals;
- Facilitate an effective response to research program opportunities arising from NOAA activities;
- Help NOAA to justify its ocean R&D budget;
- Allow individual researchers to make effective decisions on the division of their effort;
- Provide incentives for cooperative work between various NOAA components;
- Encourage effective application of the results of R&D by operational units.

A simple list of goals, however, will not solve the problem. What we believe *is* needed is the following:

(i) An organizational focus within NOAA with a perspective on all elements of the ocean R&D program, priorities, and resources;
(ii) A well-articulated and continuously upgraded set of ocean R&D goals in NOAA; and
(iii) A sharing of those goals and their development with NOAA's R&D staff.

An important aim of the R&D work is to provide scientific and technical support to NOAA's operations. We noted some instances where the results of good R&D work were not being adopted by operational units. A factor that impedes the transfer of ideas and methods from laboratory to day-to-day operations may be a conservatism noted in some of the operational units that restrains the adoption of new techniques that might be of value. One example of this is the application of results of tidal research to the national program of tidal observations.

Other factors are the organizational obstacles in transferring research results between different Major Line Components. This kind of obstacle may result from the pressures to conserve limited funds by each Major Line Component. Finally, we note a natural tendency for laboratories and operational units to want to do their own development work and to be suspicious of results developed elsewhere.

We noted a tendency at the project and laboratory level to be unaware of NOAA's impressive in-house technical and scientific capabilities. These capabilities can be found, for example, in the NOAA Data Buoy Office, the National Systematics Laboratory, the Engineering Development Laboratory, and the Fisheries Engineering Laboratory. Each provides a capability that might be more widely called upon if there were better recognition of the existence of the facilities and if better methods were found for applying the skills of these units to those areas within NOAA that need them. It may be that organizational barriers within NOAA, such as those between Major Line Components, are preventing an effective transfer of technology and science.

Somewhat related to the question of ocean R&D in support of NOAA's statutory obligations is that of projects supported by reimbursable funding. These are sometimes undertaken by NOAA laboratories to supply national needs for oceanic R&D. Although often viewed simply as a financial supplement to base funding by laboratory directors and scientists, they in fact comprise one important element in the overall program of ocean R&D within NOAA. We were told frequently by NOAA scientists and engineers that reimbursable work was a serious diversion from base-funded research. It was our impression that there was a tendency for staff to be overly critical of this work, a problem that might be solved by better communication of objectives. Nevertheless, we did note pressure within some laboratories to accept reimbursable funds simply to meet payroll commitments even though the associated research might contribute little to NOAA's overall research mission. The effect in these cases is to produce R&D priorities by default. We believe that reimbursable funds should be accepted when appropriate and within overall NOAA mission priorities. Research personnel engaged in such work should be better informed about the purposes and importance of reimbursable work.

Our review did not examine the balance between oceanic and atmospheric research activities within NOAA. We met individuals in some oceanic laboratories who complained that the atmospheric sciences received more sympathetic attention and better funding support from NOAA headquarters than did the ocean sciences. We are not persuaded, on balance, that this complaint is justified.

RESEARCH MANAGEMENT AND LEADERSHIP

We believe that some improvement in management and leadership is needed at the laboratory and program level to improve the quality of NOAA's ocean R&D program. In arriving at this conclusion we considered the nature of the planning process. Did the initiative come from above or below, or did several levels share in setting NOAA's ocean R&D priorities? If several levels shared in the planning, was there a cohesive sense of direction? We were informed by NOAA headquarters managers and by Major Line Component directors of the procedures normally followed in research planning, and we discussed the subject extensively with NOAA R&D staff members during the laboratory site

visits. Our impression was that often there was not a cohesive sense of direction and that the initiative for priority setting may come variably from above or below. As a whole, we found the ocean R&D program in NOAA to be large, complex, sometimes fragmented, and not always working effectively to accomplish NOAA's R&D goals.

There were a number of reasons for this. Communication was an important one. Our first impression was that communication was inadequate, not only vertically in the NOAA organization but also particularly between scientists and engineers in different Major Line Components in NOAA who would have profited by better knowledge of each other's programs and capabilities. However, the communication problem may be only a symptom. The real problem could have been lack of an ocean focus and of shared research objectives by those involved with ocean R&D within NOAA.

Communications in NOAA were further constrained by other factors. An important one was lack of interlaboratory cooperation, particularly noticeable between Centers in the National Marine Fisheries Service. On a larger scale, the division of NOAA into Major Line Components may have impeded natural groupings that might have been more effective in solving ocean R&D problems. Too often we found that laboratory directors and project leaders had a narrow outlook without an effective awareness of the NOAA-wide perspective. The broad perspective seemed to be present in NOAA headquarters but was not manifested in the laboratories.

The structure of NOAA that we reviewed, organized to meet NOAA operational mission responsibilities, may not have been the most effective to achieve overall ocean R&D goals. There may have been too many laboratories, particularly in the National Marine Fisheries Service. This created some laboratory staffs that were so small that effective communication between researchers was made more difficult.

Management at the local laboratory level was a major factor determining quality. There is no substitute for a good local laboratory director and project leaders. (Another weakness arising from proliferation of laboratories is that there may not be enough management talent to run them all effectively.) We also noted that the best laboratories had a well developed and shared sense of mission, enough autonomy to achieve it, and the sense that their work was known and appreciated within NOAA and by their professional peers.

We are convinced that there needs to be more input and participation in the research planning process at the laboratory level by NOAA scientists and engineers. To make this effective, this must be combined with a better hierarchial awareness of goals. NOAA management at midlevels seemed to be unaware of the R&D talent it had within the organization. These scientists and engineers could more effectively be brought into the research planning process to the benefit of the overall program and to improve morale.

THE RESEARCH AND DEVELOPMENT CLIMATE IN NOAA

We were struck by the number of scientists and engineers we met who did not seem to have the feeling of professionalism that one expects to find at such levels in the rest of the ocean-science community. By this, we mean a feeling of dedication to R&D tasks, independence of the individual to set his own working habits and procedures, and ability of the scientist or engineer to participate in defining his or her own research goals. This lack of "professionalism" was less pronounced in the Environmental Research Laboratories but was evident even there. We often found that the researcher's image of himself or of ocean R&D in NOAA was not that of excellence. Furthermore, many staff interviewed did not consider themselves to be either "scientists" or "researchers." We were told during some interviews with R&D staff that there was no good ocean R&D to be found within NOAA. This was clearly untrue, but we were disturbed that some individuals had sincere convictions that this was so.

The feeling of lack of professionalism, of lack of a commitment to excellence, and even of lack of scientific identity, seemed to arise from a number of factors. Among these were a lack of opportunity to undertake significant research projects within some segments of the organization, a perceived lack of career rewards for research excellence, poor research performance in comparison with recognized peer groups, and often an assignment of responsibilities to individuals beyond their professional capability or training.

A creative research atmosphere is sensitive and fragile. Considerable management skill is needed to build and maintain it within a program of mission-oriented research. It is to NOAA's credit that some of the laboratories we visited had succeeded. However, the required management skill is limited, and R&D staff in some other NOAA laboratories were working under conditions that were not conducive to research productivity. Such local conditions included clock-watching by supervisors, underqualified colleagues, an arbitrarily bureaucratic attitude by local laboratory management, external pressures that dictated (or prevented) the direction of research and publication, and artificial barriers that made communication with professional colleagues difficult.

We were disappointed to find some laboratory directors and project leaders who were not sympathetic to the professional needs of research staff members. We are concerned about the career rewards available to NOAA ocean scientists. In the minds of many NOAA scientists we interviewed, promotion was not clearly linked to scientific productivity. There was a widespread feeling, despite examples to the contrary, that a scientist could be promoted only so far as a scientist and that above a certain level the criteria for promotion did not generally appear to include research excellence. We believe that it is vital that research accomplishment be recognized by peers and by the management hierarchy, and it is essential that scientists who perform well be clearly rewarded. In saying this, we recognize that career rewards and incentives must also be provided for excellence in administration

and that the civil service system generally imposes certain inhibiting factors for promotion for scientific achievement beyond a certain career point.

Administrative tasks were a strong factor damping the creative scientific atmosphere in some of the laboratories. Management does have a responsibility to buffer the R&D staff from external pressures and excessive paperwork. In some areas, it was clear that too many administrative tasks were imposed on researchers. We also found some examples where administrative tasks were being used as an excuse by researchers for lack of accomplishment. A better balance may be needed between response to external and operational pressures and insulation of staffs. A partial buffer is needed if a staff is to have the freedom necessary for research excellence.

External pressures are a factor influencing the research atmosphere within NOAA ocean laboratories. NOAA's diverse constituency being what it is, these are likely to continue. Pressures have come from industry and conservation groups, to name but two, and NOAA has a national responsibility to respond. However, these responses must be carried out in a way that insulates productive scientists from excessive pressures that can reduce the quality of long-term research programs.

Another factor operating to the detriment of a professional research atmosphere was the pressure for visiblity. Some laboratories with a potential for doing good research put too much stress on immediate, short-term results. This emphasis on short-term results may have been intended to demonstrate the quality of the laboratory. However, the long-term effect was detrimental to the research going on in those laboratories. A parallel problem was the organizational pressure felt in some laboratories to justify their continued existence. We found it particularly bad for morale and for research when the staff in some NMFS laboratories that we visited were uncertain that the laboratory would continue the following year. A clear conception of the research goals of these units is needed at decision-making levels in NOAA and by the R&D staff. This should relieve perceived pressures for justification and allow development of better quality research.

Quality of staff was another important factor in the R&D climate. A few laboratories had a high proportion of poorly trained staff. This often was correlated with laboratories whose quality and productivity we judged the poorest. An important factor may have been recruiting procedures that often seemed to work against quality. We were informed that research job openings were not routinely advertised in the ocean-science community outside the federal government. Even though salaries were high in comparison with universities, some components of NOAA had trouble recruiting competent scientists and technicians. We judged that this was in part because NOAA was perceived to have low professional standards.

We found a professional problem in terms of travel, centered in the National Marine Fisheries Service. Many young staff members indicated that they were unable to attend enough scientific meetings to communicate their research results and to maintain professional contacts. This may have been a fault of local management, or it may have been due to NOAA-wide travel restrictions. We believe that there

should be more awareness by laboratory directors and project managers of the need for young scientists to travel; each young professional might be permitted to attend one professional scientific meeting annually. Presentation of papers at these meetings should be encouraged.

We were impressed with the use of sabbaticals and educational leaves throughout NOAA. We noted many examples where they were being put to good use in improving the professional qualifications of the staff. However, too few staff members appeared to be taking advantage of these opportunities.

Peer communication in general is an important aspect of the R&D climate. Research staff need contact with colleagues, both near and distant, for the stimulation that comes from critical discussion and for inspiration from the successes of others. Travel is part of this; publication in journals is also important. We found some laboratory directors who did not encourage such publication. Scientists in all the Major Line Components should be encouraged to publish in refereed scientific and technical journals.

At a few laboratories in the National Marine Fisheries Service we noted a problem concerning constraints on publishing results. This arose in cases where scientific results had impact on nonscientific affairs. (Examples were the tuna-porpoise problem, the establishment of limited-entry fisheries, and international negotiations.) There needs to be recognition of this problem, and R&D staff should be buffered from these pressures by laboratory managers. At the same time, scientists should be encouraged to publish their scientific results related to these matters in the open, scientific literature.

As noted earlier, communication laterally between laboratories and research groups was poor. The Major Line Component structure within NOAA appeared to create staff attitudes that in turn hindered communication between peers. Within a laboratory, a regular research seminar series can be important, but we were disappointed to find that they were rare, even in the larger NOAA laboratories.

The *Fishery Bulletin* as one special case is important. As a visible image of scientific quality in NMFS, it should be encouraged and supported.

SERVICES AND FACILITIES IN SUPPORT OF OCEAN RESEARCH AND DEVELOPMENT

Facilities and services were not perceived by us to be a major factor in limiting NOAA's ocean R&D program. Again, because the organization was large and diverse, the quality of service support varied from excellent to poor.

Support personnel were generally in short supply. In many laboratories there were too many chiefs. We found some professional people doing their own technical support work such as typing, drafting, computer programming, and routine laboratory work--even washing glassware. On the other hand, in some laboratories, support people often were assigned tasks above their levels of competence. It is important to distinguish between technical support people and undertrained

research staff. More junior staff may be needed to handle routine jobs to free senior people to expand their overall capabilities.

In some laboratories, space was wastefully used, while in others there was unacceptable crowding. Some laboratories had support facilities that were too good, as judged by the demands of stringent budgets. Drafting and reproduction facilities throughout the organization were variable but generally good. Computers ran the entire gamut of quality, as did libraries. Some were excellent; some were inadequate.

We heard complaints by NOAA researchers about the support provided by NOAA's fleet. After extensively discussing whether this was a major problem affecting the R&D quality, we concluded that, although the use of NOAA ships seemed inefficient for science, it was not a major factor in determining quality. Flexibility of operation did not appear to be so great on NOAA ships as it is on their academic counterparts. We heard tales of science having to adapt to fit ship operations needs rather than the other way around and that ship-based scientific equipment sometimes was in a state of poor repair. The attitude of ship operations in support of research seems to be improving.

Aircraft seemed generally little used in support of NOAA's ocean R&D program. The Research Flight Facility appeared to have atmospheric research as its first priority. Increased use of this facility might add materially to some ocean R&D programs.

GENERAL RECOMMENDATIONS

The recommendations given here are intended to apply to all or several of the NOAA laboratories engaged in ocean R&D. They are thus in addition to the recommendations given with each laboratory report presented in Part II. The purpose here is to underline general concerns with factors that affect the quality of NOAA's ocean R&D.

Research Mission and Priorities

1. The elements and program of ocean R&D should be reviewed in the light of NOAA's statutory responsibilities. The result of such a review should lead to a consolidation, updating, and strengthening of the ocean R&D program at the same time that its relevance to NOAA's missions is improved.
2. Clear statements of NOAA's ocean R&D goals and missions should be developed. These should be shared with all interested NOAA employees. In addition, these employees should be provided with a clear conception of the R&D management philosophy in NOAA. This awareness of NOAA's ocean R&D direction should be implemented at the project, laboratory, Major Line Component, and headquarters levels.
3. An organization focus for ocean research and development should be established at a high level in NOAA.

Research Program

4. The workload, long-range tasks, and objectives should be reviewed at each of the laboratories engaged in ocean R&D. As required, the number of tasks should be reduced or additional support should be provided to those that are overcommitted.

5. Reimbursable support should continue to be accepted in accord with overall NOAA goals. Staff involved in such work should be informed about the purpose and importance of such support.

6. The role of oceanography in support of fisheries problems should be clarified.

7. More effective use might be made of the unique capabilities of NOAA's ocean research laboratories:

(a) As the civilian federal agency with the greatest capability in deep-sea research, NOAA should be more aggressive in developing its scientific programs in marine geology and geophysics, the use of satellites in ocean research, and the oceanic as well as the atmospheric veiwpoint in ocean-atmosphere coupling.

(b) Efforts should be made to strengthen ties with academic institutions having ocean research programs. This can be done both by collaborative work and through direct support of research.

(c) The long-term data base in some fields (e.g., fisheries stocks) should be used as a base for continued studies of long-term variations and trends in the marine environment.

8. More efforts should be made (generally across the lines of the Major Line Components) to maximize the application of results of ocean R&D to operational activities.

Professional Development

9. The professional standards of the R&D staff would be improved by:

(a) Establishing clear NOAA-wide policies that encourage open publication of results in refereed journals.

(b) Exchanging research staff between NOAA laboratories on temporary assignment, to improve staff understanding of the commonality of many ocean problems and to improve the application of research skills to the solution of those problems.

(c) Reducing, where possible, the administrative tasks and paperwork expected of research staff members.

10. The research staff should be provided with a clear conception of NOAA's ocean research goals. This should be combined with increased input and participation in research planning at the laboratory level by NOAA scientists and engineers.

11. Research accomplishment should be recognized by career rewards and promotion.

12. In some sectors, stronger buffers are needed to protect the research staff from external pressures in order to improve the possibilities for research excellence.

13. There should be explicit recognition by laboratory leaders of the need for young scientists to travel for professional purposes. Young staff should be encouraged to attend and participate in at least one professional meeting annually.

PART II

Individual Laboratory Reports--
Their Strengths, Weaknesses, and Recommendations

ENVIRONMENTAL RESEARCH LABORATORIES

1. Geophysical Fluid Dynamics Laboratory (GFDL)
NOAA Environmental Research Laboratories
Princeton, New Jersey

Site visit: May 10, 1976

Review team members: Ferris Webster (leader), Steven Piacsek, Pierre Welander, and Richard C. Vetter

Laboratory director: Joseph Smagorinsky

1975 Ocean R&D Budget: $1,565,000

NOAA-defined function: *Carries out a program of fundamental investigations on the dynamics and physics of geophysical fluid systems to develop a theoretical basis for the behavior and properties of the atmosphere and the oceans. The program areas under study may be defined in a number of ways--in terms of the fluid medium, the scale of motion, the physical mechanism, a particular phenomenon, or the research method. The program will include such areas as Radiative Transfer, Condensation Dynamics, Turbulent Transfer, Small-Scale Convection, Deep and Shallow Ocean-Atmospheric Interaction, General Circulation, Dynamics of the Higher Atmosphere, Experimental Prediction, and Numerical Analysis.*

The Geophysical Fluid Dynamics Laboratory (GFDL) carried on a small program of ocean research of outstandingly high quality. The individual scientists involved in this program could hold their own for ability with their colleagues anywhere and were better than the average level found in most academic oceanographic groups.

The GFDL has a superb computer facility, and its availability has, quite naturally, influenced the kind and quality of research undertaken by GFDL staff. This facility could result in approaches to ocean problems that are dominated by the numerical method, to the possible exclusion of analytical and experimental approaches that may have been more fruitful. The director is aware of this possibility and took pains to point out that analytical and experimental approaches in parallel are needed. Nevertheless, there is some indication that the sheer magnitude of the computing power and the size of the staff

needed to maintain it does influence the approaches to oceanographic problems at GFDL. We urge continued efforts to maintain a balanced research staff capability.

In this regard, we found the Princeton University contribution to the GFDL ocean research program disappointing to date. We strongly support the plans discussed to add a tenured oceanographer to the Princeton faculty so that the GFDL-Princeton partnership can become scientifically productive.

GFDL must be commended for having the only world ocean numerical modeling effort going today. GFDL modeling efforts in the Indian Ocean and the North Atlantic are also of high quality and seem to be well designed to answer important scientific questions in ocean dynamics. However, parallel research advances in turbulence modeling, mixed-layer parameterization, air/sea exchange mechanisms, and numerical techniques, both within and outside GFDL, are not made full use of in the world ocean model. Presumably, plans are being made to implement some of these advances in the near future. For example, studies could be started on alternate formulations of the ocean modeling problem (e.g., layer models and finite elements) by visitors, students, and contracts with other groups. These studies could be followed up if they compare favorably with, or exceed, current modeling results.

The director has dominated the building and development of the GFDL. He has created a research group of which he can be truly proud. His high personal standards have played a major role in producing the highest quality oceanographic research of any NOAA laboratory. However, we are concerned that the management style of the director will be difficult for a successor to maintain, and it is not clear where the long-range direction of the GFDL will come from when he retires.

As part of his managerial style, the director has sheltered his research staff from excessive administrative and bureaucratic tasks. He has set up a system whereby excellent scientists are promoted on the basis of their research abilities and contributions, instead of, as seems to be the case in most other NOAA laboratories, on their administrative duties. We suggest this as a model for other NOAA research laboratories. (It should be recognized, however, that the senior scientific staff at GFDL *do* spend a major part of their time in scientific management. In this they are no different from the pattern of senior ocean scientists everywhere.)

Communications between GFDL oceanographers and their colleagues might be improved, although this is not a serious problem. The senior research people have generally excellent professional ties with oceanographers around the world. However, some less senior staff members complained of a feeling of isolation, even from colleagues within the GFDL, and they would benefit from better contacts with outside colleagues. We were favorably impressed with the visiting scientist program. This program could be strengthened by occasionally inviting a well-established leader in the field who could act as a constructive critic and innovator for new approaches. Such an individual could stimulate research versatility at GFDL and lessen some of the feeling of isolation.

Other NOAA ocean research laboratories and some operational NOAA units have much to gain from close ties with the GFDL both in their understanding of the ocean and in their development of techniques. However, we found that communications with other NOAA laboratories doing ocean research is weak. Substantive interaction with other NOAA ocean research laboratories should be increased *if* this could be done without serious distraction from GFDL's own basic research effort. It should be rewarding to establish stronger ties with AOML and PMEL and with their seagoing and descriptive oceanographic capabilities.

The GFDL library is small, and its oceanographic content is miniscule. (The oceanographic atlases in this library were from the personal collection of one of the senior oceanographers.) There is reported to be good access to the oceanographic literature via inter-library loan and the Princeton University Department of Geology and Geophysics library. The limited oceanographic collection may not be a serious handicap for the senior GFDL oceanographers, but we believe that younger staff members would benefit from better access to the oceanographic literature.

Strengths

1. The GFDL ocean research program is excellent.
2. The GFDL has a superb computer facility (its availability has influenced the kind and quality of ocean research).
3. GFDL should be commended for having the only world ocean numerical modeling effort going today.
4. The research staff has been sheltered by the Director from excessive administrative and bureaucratic tasks.

Weaknesses

1. There was a tendency to orient the ocean research problems around the computer system with the risk of excluding analytical and experimental approaches that may have been more fruitful.
2. The Princeton University contribution to the joint GFDL-Princeton ocean research program was disappointing.

Recommendations

1. The current efforts to maintain a balanced research capability should be continued.
2. Princeton University should be encouraged in its plans to add a tenured oceanographer to the Princeton faculty.
3. Ties with other NOAA physical oceanographers should be strengthened.

2. Great Lakes Environmental Research Laboratory (GLERL)
NOAA Environmental Research Laboratories
Ann Arbor, Michigan

Site visit: May 11-12, 1976

Review team members: Robert A. Ragotzkie (leader), William Drescher, Claire Schelske, Richard C. Vetter, and Ferris Webster

Laboratory director: Eugene J. Aubert

1975 Budget: $3,831,000

NOAA-defined function: *Conducts integrated interdisciplinary environmental research in support of resource management and environmental services in the Great Lakes and their watersheds. Performs field, analytical, and laboratory investigations into the limnological, hydrological, meteorological, and limnogeological properties of the lakes and atmosphere. Places special emphasis on a systems approach to problem-oriented environmental research in order to develop environmental service tools. Provides assistance to the resource managers and others in obtaining and applying the information and services developed by the laboratory.*

The Great Lakes Environmental Research Laboratory (GLERL) was established in 1974 by combining the International Field Year for the Great Lakes Project Office and the Limnology and Computer Divisions of the Lake Survey Center.

The laboratory is organized into four groups: Physical Limnology and Meteorology, Chemistry and Biology, Lake Hydrology, and Environmental Systems Engineering. The first three are primarily research groups, with the fourth serving mainly to synthesize and disseminate GLERL research to the user community and to involve user needs in research program planning and operation.

THE ROLE OF GLERL

The role of the GLERL within NOAA is unique. It is probably the most broadly based of any of the NOAA marine laboratories, with biological, chemical, physical, and hydrological groups. Full advantage was not being taken of this interdisciplinary capability. There was a need to develop more definite long-term goals and objectives both for the laboratory and for the research groups. Once these are determined, it may be necessary to revise the organization of the laboratory in order to make it more responsive to the established objectives.

We agreed with the view frequently expressed by the GLERL staff that the special research needs and opportunities in the Great Lakes are not well recognized at ERL or NOAA headquarters. Clearly, there must be a balanced evaluation of Great Lakes needs versus other missions in NOAA research. However, we were not convinced that the decision-making process in NOAA was adequately considering NOAA's role--and GLERL's capability--in Great Lakes research.

GLERL should strive for better coordination and cooperation with the Great Lakes programs of the academic institutions of the region. The resources, both intellectual and physical, of these institutions are substantial and represent a potential for filling the program gaps and augmenting the limited resources of GLERL itself. Such a cooperative program might take the form of personnel exchange, with GLERL scientists becoming involved in university programs and graduate instruction through adjunct professorships and by faculty members and advanced graduate students participating in GLERL programs.

Morale of the laboratory was excellent. The director was enthusiastically accepted and generally respected by the staff.

PROGRAM DEVELOPMENT

The research program of GLERL was considered as good to excellent. The mission and objectives of the laboratory demand a programmatic approach to the planning and organization of research. However, the organization of the research groups was along disciplinary lines, and interaction among these groups was weak. The actual goals and objectives of the groups seemed to be mainly a function of the aspirations and capabilities of the individual scientists and were little influenced by the group leaders.

Shortly after the laboratory was established, a planning workshop of scientists from the Great Lakes scientific community was convened in 1974 to help identify major Great Lakes environmental problems and to develop scientific objectives for the laboratory. A technical plan was proposed based on this workshop and later planning by the staff of the laboratory. Although this plan is comprehensive, it tends to be small-project oriented, and, taken as whole, it is overly ambitious in terms of the funds and manpower available. There was also an effort to take into account user needs as expressed by contacts with the Environmental Protection Agency, the International Joint Commission, the Corps of Engineers, and the Great Lakes Basin Commission. These contacts and the 1974 workshop have provided the strongest influence on program direction; there was little evidence of strong program direction by the leadership of the laboratory.

PHYSICAL LIMNOLOGY AND METEOROLOGY

This group's meteorology activities were limited to studies of the effects of the atmosphere on the lakes. The group was primarily occupied with studies of lake circulation and of lake waves and oscillations.

The lake circulation studies program, which included a strong field observation capability using moored current meters, was the only comprehensive program of its kind in the United States. The field operations of this program were ambitious for the size of the group and the resources available. Some of the needs for personnel and resources were being successfully met by cooperation (including contracts) with university groups. We support this close cooperation and encourage GLERL to build on this sort of interaction in all the research groups.

The scientists were abreast of the state of the art in field observations of circulation and data analysis. The publication record of this program was based mostly on former International Field Year for the Great Lakes (IFYGL) work and was reasonably good. In view of the excellent observational and data-handling capability of the group, strong encouragement should be given to publish results in scientific journals.

The surface wave and lake oscillation studies appeared to be of excellent quality. There was good interaction with the scientific community both in the United States and abroad. There was a good mix between theory and observation. The publication record was excellent and showed promise of continuing. There was a strong desire, only partially satisfied, to cooperate with other NOAA labs.

LAKE HYDROLOGY

This program was almost entirely a carryover of Lake Survey activities transferred with personnel at the time GLERL was established. The work was designed to meet the needs of other agencies and users of information. Emphasis was on ice research and channel hydraulics. Shoreline effects and water levels were also covered. Some work on tributary streams and additional needs were recognized. Manpower shortages precluded work on groundwater and river-basin-precipitation response, but these were to be undertaken later if possible. Interaction with other agencies was good from the standpoint of using data and avoiding duplication. Ice research was being conducted in cooperation with the State University of New York at Buffalo and the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.

Much of the work of this group appeared to be service response to user needs with plans to move into research areas that would increase useful information for the same users. The technical expertise was thin and especially so in research capability. There was strong need for intergroup effort in the analysis of incoming flows and lake current dispersion, as well as water quality, and the flow and dispersion of pollutants.

The development of mathematical models and the subsequent operation of such models by users was commendable.

CHEMISTRY AND BIOLOGY

The research program of the chemistry and biology group had a strong orientation toward basic research, particularly in the biological components. Much of the research emphasizes ecological models of several types, and most of the more basic research was being planned so that it could be used in these models. The quality and vigor of the modeling work was particularly good considering the short time that it had been under way. Significant problems had been identified, and the modeling experiments that were being conducted and planned were adequately designed to test the hypotheses that had been formulated.

Most of the basic research work was relatively new, having been started since the laboratory moved to Ann Arbor two years before this review. For this reason, it was not possible to judge the ultimate success of this research. Many critical experiments were to be conducted during the 1976 field season.

As would be expected from a newly developing group, there were too many tasks for the size and resources of the group and the research effort was spread too thin. Some of the research was not well focused. In some cases, the objectives were not clear, i.e., the need and purpose in collecting much of the chemical data seemed not to be closely coordinated with some of the biological work. In addition, there did not seem to be justifiable objectives from the standpoint of significant chemical problems. Setting up the laboratory in Ann Arbor should strengthen this part of the research program as some of the projects undertaken previously (partly in IFYGL and partly in the Lake Survey) were of definite lower quality than work initiated more recently. The research undoubtedly suffered from the lack of technical support.

There was a lack of coordination with the other groups within GLERL, particularly with the physical limnology group, which could potentially provide much help with clarifying objectives and designing field experiments for investigating the spatial and temporal distribution of dissolved substances and plankton.

ENVIRONMENTAL SYSTEMS ENGINEERING

This group was an anomaly, since it seemed to be trying to combine an information synthesis function and a user interface role. The priorities of the group were not clearly evident. The resources being allocated to advisory services were almost negligible; therefore, the effort was coming largely out of the hide of scientific personnel in this group and to a small extent from other groups. Since little organized research was being conducted within this group, consideration might be given to re-examining the objectives of the group and possibly realigning some of the people. The potential capability of the personnel of the group is excellent and ought to be used more productively.

FACILITIES

The GLERL staff was crowded into quarters that were barely adequate. Indefinite use of the existing "temporary" buildings will be a severe constraint on the future growth and development of this new laboratory.

The library was small and poorly organized. The resultant limitations to access to the limnological literature may have been impeding the research of the younger laboratory scientists. The University of Michigan library, while accessible to GLERL scientists and heavily used for interlibrary loans, is not an adequate substitute for a good library in GLERL.

Computer facilities are of major importance to GLERL research activities. We were thus concerned to hear near-unanimous expressions of disappointment with the existing computer arrangement from users. Nevertheless, it was our impression that the computing needs of the laboratory *were* being met with the tie to the CDC-6600 computer in Boulder. The discontent arose from previous experience with a commercially operated IBM 370 computer system. The previous system was more than adequate and highly responsive. The NOAA system was less responsive to user needs, had a hand-me-down image, and had a less impressive reliability rate. Although the Boulder System could be made more responsive, the work was getting done, and the computer needs of GLERL were being met.

The in-house computer system group was responsive. We were pleased that they maintained an open-shop operation that was accessible to the scientific staff.

The marine instrumentation group was providing creative instrument engineering in support of laboratory-wide research activities. The quality of engineering design seemed high, with a realistic incorporation of state-of-the-art techniques. Although this group was expected to provide state-of-the-art engineering, their cramped quarters and somewhat limited technician support presented handicaps that reduced effectiveness.

Strengths

1. The morale of the laboratory staff is excellent.
2. With a broad base in the major disciplines (physical, chemical, biological, and hydrological), the laboratory had unique research capabilities.
3. Excellent field capabilities for analytical studies were available.
4. The surface wave and lake oscillations studies were of excellent quality.

Weaknesses

1. Interdisciplinary ties and interaction among the disciplinary groups were weak.
2. The research capability of the lake hydrology program was weak. Emphasis was on services to users.
3. Although the research program of the chemistry and biology group had a strong orientation toward basic research, there were too many tasks for the size and resources of the group, and the research effort was spread too thin.
4. The priorities of the environmental systems engineering group were not clearly evident. The potential capability of the personnel of this group was excellent.
5. The GLERL staff was crowded into quarters that were barely adequate. Indefinite use of the present "temporary" buildings will be a severe constraint on the future growth and development of this new laboratory.
6. The library was small and poorly organized.

Recommendations

1. The ERL/NOAA management should re-evaluate the Great Lakes research priorities and long-term research goals in terms of overall NOAA missions.
2. GLERL should be more vigorously integrated with other Great Lakes research groups (for example, the University of Michigan).
3. The priorities of the chemistry and biology group should be re-evaluated to bring the research programs into sharper focus.
4. The objectives of the environmental systems engineering group in terms of user services versus research should be re-examined.
5. Better quarters are needed by the laboratory and should be provided.

3. Atlantic Oceanographic and Meteorological Laboratories (AOML)
NOAA Environmental Research Laboratories
Miami, Florida

Site visit: January 25-28, 1976

Review team members: Ferris Webster (leader), John Byrne, Christopher Garrett, M. Grant Gross, Robert O. Reid, Robert H. Stewart, Richard C. Vetter, and Carl Wunsch.

Laboratory director: Harris B. Stewart, Jr.

1975 Budget: $2,852,000

NOAA-defined function: *Conducts oceanographic research toward a fuller understanding of the ocean's physical and geological characteristics and processes, and tropical meteorology through observational and simulation studies to predict formation and movement of waves.*

AOML is the major oceanographic research laboratory in NOAA. As such, it sets the tone for much of NOAA's ocean research program. Therefore, the lack of a clear oceanic focus within NOAA is particularly critical to this laboratory.

Much of the work going on was more mission-oriented than would normally be expected in a university. These programs included the New York Bight program and the Bureau of Land Management Mississippi-Alabama-Florida Outer Continental Shelf Project work in the Gulf of Mexico. Most of the scientists we spoke with believed that this type of work was most appropriate to AOML. However, few of them could state that they understood the role that NOAA expected the laboratory to play. Most had decided that the major purpose of the laboratory was to support the "overall NOAA mission," but a precise meaning of this role had never been articulated to them. There does seem to be a discrepancy between the goals stated to us by the laboratory director--that the AOML should function as a basic research laboratory on the university model--and the actual operation of the laboratory.

RESEARCH QUALITY

There were some excellent individuals and groups in AOML. However, in some areas the quality was disappointing. Some work was clearly mission-oriented and might be turned down by many university departments. It may be that AOML should tackle these problems. Again, however, without any clear statement of mission, it is difficult to weigh the balance between basic research and mission responsibilities.

AOML needs to find a strong scientific leader for the Marine Geology and Geophysics program and it needs to decide which way it will go in the near future in marine chemistry (both done subsequent to our review); the current scientific strength is obviously inadequate. The structure of AOML appears personality-oriented. This can be an effective means for research management, and no criticism is intended by this observation. However, it is necessary to be flexible in this kind of structure when faced with personnel changes. We are concerned that the administration may not be flexible enough in this regard.

COMMUNICATIONS AND MORALE

There was surprisingly weak communication between the four constituent laboratories of AOML. We found many staff members who seemed to have little feeling of cohesiveness within AOML. This is particularly disappointing since the administrative divisions seem based more on personality and administrative convenience than on disciplinary boundaries. We are concerned that these boundaries are serving to limit desirable scientific interaction.

In this same way, the quality of the interaction with the University of Miami (RSMAS) has been disappointing. While there have been many instances of joint work and cooperation in the form of cruises and sharing of equipment, there does not seem to have been a real sharing of intellectual resources. The absence of substantial numbers of graduate students working with AOML is another symptom of a deeper problem. For whatever reason, and it may have as much to do with difficulties at RSMAS as with AOML, the partnership envisaged when the lab was placed in its present location has not been a real success.

There should be a continual conscious effort to maintain seminars and scientific meetings within AOML. We believe that AOML has the opportunity to provide oceanographic leadership on Virginia Key. Here again, seminars (for example, in physical oceanography) could serve to draw scientists together to make their work more fruitful. AOML should be more aggressive in this role.

The AOML was to a large extent established by withdrawing research people from more mission-oriented laboratories such as in the National Ocean Survey. We believe that the mission-oriented groups that remain in other components of NOAA and the R&D people within AOML would be better off by being in closer touch. We note that the NOS is gradually trying to re-establish a small research capability of its own--for example, in the area of tides--in order to ensure that it remains in touch with new techniques and instrumentation. Much of this capability could be provided by people now at AOML if there were some way to maintain the easy daily contact required in such a role.

The morale within AOML was generally high. This was due in part to the style of its director. Many staff members noted that they receive little guidance or direction. Most felt this was good because it gave them the freedom and opportunity to work on the programs they like. It was the impression of the review team, however, that stronger

intellectual leadership was needed in some areas. In work that is mission-oriented, there must be a clear understanding of what those mission objectives are.

FACILITIES

Overall, the facilities and support at AOML were good, but there were some problems worth noting. Opinions concerning NOAA ships by staff scientists ranged from high praise to strong condemnation. It was our impression that the operation of the ships for research is wasteful and inflexible by academic-fleet standards. There was some evidence that the sympathy of NOAA-corps officers for the special problems of oceanography is improving.

The UNIVAC 1108 computer suffered from having an obsolete operating system. This made maintenance difficult and deprived the system of routine manufacturer's software support. As a result, the system had degenerated to the point where many users could not trust the computations made by the machine. Consideration should be given to investing funds to upgrade the computer so that it can realize its potential. We recognize that this will be expensive and will probably have to draw on funds that might otherwise be used for research.

Library facilities seemed adequate but not excellent. With the library at the Rosenstiel School so close, this does not seem to be a serious problem.

Support personnel in engineering and computing was weak. With limited positions available for new people, we recognized that first priority had gone to research staff.

PHYSICAL OCEANOGRAPHY LABORATORY (PhOL)

NOAA-defined function: *Carries out a program of research on the physical properties and dynamics of oceans and estuaries including advective and convective aspects of circulation, the complete spectrum of water waves (tides, tidal currents, tsunamis, storm surges, seiches, wind waves, and internal waves), and the physical properties of seawater. Monitors contracts awarded to universities and private groups to balance the program.*

There were approximately eight professional-level scientists in the Physical Oceanography Laboratory. Generally speaking, the morale in the group was high, and the scientists were pleased with the working conditions and support of the laboratory directors.

A small amount of basic research was conducted within PhOL, and we regard this as healthy. The number of individuals capable of carrying out work of this type as independent scientists is few, and they have apparently been appropriately identified as such by the directors.

Overall, the research productivity of PhOL, if judged by first-class university standards, fell short of the mark. The number of papers published in refereed journals in any given year seemed rather small. A diagnosis of the cause of the problems is not completely clear. Some scientists believed that they were not given sufficient time to complete work already begun before they were diverted from it in response to pressing requests from above. Others said that they perceived a constant need to publish "visibility" papers of a popular form, whose main purpose was to keep the laboratory in the public eye (we noted that over half of the papers in the 1973 collected reprints were in unrefereed publications).

The quality of the work within the laboratory, both mission-oriented and basic, was generally competent but not especially inspired. There seemed to be a serious lack of strong, imaginative senior working-level scientists who could provide foci, criticism, and imagination for the other scientists both within and without their own particular specialties. Little critical scientific interaction seemed to take place--the lack of a departmental seminar was a symptom of this problem. In the absence of such critical self-interaction among the scientists, more scientific direction from the laboratory director is needed.

The laboratory director was seen by many scientists as the most capable scientist among them, but he was also seen as too busy with administrative duties to provide the kind of overall scientific advice and guidance they sought.

OCEAN REMOTE SENSING LABORATORY (ORSL)

NOAA-defined function: *Conducts ocean research programs by means of remote sensing from satellites, spacecraft, aircraft, and ships. Develops such new instruments and techniques as required for the indirect sensing of parameters related to this research, serves in an advisory capacity, and maintains close coordination with other laboratories engaged in remote sensing activities, both within NOAA and with other agencies.*

In assessing the overall quality of research in this laboratory we compared it with work done in established fields, such as astronomy and planetary physics, which historically have relied heavily on remote measurements. From this viewpoint the quality was disappointing. Scientists in the older fields concentrate on the physical problems illuminated by their instruments, while remote sensing of the oceans has concentrated on techniques and phenomenology.

This tendency to emphasize techniques was partly the result of organization. This group was separate from others working on the same or similar problems. Yet all but one of its members had entered the field from outside, notably from physics. They needed the close personal contact, review, and even sharp criticism that would have resulted were they part of a physical oceanographic group. In return,

they could place before their colleagues the broad view of the oceans seen from space.

The overall quality of the people, with a few notable exceptions, was good; but there were no stars who commanded the respect of the ocean community. They viewed their mission as applying remote measurements of the sea to those basic research problems that would eventually contribute to NOAA's mission, but they generated their own ideas of what problems were useful and did not rely on guidance from NOAA. Ideas about the applications of their work came from below and not from above.

The staff was strengthened by having joint appointments at the University of Miami, but these were in the physics department and not in the Rosenstiel School of Marine and Atmospheric Science. They were able to teach courses and benefited by having graduate students.

The scientists had adequate equipment, work space, library, and drafting and clerical help. They suffered from lack of sufficient computer programming and electrical and mechanical engineering support and needed a small job shop.

The staff had adequate communication with others in the field of remote sensing but lacked ties with the traditional oceanographic community. In summary, this was a competent, motivated group. Their strength lay in their ability to obtain and process satellite and acoustic data. Their weakness lay in not being able to exploit fully the information contained in these data. This could be corrected, perhaps, by establishing stronger and closer ties with the physical oceanographers in SAIL and PhOL.

SEA-AIR INTERACTION LABORATORY (SAIL)

NOAA-defined function: *Carries out interdisciplinary research on the interaction of the sea and the atmosphere by means of observational, analytical, and theoretical studies. Develops techniques and methods in predicting air-sea interaction processes such as wave growth and radiation, momentum, heat, and moisture exchanges. Undertakes field experiments in collaboration with components of NOAA and other national and international government agencies. Monitors contracts to universities and other organizations to balance the program.*

There were three main activities of this group:

1. Surface-wave measurement and analysis.
2. Mixed-layer studies.
3. Storm-surge modeling (reviewed with the Techniques Development Laboratory, NWS).

The surface-wave studies appeared to be at the forefront of international work in this field, with data being used for basic

scientific studies and mission-oriented goals. Measurements from aircraft were particularly important and perhaps deserved increased priority within aircraft allocation programs. There was some lack both of data interpretation in terms of theory and of the development of new hypotheses, but this shortcoming was partly being remedied and was compensated for to some extent through the strong international contacts of this group.

The mixed-layer studies did not seem to be of such high quality, not apparently having either the exciting new tools or the important new ideas required if the group were to become the leader in a competitive field. However, useful contributions were being made in international experiments such as the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE), and mission-oriented aspects of the work relevant to meteorological and climatological models will be valuable.

The main shortcoming of SAIL was the lack of discussion of ideas and results in the critical manner usual in top research laboratories. There was an excessive tendency for scientists to engage in busy-work within their own narrow discipline, without adequate development of broad interests and mutual criticism. This is a failing shared with the whole physical oceanographic community within AOML and could be partially remedied by establishment of an informal internal seminar series.

Morale was high within SAIL, and there was general satisfaction with both levels of management within AOML and with the facilities and services other than the computer. However, there was a feeling that research proposals got garbled at higher levels in NOAA and that the funding process was managed by people without sufficient feeling for science.

MARINE GEOLOGY AND GEOPHYSICS LABORATORY (MGGL)

NOAA-defined function: *Conducts research to understand and predict the morphology, structure, and dynamics of the seafloor in coastal zones, along continental margins, and across ocean basins. Employs systematic geophysical surveys to acquire, analyze, and synthesize seismic, magnetic, gravimetric, heat flow, and bathymetric data. Collects near-shore and deep-seafloor sediment and rock samples to measure and interpret their geotechnical, geochemical, and petrological properties. Utilizes submersibles and spacecraft sensors for special applications. Promotes national and international cooperative programs. Monitors contracts and grants to non-NOAA institutions.*

The quality of the overall MGGL program was good. As a mission-oriented laboratory, research of an applicable nature was being conducted in a competent manner. There was a general desire to do fundamental research, but the constraints of funding required a close adherence to

project mission goals. Nevertheless, research that was process-oriented was being carried out, and results of substance were being produced. The quality of research was generally on a par with similar research being conducted by the Marine Branch of the United States Geological Survey.

The group suffered from a lack of scientific leadership at the MGGL Director level. A full-time Director should be appointed as soon as possible to give overall guidance to the program (this was done subsequent to our review). Leadership at the project level was good, but without the support that can be provided only at the Director's level, progress may be limited.

Program leadership within the laboratory was good.

The scientists were judged to be competent practitioners of their respective specialties. With one or two exceptions, their productivity was at or above average. Those who were less productive would be helped by a reassignment of duty or by the provision of needed support at the technical level.

There was some question whether the program has an adequate number of scientists for the magnitude of the effort being undertaken. Although the program was generally successful, the addition of a hydrodynamicist to the sediment program and the expansion of the geophysics program by the addition of a geochemist, reflection seismologist, and possibly a petrographer would go a long way toward the creation of a truly viable independent group. [Erosion of the geological/geophysical program at the Rosenstiel School of Marine and Atmospheric Science (RSMAS) of the University of Miami was significantly detrimental to the intellectual milieu in which MGGL operates.]

Technical support personnel were needed for the program in Marine Geotechnique and possibly in other elements of the sedimentology program.

Morale was high. Most of the scientists are pleased with what they were doing. They liked the overall administration of AOML; they got on well with their colleagues in MGGL. Some expressed a desire for greater communication with their non-MGGL colleagues within AOML, particularly in support of geology and geophysics research activities. Interaction with geologists/geophysicists at RSMAS has been good in the past.

The unsatisfactory levels of communication with scientists of other federal agencies and with the scientific community at large was to a great extent attributable to NOAA-imposed restrictions on travel, both to scientific meetings and to other laboratories.

Facility support was excellent. Office and laboratory space was generally more than adequate. Scientists felt that within AOML the facilities and generalized equipment were adequate to their needs.

The major facility producing dissatisfaction within MGGL was the computer. It was inadequate, out of date, often produced spurious results, and should be updated or replaced.

Ship support was considered good as far as NOS personnel are concerned. The restriction of deck crew work to daylight hours was a problem, but most had learned to live with it.

The major problem with ship support was the lack of care given shipboard scientific equipment. *Researcher* is one of the few vessels available to scientists within the United States that carries narrow-beam echo sounders and gravimeters. Both of these devices were badly in need of maintenance and were often out of commission or are unreliable--strictly as a result of poor or no maintenance.

Facilities at RSMAS were often available to AOML researchers (e.g., electron microscope). This type of cooperation is commendable and should be continued.

MGGL Recommendations

1. The significance of AOML's marine geology and geophysics effort and importance should be stressed to NOAA management. NOAA provides the *only* federal deep-sea research capability. Programs such as the Trans-Atlantic Geophysical Traverse and the Mid-Atlantic metallo-genesis program should be carried out and should be carried out by NOAA, which has the deep-sea capability.
2. NOAA should take a positive aggressive position in asserting its role in U.S. marine geology and geophysics.
3. AOML administration should take the lead in developing and stating NOAA's marine geology/geophysics research goals and missions.
4. Attempts should be made to integrate research efforts and communication across disciplinary lines within AOML. A greater sense of identity within AOML needs to be developed.
5. An assessment of the available technical support for marine geology/geophysics should be made and the results of the assessment implemented.
6. AOML should consider whether it will, or should, provide the basic research background for NOAA's operational missions.

MARINE CHEMICAL STUDIES

Marine Chemical research at AOML had well-equipped laboratories suitable for work on physical and geological problems. The chemical group was small and had been able to address only a limited fraction of the significant chemical questions in the New York Bight project. For example, there were no data available on chlorinated hydrocarbons. Those projects undertaken seemed to be competently done.

The work had been primarily of a survey mode and in support of the geological and physical oceanography programs. The staff had not been able to exhibit their capabilities for solving problems of chemical processes in the ocean. The group may have been too small to sustain high-quality imaginative research. Individuals should be encouraged to develop closer professional ties with chemical oceanographers at the University of Miami and the University of South Florida.

The chemistry sections in MGGL and PhOL were entering a transition period because of loss of senior personnel. This left only junior-level scientists to carry on programs without close supervision. Chemistry has long been in a relatively weak position relative to other scientific disciplines at AOML. At this juncture, it would seem appropriate to assess AOML priorities and the need for chemistry in continuing programs.

If chemistry is required, it must receive substantial support and one or more senior-level scientists to guide the development and growth of a strong section. Otherwise it is likely to remain in a service role incapable of designing and carrying out independent research programs in marine chemistry. (Since this report was prepared, the Marine Chemistry program at AOML has been extensively upgraded and new people have been added.)

Strengths

1. There was generally high morale in the laboratories.
2. Facilities and support were generally good.
3. A healthy amount of basic ocean research was conducted throughout the laboratories.
4. Surface wave studies at the laboratories were in the forefront of international work.
5. Results of substance were being produced in marine geology and geophysics.
6. The laboratories were modern and pleasant, and facilities are generally adequate for the work under way.
7. The physical location adjacent to a major oceanographic university laboratory and near the Gulf of Mexico and equatorial Atlantic regions provides opportunities for interaction and emphasis on research programs.

Weaknesses

1. For the most part the staff was unsure of the "overall NOAA mission" in ocean research.
2. Communications between the four constituent laboratories was surprisingly weak.
3. The quality of interaction with the adjacent University of Miami (RSMAS) was disappointing.
4. Computer facilities were not adequate (this has been improved subsequent to our review).
5. Research productivity (as judged, for example, by collected reprints) was low relative to the rest of the ocean-science community.
6. Research quality was competent but not inspired. (More critical self-interaction would help.)
7. The Ocean Remote Sensing Laboratory lacked a perspective on ocean problems, concentrating instead on techniques and phenomenology. (This group was disbanded subsequent to our review.)

Recommendations

1. A leader should be found for the Marine Geology and Geophysics group. (This was done subsequent to our review.)
2. A decision should be made on the future of the marine chemistry program. (This was done subsequent to our review.)
3. A regular scientific seminar series should be established to improve communication within the laboratory and with RSMAS. (This was done subsequent to our review.)
4. There should be a clearer understanding of the objectives of mission-oriented research at the laboratory.
5. Measurements from aircraft are important to surface-wave studies and deserve increased priority within aircraft allocation programs.
6. The care of shipboard scientific equipment needed more attention. (*Researcher* is one of the few vessels available to U.S. civilian scientists that carries narrow-beam echo sounders and gravimeters.)

4. Wave Propagation Laboratory (WPL)
NOAA Environmental Research Laboratories
Boulder, Colorado

Site visit: February 26, 1976

Review team members: Robert H. Stewart (leader), John V. Bryne, and Ferris Webster

Laboratory director: C. Gordon Little

1975 Budget: $324,000

NOAA-defined function: *Acts as a focal point for the development and application of new methods for remote sensing of man's geophysical environment. Approach features technique development using optical, acoustic, and radio waves as sensors both singly and in combinations. Problem-oriented applications are supportive of research, operations, or both. Advisory services in these areas are also provided to industry, government agencies, and scientific institutions. Wave-propagation technology is furthered through special studies, sponsorship of conferences, and participation in meetings.*

Our overall impression of this program was that the personnel were excellent, had clear goals, and were operating at the forefront of technology. In part this was due to the guidance and support of the laboratory director, in part to their freedom to specify and solve problems within a well-defined framework.

The Sea-State group of the WPL develops remote-sensing techniques directly applicable to NOAA's mission and transfers these techniques and supporting technology to operational users within NOAA and other governmental and private groups. The group was well balanced in terms of emphasis on development of theory for remote measurement of ocean waves and surface currents and the translation of such theory into equipment and observation. We were impressed by the work under way to produce elaborate, highly technical electronic equipment that is also reliable and easy to operate and that can ultimately be used in operational systems. Nevertheless, this desire to produce the best possible instruments has tended to emphasize the design and production of electronic equipment with correspondingly less emphasis on the testing of the physical theory upon which it operates.

We recognize the anomaly of a group dedicated to developing remote techniques for the study of the ocean, located in Boulder, Colorado, a location so remote from the oceans. On the positive side, the group benefited by sharing common theory, techniques, and equipment with others at the Wave Propagation Laboratory. But we were concerned, as were those at this laboratory, with the lack of contact with outside

oceanographers. We believe that existing contacts between the Sea Studies Group and the University of Miami and Nova University should be continued and strengthened. Deep and lasting ties with one or two oceanographic laboratories will definitely benefit the group as short-term, *ad hoc* contacts cannot.

Strengths

1. The personnel and program of the Sea-State group were excellent.
2. There was good academic freedom to specify and solve problems within a well-defined framework.

Weaknesses

1. There may have been too much emphasis on techniques at the expense of theory.
2. There was a lack of contact with oceanographers at other laboratories and in other fields.

Recommendation

1. Develop stronger ties with physical oceanographers in other laboratories.

5. Pacific Marine Environmental Laboratory (PMEL)
NOAA Environmental Research Laboratories
Seattle, Washington

Site visit: September 28-October 1, 1975

Review team members: John V. Byrne (leader), Robert S. Arthur, Louis Gordon, Foster H. Middleton, Michael M. Mullin, Richard C. Vetter, and Ferris Webster

Acting laboratory director: Robert E. Burns

1975 Budget: $1,274,000

NOAA-defined function: *Conducts basic and applied research directed at achieving a comprehensive understanding of the environmental processes at work in the coastal areas of the Pacific Northwest, as well as in selected areas of the open ocean. Emphasis is placed on investigation of the natural physical processes and on monitoring and predicting the effects of man's activities in these regions on physical and associated biological processes.*

The Pacific Marine Environmental Laboratory (PMEL) was established in 1973 from a nucleus of 11 personnel from the Pacific Oceanographic Laboratories and the Marine Minerals Technology Center. It had grown to a total staff of about 75. Most of this rapid growth occurred during the year before our review. As a result, a significant portion of the activity at the laboratory was of a management nature in preparation for doing research, such as proposal preparation, acquisition of equipment, and hiring of new personnel. Only the two older project areas, Ocean-Atmosphere Response Studies (OARS) and Modeling and Simulation Studies (MASS) were in the full swing of carrying out research. Since our review was conducted, major changes have taken place in the laboratory leadership.

The lack of a coherent statement of laboratory goals and objectives, as well as the lack of specific NOAA goals and objectives (missions), was a concern of many of the individuals interviewed. If such missions, goals, and objectives did exist, they were not generally understood by the scientific and technical staff. Formulation of such laboratory goals and objectives, and possibly the formulation of strategies to accomplish them, would enhance the development of a sense of purpose among the scientists and technicians of the entire laboratory. Because most of the personnel and projects were relatively new, an excellent opportunity existed to develop a strong sense of laboratory mission.

The personnel were competent to carry out the research already outlined. As evidenced by its recent development, by the organization of personnel, and by the increase of activity level through reimbursable projects, the administration of the laboratory appeared to be in good hands.

The OARS group had attained a reputation for first-rate scientific research in the area of air/sea interaction. The other project elements gave promise of developing into competent research groups. At this stage of laboratory development, many of the scientists were spending a major portion of their time in developing proposals to carry out research on a reimbursable basis. Although possibly necessary to the further expansion of the laboratory (because of the present funding situation), this effort has often delayed progress on current research programs.

Reimbursable funds had been used to hire virtually all of the technical support personnel and to purchase equipment and supplies. Base funds were used for principal scientist salaries; but of the funds actually used within PMEL, 57 percent was reimbursable or contract funds. The operation of the laboratory largely on such funds creates problems in rapid hiring and in developing long-term goals for the laboratory.

The organization of personnel was generally good. However, one research area where integration of effort might have been improved by regrouping personnel was the area of coastal and estuarine research. The review committee questioned the separation of physical oceanography from biological and chemical oceanographic studies of these shallow-water areas. A second organizational problem involved duplication of technical support between OARS and the Base Operation Support Services (BOSS) groups. Possibly, this duplication will disappear if the new BOSS group develops to the level of sophistication of the OARS technical support element and demonstrates that a centralized support group is more efficient than a number of individual technical support groups.

Ship support by NOS was apparently variable in quality--both good and bad reports were received. Failure by NOS to set a schedule until a late date prior to sailing, inflexibility in altering the cruise plan once at sea, the lack of high priority for science while at sea, and some inadequacies of the NOS vessels were matters of considerable concern expressed by several scientists. Other scientists had good experiences with NOS ship operations and commented on the excellent cooperation they received while at sea.

In any large organization, communications are always a problem, either real or apparent. PMEL was not exempt from the problem. Several scientists expressed concern regarding communication with ERL headquarters in Boulder, particularly in regard to (1) PMEL's mission and (2) making their needs known to ERL administrators. Efforts to improve this communication would undoubtedly improve morale.

Apparently relatively little communication took place with the NMFS Northwest Fisheries Center. However, excellent communications existed with the University of Washington Department of Oceanography; this was regarded as one of the real assets to working at PMEL. This relationship, so beneficial to the oceanographic science carried out at PMEL, should be maintained and strengthened.

OCEAN ATMOSPHERE RESPONSE STUDIES (OARS)

OARS conducted laboratory and field experiments primarily to investigate and describe physical processes occurring in the ocean resulting from variable atmospheric forcing. This project was one of the strongest projects in the laboratory. The group had achieved a national reputation for the excellence of its research in the area of air/sea interaction. A high degree of pride and morale existed within the group. It enjoyed a strong leadership and has developed an independence of operation. The OARS program identity and staff should be maintained because it gives prestige and visibility to the developing PMEL.

The group maintained its own technical support capability in spite of the existence of BOSS. Although this duplication of technical effort may constitute a source of irritation to some elements of PMEL, in view of the excellence of the present OARS program, serious thought should be given before the OARS technical support activities are consolidated with BOSS.

STUDIES OF COASTAL AND ESTUARINE NATURAL ENVIRONMENTS (SCENE)

The overall quality of the research of SCENE appeared to be good. Because of recent reorganization and a marked increase in number of personnel, a rigorous evaluation of quality was not appropriate during our review. Recent activity was focused primarily on the management aspects of developing a program. Nonetheless, the potential seemed clear for developing a good research and development program comparable with that of universities. The strengths of the program lay heavily in the quality of most of the investigators, who appeared to be competent to direct and do good work. There was a mood of enthusiasm and excitement for the research.

There appeared to be some confusion caused by apparent differences between the stated SCENE mission--to understand "basic integrative processes"--and the actual work done in response to needs on a discipline-by-discipline basis. A high value was placed on an ability to operate in the latter mode, while wistful references were made to the former. We viewed this as a function of funding realities and decision-making in research and development policy, which were occurring at levels higher than SCENE management.

This group suffered, as do others, from lack of solidly based financial support for the development of long-term basic science programs. Most of the support for building a program came from "soft," reimbursable contract funding. This often makes timely hiring of support personnel difficult. Equipment money was hard to come by on an orderly basis. The group probably is large enough and sufficiently diverse to meet most of its working objectives in response to outside needs.

In summary, prospects for quality, viability, and effectiveness appear to be good. The problems involved with contract funding were evident and must be addressed.

MODELING AND SIMULATION STUDIES (MASS)

A primary objective of MASS was the development of models to interact with and support interdisciplinary environmental studies.

The quality of the research and development in MASS was comparable with similar work being done elsewhere. There was some attention to innovation, although existing techniques were used whenever possible. A major strength of the group was the experience of the staff and the interest in using models to aid in an interdisciplinary approach to problem solving. These uses involved interpolation and extrapolation of data and contributions to the synthesis and analysis of observations. There appeared to be a considerable demand for the use of models in the diagnostic as well as predictive sense, and there was some danger that this group could become overextended.

If attention can be limited to a few studies over a reasonable period of time, it is probable that the objectives will be achieved. The demand would seem to indicate a need for some future expansion in staff. Access to better computer facilities may be required as the complexity of the studies increases.

Communication with outside groups doing similar work was satisfactory. Cooperation was under way with the Geophysical Fluid Dynamics Laboratory at Princeton and the National Center for Atmospheric Research at Boulder. The affiliation with the University of Washington was mutually supportive and stimulating.

MARINE LIFE AND GEOCHEMICAL STUDIES (MARLAGS)

MARLAGS was the major biological and chemical oceanographic focus at the laboratory and was almost entirely committed to the Outer Continental Shelf Energy Program in Alaska and to DOMES.

The group suffered from imbalanced and uncertain funding and the pull and push of having to respond to constantly changing needs. Furthermore, too much of the decision making seemed to rest with the funding agency rather than with the investigator, who then responds rather than initiates. Even when the investigator initiates, he feels constrained to second guess what other agencies want instead of being guided by the needs of his future research. An apparent lack of well-defined long-term goals may be overcome as the group matures.

The group also suffered from having been put into a biology-chemistry compartmental situation. It is difficult to see how it can perform well in today's research and development atmosphere without a strong interdisciplinary approach. The separation from SCENE was perhaps unfortunate and probably a major cause of the poor morale of this group. The investigators in this group correctly identified the need for interdisciplinary programs but were discouraged by not being able to work strongly in this way. Many of the biological techniques used were routine and lacking in innovation.

On the positive side; the biologists took the initiative to seek outside sources of support from other agencies; they felt that publication in the refereed literature was encouraged above and beyond the

data reports that might satisfy the funding agencies; they were pleased with the quality of technical help they had been able to hire; and they talked about research projects that they were interested in and would try to pursue, independent of the funding agencies' requests. This last view was in marked contrast to that expressed by the Seattle area NMFS scientists with whom some of us talked during the Northwest Fisheries Center review. There were some good contacts with university people.

DEEP OCEAN MINING ENVIRONMENTAL STUDIES (DOMES)

The goal of DOMES was to identify potential environmental problems that may arise from the deep-ocean mining of manganese nodules. The program functioned in PMEL entirely at the management level. Because all research and development studies were contracted out to universities and other agencies, an evaluation of the quality of this research was outside of the scope of this review. The specific sites had been selected, investigations were under way, and the program was moving on schedule. It was not clear to us that this program fits into the general work of PMEL.

BASE OPERATIONS SUPPORT SERVICES (BOSS)

BOSS was recently established to provide technical support for research projects undertaken by PMEL. It had mostly new people and was limited in financial support. Perhaps the formation of BOSS was badly timed in terms of the fiscal cycle. Staff consensus was that support should improve.

Some within BOSS saw a need for a fairly high-level professional engineer to serve as internal consultant. The PMEL management told us that engineers are generally "too expensive" and that engineers prefer to generalize a problem before they solve it. (This view may be common throughout NOAA ocean laboratories.) We believe that the proper kind of engineer at PMEL could strengthen BOSS, improve communication with such NOAA groups as the Engineering Development Laboratory and the NOAA Data Buoy Office, and be of benefit to all concerned.

Strengths

1. The scientific staff was of high quality.
2. The ocean-atmosphere research program had a reputation for first-rate scientific research.
3. The close working relationship with the Department of Oceanography of the University of Washington was an asset to the scientific program.
4. The modeling and simulation studies group provided strength in using models for interdisciplinary problem solving.

Weaknesses

1. Many of the research staff were concerned about the lack of a coherent statement of laboratory goals and objectives.
2. Fifty-seven percent of the laboratory support was from reimbursable funds; thus there was a weak financial base for developing long-term research programs.
3. Compartmentalization between disciplines in several groups resulted in a less-than-optimum overall program. It is difficult to see how these groups could perform well without a strong interdisciplinary approach.

Recommendations

1. Because the laboratory is new, an excellent opportunity exists to develop a strong sense of laboratory mission and purpose. This should be done.
2. The organization and ties between physical, biological, and chemical oceanographers should be strengthened to improve the shallow-water research work.
3. A centralized group (Base Operations Support Services) should be strengthened to provide technical support services to the several groups in PMEL.
4. Additional efforts should be made to improve communications within the laboratory and with ERL headquarters.
5. A statement of PMEL missions, goals, and objectives and the strategies to achieve them should be developed.

6. Joint Tsunami Research Effort (JTRE)
NOAA Environmental Research Laboratories
Honolulu, Hawaii

Site visit: December 5, 1976

Review team members: Ferris Webster (leader), Li-San Hwang, and Richard C. Vetter

Program director: Gaylord Miller

1975 Budget: $345,000

NOAA-defined function: *Conducts basic research in the fluid dynamics of tsunamis and other wave and large-scale water motion with an objective of improving the tsunami warning system and improving the design criteria for tsunami hazards to coastal structures and the coastline. Also specializes in numerical hydrodynamics and theoretical fluid hydrodynamics.*

The research program of the Joint Tsunami Research Effort (JTRE), carried out jointly between NOAA and the University of Hawaii, was excellent, with standards and techniques that would do credit to any organization, academic or industrial.

There was good academic freedom, and good relations existed between NOAA scientists and their academic colleagues at the University of Hawaii. Many of the senior JTRE staff were teaching and advising graduate students at the University.

All staff members interviewed cited the excellent leadership of the director as a significant factor in establishing and maintaining the excellence of the group. Their efforts have been hampered by the ERL administrative structure (JTRE reports to ERL headquarters via the Pacific Marine Environmental Laboratory in Seattle) and limited local authority.

In the face of such an excellent program, the following comments and criticisms would probably escape notice at most NOAA laboratories.

Consideration should be given to extending the tsunami data-gathering capability of the group. NOAA's program stability (relative to most universities) provides an opportunity for collecting long-term field observations of this occasional and intermittent phenomenon. In addition, additional efforts to verify existing numerical models through wavefunction and source-function (seismic) data should be considered. These studies might be combined with an increased effort to ensure close collaboration between theory and observation. The review team sensed the possibility that major scientific activities of the group could evolve into theoretical and observational work, with a resultant decrease in overall balance and effectiveness.

Some work under way and planned might be duplicative of outside activities. Within the limits of tight budgets, JTRE might best channel its resources by reducing duplication where possible.

Facility support for JTRE seemed good. There is only limited technical support, but it seems to be adequate. The only complaint heard was the need for more secretarial help in manuscript typing.

Strengths

1. Scientists from NOAA and the University of Hawaii formed an effective and adequate sized group for carrying out the tsunami research program.
2. The technical and academic staff were well trained.
3. The atmosphere for research was excellent.

Weaknesses

1. Data-gathering capabilities were limited.
2. There was an apparent trend toward observations at the expense of attention to theory.

Recommendations

1. The data-gathering capability of this group should be extended. NOAA's program stability provides an opportunity for collecting long-term field observations of this occasional and intermittent phenomenon. Additional efforts are needed to verify existing numerical models and to ensure closer collaboration between theory and observation.
2. Care should be taken to avoid duplication of work by other groups as a means for working within tight budget limits.

NATIONAL OCEAN SURVEY

7. Oceanographic Division (OD)
NOAA National Ocean Survey
Rockville, Maryland

Site visit: May 28-30, 1976

Review team members: Carl Wunsch (leader), Robert O. Reid, Richard C. Vetter, and Ferris Webster

Division chief: Carl W. Fisher

1975 R&D Budget: $35,000

NOAA-defined function: *Plans oceanographic surveys for the collection of tide, current, temperature, and salinity data; for water-column and sea and swell observations; for suspended sediment studies; and for estuarine surveys and modeling. Processes and analyzes oceanographic data for the preparation of nautical charts for use in oceanographic research by NOAA, NOS, other domestic institutions, and the national data centers. Processes, compiles, and analyzes tidal and current data from domestic and foreign sources. Prepares tidal current charts and annual tide and tidal current tables for publication. Publishes tidal bench-mark and tidal datum plane information as determined from level records and tide observations.*

The primary mission of the Oceanographic Division was operational--the maintenance of a large grid of tide stations, the reduction of the resulting data, the production of tidal predictions and charts, and the provision of data for use in legal testimony. Much activity was in support of the charting operation of NOS and, more generally, to assist the mariner.

The actual research component of the group was small. The persons who previously provided some research capability within the group were transferred to what is now the Atlantic Oceanographic and Meteorological Laboratories (AOML) in Miami when the Environmental Science Services Administration was formed. The small group identified as performing some research were hired in recognition of the fact that some research capacity was required within the organization.

We were favorably impressed with the enthusiasm and interest of the people doing research. They were clear that their major mission was in support of the operations group, and they felt some responsibility to act as resources and advisers to the operations people.

We judged the actual research level as competent, if not especially inspired nor of front rank. This may be all that can be expected within the environs of an operational organization. The group no longer had the historical (30 years ago) intellectual edge that it once had. Neither the hardware development nor the data-reduction procedures used by the service could be considered state of the art. We noted that personnel often felt compelled to consult outsiders concerning ideas and methods in which the group rightfully should be the experts. [In this sense, the group compares unfavorably to its British counterpart, The Institute of Oceanographic Sciences, Bidston Observatory, Birkenhead, (formerly the Institute of Coastal Oceanography and Tides).]

The scientists within the group could clearly have benefited from enhanced contacts with scientists outside the organization. There was not a large enough group of scientists working with sea level/tide data, new hardware developments, or data-processing techniques to be effective. Some tide and sea-level work takes place at AOML, and it might be appropriate to consider some organizational change that could bring working scientists in closer touch with the operations group.

In more general terms, we believe that the organization has not been able to fulfill its potential for leadership and interaction with the outside scientific community. Sea-level and tide-gauge records have become of increasing interest to a large number of scientists in recent years. The NOS has not been able to respond to either requests for the placement of additional gauges in scientifically interesting areas nor even, given the recent volume of requests, to respond to archival requests.

We recommend that the archives be turned over to the Environmental Data Service. None of the legal or data-handling problems that might be raised as arguments against this appear to be compelling. NOAA should encourage the NOS to increase its responsiveness as a potential ocean monitoring organization. This group should be exploited as one of the few national organizations equipped to carry out the process of ocean monitoring.

The Division should acquire the capacity to interact in a more creative fashion with the scientific community at large. It should therefore actively seek a professional-level individual (probably Ph.D.) with a specific interest in the measurement of tides, tidal currents, and sea level; who would be able to bring state-of-the-art expertise to the data-acquisition problems and to new forms of instrumentation; who is able to communicate effectively with development engineers; who is knowledgeable about data processing (use of response and other methods); and who could actively seek cooperative efforts with the outside scientific community.

The Division should develop an active cooperative program, perhaps with the Engineering Development Laboratory, to dedicate at least a few field stations to hardware developments. This should be done deliberately and on a noninterference basis. This step should be considered as part of the overall aim of regaining the lead in both hardware and data management.

Strengths

1. The enthusiasm and interest of the staff was evident.
2. The group seemed to have a clear idea of their mission and how their research supported that mission.
3. The group was equipped for large-scale ocean monitoring and had a long-standing tradition of maintaining tide stations and generating reliable data.

Weaknesses

1. The research capability was competent but not outstanding. The group was not advancing the state of the art with ideas and methods as is its British counterpart in Liverpool.
2. The group has not been able to fulfill its potential for leadership and interaction with the general scientific community.

Recommendations

1. Strengthen the interactions with the general ocean-science community to improve the contacts with new ideas, or
2. Consider some organizational changes that could bring working scientists into closer touch with the operations group.
3. The archives might be turned over to the Environmental Data Service, to free NOS to direct more effort to ocean monitoring.
4. The group should seek a professional-level individual (possibly Ph.D.) with a specific interest in tides, tidal currents, and sea level, with expertise in data acquisition and processing and who might actively seek cooperative efforts with the general scientific community.
5. The group should dedicate a few field stations to hardware development as a means of regaining the lead in hardware and data management.

8. Engineering Development Laboratory (EDL)
NOAA National Ocean Survey
Rockville, Maryland

Site visit: May 28-30, 1975

Review team members: Foster H. Middleton (leader), John V. Byrne, Lester LeBlanc, Richard C. Vetter, and Ferris Webster

Laboratory director: M.G. Ringenbach

1975 Ocean R&D Budget: $655,000

NOAA-defined function: *Provides engineering services in support of data acquisition and processing functions encompassing the areas of systems engineering analysis; exploratory development; engineering and prototype hardware/software model design and development; system and subsystem test, evaluation, operational integration and technical specification formulation, including integrated logistics support.*

The mission of the Engineering Development Laboratory was to apply the most advanced techniques available to the solution of operational problems in the field for the National Ocean Survey. Examples were the development of new water-quality sensors and refinement or improvement of existing instruments or platforms. Although the definition of "basic" depends on the observer, there was no basic research under way at the laboratory. There was meaningful applied research under way.

Employees were motivated and proud of their activities. It was clear that the image and function of the laboratory had been improving in recent years. The attitude of the director had influenced the workers in a positive way. The quality of the project engineers and other professional staff was good. Aside from the director, there appeared to be no high-level, long-experienced engineering talent onboard.

In a general way, each project engineer was being challenged to the limit of his capabilities. The appearance was given that billet limitations, if not now serious, could be at some time in the future. The impression was received that the caliber of the professionals had improved and was still on the rise.

The laboratory was operating much like an academic organization in the manner in which reimbursable funds were sought for specific projects. This was not a bad procedure inasmuch as nearly half of the support funding was from outside EDL. This sort of funding basis requires a more aggressive attitude on the part of senior staff, particularly the director. A considerable fraction of the director's time was required for proposal work, negotiations, and related matters.

The applied research work going on was of good quality, considering the limited experience of the project engineers. Some guidance and advice by a senior technical person, working with the director, would help to shape the further development of the professional staff. Communications with other parts of NOAA in general seemed to be limited. However, in the case of the NOAA Data Buoy Office, deliberate efforts were being made to exchange ideas and to discuss projects. There should be more of this. The stature, reputation, and image of the laboratory was improving, and emphasis on expanded communication with other NOAA units will help greatly.

Strengths

1. The staff were motivated and proud of their accomplishments.
2. There had been a recent improvement in the image, function, and capability of the laboratory.
3. The laboratory provided a special ocean engineering capability within NOAA.

Weaknesses

1. There was a lack of experienced ocean engineering talent on the staff. This was manifested in some of the engineering projects that were reviewed in depth.
2. Other NOAA laboratories that might benefit from EDL assistance were not utilizing this laboratory.

Recommendations

1. Better ties are needed with other parts of NOAA that could use EDL services. Special attention should be given to ties with the NOAA Data Buoy Office.
2. A high-level technical person should be recruited to assist the director in the guidance of individual project engineers.
3. There should be a continuing process of upgrading technical staff billets. This should provide sufficient career motivation to retain the lead people as they develop and mature.

9. Geodetic Research and Development Laboratory (GRDL)
NOAA National Ocean Survey
Rockville, Maryland

Reviewed at Miami, Florida: January 26-27, 1976

Review team members: Christopher Garrett (leader), Carl Wunsch, and Ferris Webster

NOAA-defined function: *Is the focus within NOAA for conducting research and development in accordance with the mission of NOAA in geodesy, and impinging on allied fields including photogrammetry, geophysics, astronomy, and computer sciences. Is responsible for the formulation and execution of programs, encompassing all phases of physical and geometric geodesy, for the purpose of introducing successful innovations in geodetic practice. Applies results to improve NOAA operating procedures and to further the general state of geodetic knowledge.*

The review of the Geodetic Research and Development Laboratory (GRDL) consisted of discussions with Bernard Chovitz, Chief of the Physical Geodesy Branch, who visited the Atlantic Oceanographic and Meteorological Laboratories in Miami for this purpose. We were unable to interview three other members of this laboratory engaged in oceanographic applications of geodesy.

We were impressed with the work and general philosophy of this group. Areas of scientific research are carefully chosen to make use of routine geodetic work and to have potential for discoveries that will lead to improvement of basic techniques and results in geodesy.

The work of this group appeared to be competitive at the agency, national, and international levels, and communications between these levels was good. A particular effort was directed to work with physical oceanographers within AOML interested in satellite applications. There is potential for even greater outside contact, which should not be restricted to NOAA.

Perhaps a separate review of the whole Geodetic Research and Development Laboratory should be undertaken. Our own impression is that this may be a group with potential for successful expansion to exploit the importance of modern geodetic techniques for basic problems in geodynamics as well as in oceanography.

10. NOAA Data Buoy Office (NDBO)
NOAA National Ocean Survey
Bay St. Louis, Mississippi

Site visit: January 8-9, 1976

Review team members: Foster H. Middleton (leader), Henri Berteaux, Jerome H. Milgram, Claes H. Rooth, Richard C. Vetter, and Ferris Webster

Director: James W. Winchester

1975 Budget: $9,497,000

NOAA-defined function: *The NDBO exists to provide and improve data buoy technology; perform systematic development, test, and evaluation for a wide-range of environmental data buoys to meet specific user needs; and provide technical support to government and industrial programs, both national and international.*

The NOAA Data Buoy Office was formed from the National Data Buoy Office of the U.S. Coast Guard in 1970. Its direction has changed dramatically since that time. Aspects of this history have a bearing on the character and organization of the Office. A measure of continuity has been provided by the Interagency Agreement, which established a USCG contingent in the Office. This contingent is headed by a Coast Guard Captain, who serves as Deputy Director of NDBO. The agreement provides for 15 USCG people in NDBO.

The NDBO has immediate access to aircraft and ships of the Coast Guard, including a buoy tender vessel that has its primary assignment to NDBO. Access to USCG facilities is available generally without the necessity of going through USCG Headquarters with a request. Deployment, servicing, and retrieval of buoys are performed with Coast Guard assistance.

The NOAA Data Buoy Office placed emphasis on engineering development as contrasted with research. The development effort was limited to specific mission-related projects to develop technology to be transferred to users within and outside of NOAA. Considering the limited resources available, the review team questioned the advisability of NDBO not assigning more development to users or other groups. The review team was also concerned about the written statements of NDBO objectives and the lack of engineering research effort in support of those objectives. To gain the lead in development of new buoy technology requires more engineering research.

There is no question that good development work was in progress in NDBO and that NDBO efforts related to other parts of NOAA. The communication between NDBO and the rest of NOAA and the scientific community outside NOAA appeared to be variable. In some instances it

was good, close, and regular. But in others it was poor, including that between NDBO and NOS Headquarters.

Participation in NDBO programs and program planning did not appear to involve experts from outside of NOAA. At the same time, some outsiders were familiar with and involved with NDBO buoy work and data products. The review team recognized that broadening this communication base would require deliberate effort and support from NDBO and that it should be considered.

Nearly all of the effort at NDBO was in engineering development, in the administration of development, or in the maintenance of systems that have been developed. The sense of direction for "what will be developed" appeared to the review team to be inappropriately narrow. Essentially, no concepts or ideas come from NOS headquarters. A limited amount of concept direction came from the buoy user community and the remainder from within NDBO. There did appear to be strong interest within NDBO for long-range guidance from NOAA headquarters on buoy technology requirements and priorities.

Because of the compelling desire to get results in a hurry, the quality of some buoy systems developed by NDBO was low. On occasion, the measurements for which the buoy system was designed were taken and used without checks to determine accuracy. What seemed to be lacking in most instances was the background research needed to know what will be measured by a buoy system. Furthermore, there seemed to be inadequate study to determine the degree of correctness of measurements that are made. NDBO personnel were aware of these shortcomings, and some attempts had been made to reduce them.

In one instance, a research effort was launched to develop a spectral correction for bandpass-filtered wave data. In the course of this work, a basic problem in the data interpretation was found. Nevertheless, research into the problem was halted because of pressures for hardware development. The buoy system was thus apparently going forward without the needed work to solve the problem with the processing system.

The engineering development work at NDBO appeared to be more satisfactory than did the research work. Development work at NDBO starts with the construction of a prototype, using as many off-the-shelf components as possible. Little background work precedes this prototype phase. As might be expected, the failure rate on the prototype system is unduly high. Failures are repaired, remedies incorporated, and the prototypes refined until the reliability reaches acceptably high levels.

In many instances this approach is appropriate and it has enjoyed considerable success. In spite of these successes, the review team believes that the prototype approach is not always the correct one, and NDBO should learn to recognize when it should not be used. Quite clearly, prototyping can be unduly expensive. It is our impression that the time may be at hand when a new buoy requirement should start with significant research study. Inherent cost savings are possible when one considers the relative expense of research in the laboratory as opposed to operations at sea.

The disadvantage of starting a new project with an initial research or study phase is that field results will be delayed. The overwhelming motivation for NDBO to get some successful moored and free-drifting buoys in the deep ocean or on the continental shelf is understandable. The review team is of the opinion that NDBO has achieved this initial visibility. It is now time to turn to a more forceful approach combining engineering research and development as necessary, to improve the prototype systems so as to satisfy users needs with a minimum of retrievals and repairs.

There was evidence of a lack of communication between NDBO and NOS headquarters. The impression gained by the review team was that essentially no technical direction or leadership comes from NOS or NOAA headquarters. Communication between NDBO and other units of NOAA on buoy technology matters was not good. NDBO did not appear to enjoy a leadership role, either within NOAA or within the scientific and engineering community. Private institutions do not appear to look to NDBO for leadership in buoy technology.

An excellent form of communication initiated by the NDBO Director was the Buoy Technology Workshop. This is not a periodic affair, and broad participation was not achieved, but the effect has been good. Perhaps more of this sort of activity would serve to advance NDBO into a position of leadership. Also, workshops, and the proceedings of the workshops, usually produce some kind of follow-up or continuity from one workshop to the next. If any agency should perform this function, perhaps it is the NDBO.

The question arises about the future of NDBO and what kind of priorities it ought to have. It is our impression that it is time for a change. The ability to put hardware in the ocean has been demonstrated. It is time now to dedicate more effort toward buoy system quality. It was made clear to us that this idea is not inconsistent with the thinking of NDBO administration. In fact, a new Chief Engineer with a Ph.D. degree has been found and offered a permanent position. This is a step in the direction of our recommendation.

Strengths

1. The office has access to aircraft and ships of the U.S. Coast Guard to aid in carrying out its mission.
2. The office is able to call upon a large pool of talent to advance buoy development and servicing.
3. Good hardware development work is in progress.

Weaknesses

1. Little basic buoy engineering research is under way at the laboratory.
2. Limited advantage is taken of talents from outside of NOAA.

3. There is a substantial level of trial-and-error philosophy in many projects.

4. Little effort has been assigned to buoy data quality studies.

Recommendations

1. Increase attention to improvements in buoy measurement techniques. This is the next step beyond just getting a buoy to reliably service a station and requires a change in philosophy from just making a buoy system function to considering the quality of the data product.

2. Make the transition from a trial-and-error approach to reliability engineering from the onset. This will require making more use of basic studies and laboratory testing.

3. Expand on the Buoy Technology Workshop idea instituted by the Director of NDBO. Expand the participation in such workshops and take the lead in following up on workshop suggestions.

4. Obtain the services of a strong Ph.D. in engineering to strengthen the NDBO staff.

5. Enlist the talents of buoy experts from outside of NOAA.

NATIONAL WEATHER SERVICE

11. Techniques Development Laboratory (TDL)
NOAA National Weather Service
Silver Spring, Maryland

Site visit: May 28-30, 1975

Review team members: Robert O. Reid (leader), Foster H. Middleton, and Ferris Webster

Acting laboratory director: William H. Klein

1975 Ocean R&D Budget: $140,000

NOAA-defined function: *Conducts or sponsors applied research and development aimed at improvement of diagnostic and prognostic weather information primarily intended to be issued directly to the public and other user groups by field offices. Carries out studies both for the general improvement of prediction methodology used in the National Meteorological Service System and for more effective utilization of weather prediction by the ultimate user. Develops computer programs required to improve the overall performance of the Service. Directs effort to the improvement of prediction techniques in the areas of agricultural weather, fire weather, marine weather, and aviation weather. Special emphasis is given to the development of improved methods for prediction of tornadoes and severe local storms. Projects involve use of modern physical, dynamical, and statistical prognostic techniques, high-speed electronic computers, special networks for measurement of meteorological phenomena, and the like.*

The general mission of the Techniques Development Laboratory was the development and continual improvement of techniques for forecasting surface phenomena from weather data and predictions. Tasks under way included development and improvement of techniques for forecasting storm surges on the open coast due to hurricanes, forecasting storm surges on the open coast and Great Lakes due to extratropical storms, and forecasting waves and swell over the Atlantic and Pacific Oceans and the Great Lakes. In addition, this group had undertaken reimbursable studies concerned with establishing storm-surge statistics for certain coastal locations based on hurricane statistics.

The senior scientists were highly competent judging from the quality of their reports and their reputations with their scientific peers. It did appear that the senior people were overly involved with routine operations. For example, they did their own programming instead of using a professional programmer.

Finally, we were concerned with the fact that NOAA's involvement in storm-surge research was fragmented (at least administratively) among three different NOAA laboratories. The Atlantic Oceanographic and Meteorological Laboratories and the National Hurricane Center in Miami had individuals involved in such work, none of which may have staffs large enough for optimum research work. Because it was not clear where the real direction existed for long-range projections of research in the NOAA storm-surge efforts, we examined this question separately, and a brief report follows.

Strengths

1. The senior staff was competent, with an international reputation.
2. The laboratory had a clearly defined product and hence a good sense of mission.

Weakness

1. Senior people may have been overly involved with routine operations and computer programming.

Recommendation

1. Improve the coordination and leadership of storm-surge work within NOAA.

Addendum: Hurricane Storm Surge Research and Development (R. O. Reid)

The goal of the program of storm-surge R&D within NOAA is to develop operational models that realistically simulate flooding in coastal areas, including vulnerable bays and estuaries, in order to forecast and evaluate flooding risks. Components of this program were divided primarily between the Techniques Development Laboratory of the National Weather Service in Silver Spring and the Sea-Air Interaction Laboratory of the Atlantic Oceanographic and Meteorological Laboratories (AOML) in Miami, with some nominal technical help from the National Hurricane Center, also in Miami. The program formerly in the National Hurricane and Experimental Meteorology Laboratory in Miami has been terminated.

While we were concerned with the fragmentation of efforts on this program within NOAA, we found that communication at the working level among the different components appeared to be reasonably good.

The efforts within SAIL involve both oceanographic and meteorological aspects of the problem. These efforts, while limited, appeared to be innovative and of good quality.

We believe that this program is important but that the present level of support falls far short of that required for accomplishment of its goal and that it lacks the needed leadership. One way to help may be to invite visitors with expertise in storm surges to visit AOML.

ENVIRONMENTAL DATA SERVICE

12. Center for Experiment Design and Data Analysis (CEDDA)
NOAA Environmental Data Service
Washington, D.C.

Site visit: April 20-21, 1976

Review team members: Ferris Webster (leader), Gabriel T. Csanady, Robert A. Ragotzkie, and Richard C. Vetter

Laboratory director: Joshua Z. Holland

1975 Ocean R&D Budget: $192,000

NOAA-defined function: *Provides services and support in data management and scientific analysis for large-scale environmental field research projects. Assists in the planning, design, and implementation of such projects to ensure that data needs are met. Conducts related scientific and technical studies.*

The Center for Experiment Design and Data Analysis was primarily occupied with the management and handling of atmospheric and oceanic data arising from a number of international air/sea interaction experiments, including the GARP Atlantic Tropical Experiment, the Barbados Oceanographic and Meteorological Experiment, and the International Field Year of the Great Lakes. The atmospheric part of the research activities dominated and appeared to be of relatively high quality. However, CEDDA was not primarily a research organization, and its involvement in ocean research was small. We were asked to rate the quality of this research in comparison with the rest of the ocean-science community. By these standards, the quality of the research was pedestrian.

The oceanographic research publication record of CEDDA scientists while they were at CEDDA was not impressive. There was apparently good attendance at meetings, and numerous papers were given by CEDDA scientists, but these papers tended to be data-oriented and were not especially imaginative or innovative.

The CEDDA ocean research program suffered from weak professional contacts with other oceanographers both in other NOAA components and with the academic oceanographic community. Although there seemed to be strong and healthy ties between CEDDA and scientists in the atmospheric science community, analogous ties to the ocean-science community

had not been developed. If ocean research is to be a part of CEDDA's future activities, such ties both within and outside of NOAA are essential.

There was evidence that interaction by CEDDA with other NOAA components was actively resisted by other components and scientists. For example, data collected by the National Ocean Survey (NOS) for the MESA project was not available to CEDDA for use in the Bureau of Land Management project until the NOS scientists had first opportunity to publish it; nor had this data been turned over to the National Oceanographic Data Center at the time of our review even though it was collected by a NOAA group.

This example was symptomatic of a general tendency for lack of cooperation between NOAA components with regard to data as well as the sharing of scientific thinking and research exchange. A more collegial atmosphere among scientists in the various NOAA oceanographic research activities would be highly desirable. CEDDA research scientists felt somewhat cut off from the rest of NOAA's oceanographers. A contributing factor may have been that the ocean mission of NOAA was not clearly understood by CEDDA scientists. They were confused about whether their own research activities were consistent with NOAA objectives or even what these objectives were.

Much of the laboratory atmosphere was not conducive to research pursuits. The review team wondered if it might not be healthy in the long run to consider the possibility of moving CEDDA away from Washington, D.C., to the campus of some university with either an atmospheric or oceanographic department. Such a move might do little, if any, harm to the operational side of CEDDA, but could provide an immense stimulus to the research work.

The data management and processing skills of CEDDA were impressive. Such skills could be effectively applied to fields outside those of meteorology and oceanography. For example, the growing national environmental activities could be an area where CEDDA's technical skills might be valuable.

The personalities of the director and of the head of the research division contributed to maintaining high morale in the Center. The searching scrutiny given to the atmospheric surface layer data by the scientists was gratifying.

Control of the scientific quality of the output was effected partly by contact with the GATE academic panel. Research at CEDDA was justified as an inducement to attract and keep good scientists, to work mostly on data management. As part of the bargain, CEDDA scientists should be allowed to spend part of their time on research, including interaction with other oceanographers, both in NOAA and in the academic community. This philosophy was at best only partially put into effect.

CEDDA scientists have an excellent opportunity to undertake and carry through ocean research using large data sets and applying new techniques of data analysis and presentation. Although this opportunity was recognized by some of the scientists, there seemed to be no effort to attempt a new approach capitalizing on the data availability and technical expertise within CEDDA.

There was also a tendency to emphasize the atmospheric side of the air/sea interaction and to downplay the effect of the atmosphere on the ocean.

RESEARCH DIVISION

The boundary-layer work appeared to be the strongest element in the research division, reflecting the director's interests. The focus of the group's efforts was, however, narrow, being confined to surface fluxes of momentum, heat, and vapor. These topics clearly have relevance to oceanography, but the connection was not exploited explicitly by this group. An impressive fact is that, during GATE, the boundary-layer work was carried through by members of this group from experiment design to field observations to data processing and to at least some limited scientific analysis. The quality of the work appeared to be high, although the publication output was meager and not impressive. Work in progress on oceanic surface mixed-layer phenomena was promising.

Studies of atmospheric mass, energy, and momentum budgets over large regions of the ocean have clear oceanic relevance. The quality of the work was good, but its current connection to oceanography was indirect.

A small effort was being made on an oil advection project on an *ad hoc* basis. No claim was made to serious research significance.

OPERATION DIVISION

The ocean-related activities in this division were almost totally confined to the handling and management of data sets arising from ocean-atmospheric experiments. The technical skills applied to this task seemed excellent. The ocean research output was nearly nonexistent, judged by papers in refereed journals.

The scientists in this division all reported that they were given full freedom to pursue ocean research of their choosing. Nevertheless, the combination of day-to-day operational responsibilities and perhaps the absence of a research climate within the division seemed to have prevented any significant research output.

FACILITIES

The laboratory depended heavily on good computer facilities. Three computers were available: an in-house PDP-11, the nearby IBM 360-65 shared with other NOAA activities, and a tie-line to a CDC-6600. We were told that the 6600 computer would soon be abandoned. This was causing concern on the part of those scientists using it, because they perceived that the IBM 360-65 computer did not provide an adequate alternative. The turnaround on the IBM machine seemed too long to allow effective program development. Perhaps a better internal awareness of future computers plans would help allay staff concerns.

Reports of use of NOAA ships were similar to the stories heard at other NOAA labs: an expensive operation in which science was not the first priority. It seemed regrettable that the operation of the ships was not more sympathetic to the special needs of research at sea. The shortcomings of NOAA ships for research puts NOAA research at a competitive disadvantage in comparison to that done by academic research vessels.

The NMFS library in the CEDDA building was of limited value to CEDDA researchers. Although books and references were available by interlibrary loan, the lack of direct access to a first-rate oceanographic library was a minor handicap. The level of research activity and the location in Washington did not justify a major effort to upgrade the fisheries library to serve CEDDA's research needs.

Strengths

1. The center had impressive data management and processing skills and had access to large data sets.
2. The center had high morale.
3. The atmospheric research aspects of air-sea interaction activities at the center seemed to be of high quality.
4. The center possessed an impressive capability for end-to-end data handling, that is, from experimental design, to field observations, to data processing, and to limited scientific analysis.

Weaknesses

1. Judged by the standards of the rest of the ocean-science community, the quality of the ocean research at CEDDA was pedestrian, with an unimpressive publication record.
2. The program suffered from weak professional contacts with oceanographers, both within NOAA and outside.
3. The research program emphasized the atmospheric aspects to the detriment of the oceanographic. (This may be a weakness only from the *oceanographic* point of view!)

Recommendations

1. The ocean research mission of CEDDA should be specified, and the priorities should be made known to the research staff. (Is "research" part of the CEDDA mission, or is the center to be engaged only in "service" activities?)
2. If the center is to have an ocean research component, a senior oceanographer should be recruited to lead and stimulate an ocean viewpoint to the ocean-atmosphere problems that CEDDA is studying.

NATIONAL ENVIRONMENTAL SATELLITE SERVICE

13. Office of Research (OR)
NOAA National Environmental Satellite Service
Suitland, Maryland

Site visit: May 28-30, 1975

Review team members: Ferris Webster (leader), John V. Byrne, Lester LeBlanc, Richard C. Vetter, and Carl Wunsch

Director: Harold Yates

1975 Ocean R&D Budget: $1,033,000

NOAA-defined function: *Provides overall guidance and direction for the research activities of NESS. Coordinates the efforts of the Meteorological Satellite Laboratory, the Satellite Experiment Laboratory, the Environmental Sciences Group, and the Computation Group. Assesses the requirements and goals of the NESS research program and evaluates its progress.*

The ocean mission of this office was to develop the uses of satellite data for oceanography R&D and to make these uses known to the oceanographic community, most specifically to the NOAA oceanographic element.

The general competence of individuals on the staff to carry out this broad mission was judged to be adequate. All the people involved seemed capable, were interested in the science, and seemed eager to do a good job.

The research undertaken was judged to be of medium quality. Although new and exciting technology, i.e., satellite and remote-sensing data-acquisition systems, serves as the basis of the research, the problems being worked on bordered on routine. However, this level of research was in keeping with the mission of the group to demonstrate the utility of satellite data to the oceanographic community. In the judgment of the review team, the research being conducted was below the competence level of the investigators and, consequently, could be improved.

A number of factors appeared to be detrimental to the quality of the research. Foremost of these factors was the lack of a clear definition of mission objectives. A number of the investigators

expressed a feeling of pressure caused by too many research and management tasks being imposed on them. Time was judged to be insufficient to complete specific research projects in depth.

The lack of technical support undoubtedly contributed to this pressure. Technical assistants, draftsmen, and programmers were not available in sufficient numbers to provide the support needed to free the scientists to carry out the more intellectual aspects of the research.

Communication with other scientists within NOAA was relatively poor. In addition, it was questionable as to whether there was a large enough number of research scientists within OR/NESS to carry out their programs effectively.

Strengths

1. The staff was competent and enthusiastic.
2. The staff had access to new technology in satellites and remote sensing that provided a basis for significant research advances.

Weaknesses

1. The staff expressed a feeling of pressure caused by too many imposed research and management tasks.
2. Employment ceilings resulted in a lack of technical support.
3. Communications with other NOAA scientists was relatively weak.

Recommendations

1. Develop a statement of the ocean R&D mission objectives for this office.
2. Improve communications with other scientific groups, possibly by adding enough additional staff to permit NESS oceanographers to be assigned temporarily to other NOAA laboratories.
3. Consider adding an extension agent-type person to the staff. It would be this person's function to make the research results of the NESS group known to the user community and to bring problems faced by the operational and other research areas to the attention of the NESS group.

NATIONAL MARINE FISHERIES SERVICE

14. Northeast Fisheries Center (NEFC)
NOAA National Marine Fisheries Service
Woods Hole, Massachusetts and Narragansett, Rhode Island

Site visit: June 22-26 and July 3, 1975

Review team members: J. L. McHugh (leader), Peter J. Colby, M. Grant Gross, Bostwick H. Ketchum, Harold Lokken, Foster H. Middleton, William D. Youngs, Richard C. Vetter, and Ferris Webster

Center director: Robert L. Edwards

1975 Budget: $2,731,000

NOAA-defined function: *Conservation of the living marine resources of the Northwest Atlantic.*

The fishery programs under way at the Northeast Fisheries Center fell into two main categories, Resource Assessment and Ecosystems Analysis. In addition, there were programs on Fisheries Oceanography and Fishery Engineering. A group at Narragansett conducted laboratory and field studies of the life history, distribution, and physiology of larval fishes.

The work of the Resource Assessment groups appeared to be good. The program was highly oriented toward fishery management. The scientific and administrative staff were preoccupied with the International Commission for the Northwest Atlantic Fisheries (ICNAF) (The U.S. withdrew from ICNAF on January 1, 1977. Work of the Center is still dominated by Northwest Atlantic fisheries management problems.), and with the need to maintain or restore the fishery resources of the ICNAF regulatory area to a condition of maximum biological productivity, to preserve access to the living resources for American fishermen, and to resolve bilateral problems with other nations. The need to build a strong scientific case for resolution of these problems occupied nearly all the time of the scientific staff. This brought these scientists into closer contact with their counterparts from Europe and elsewhere than with academic and governmental colleagues in the United States. The pressures to produce results of immediate benefit to management of fisheries in the ICNAF area had led to publication of

most of the results in background papers for negotiations or in ICNAF publications. The scientists received their satisfactions from seeing the results of their work applied to solution of fishery management problems and from close associations professionally and socially with their peers in the international fisheries community. These scientists had a clear idea of their objectives and were working hard in that direction. They did not publish much in the standard scientific journals. The scientific and administrative environment in which they worked was not conducive to a proper balance between long-range objectives and short-term management research.

The Ecosystems Analysis groups of scientists did not appear to have such clear-cut objectives. At least some of them were not under pressure to produce results of immediate practical application. Many of the Ecosystem Analysis group believed that the Center placed too much emphasis on ICNAF. They recognized that there were other client groups to satisfy and believed that this part of the program was spread too thin. The group at the Narragansett facility saw advantages to being away from Woods Hole because this relieved them of some of the day-to-day pressures.

We detected what appeared to be some disjunction between the breakdown of these two broad programs and the table of organization of the Center. It appeared that too many people were reporting to the Director and that he needed to delegate more responsibility to allow himself time for continuing review and guidance of his scientists.

RESOURCE ASSESSMENT PROGRAM

The Resource Assessment Group had the primary objective of preserving the stock through monitoring programs and recommending quotas. They believed that this activity had been effective and realistic. Without U.S. involvement, the stocks would have been in even greater trouble or might have been destroyed. The scientists considered that publication of scientific papers in primary journals was of secondary importance and that ICNAF research reports were of sufficient quality to meet the needs of their peer group--the North Atlantic scientific community. This group also realized the need for synthesizing and modeling their data and the value of obtaining an holistic overview of the ecosystem but could not find the talent or resources to do it.

Outside of ICNAF there appeared to be little interest or effort by the Assessment Group to communicate with the rest of the scientific community, which was probably to the disadvantage of the individual scientist. However, members of this group felt that the sacrifice was justified because their satisfaction was received by contributing to the ICNAF program. There had been a significant turnover of personnel and possibly those who left were less self-sacrificing.

Members of the Assessment Group also felt that there would be more publications as sufficient data are accumulated, but at the time of our review it was too early in the program to evaluate long-term trends.

Other Center staff members felt that too much emphasis was given to ICNAF and questioned the value of the U.S. contribution to preserving the stocks. They felt that they were spread too thin and should do fewer things more thoroughly. They believed that a greater return on investment could be realized if more time were available for publishing their findings. This group felt that other client groups (other federal agencies, state agencies, and industry) would be better served if emphasis were given to publishing the wealth of information that had already been accumulated. Possibly a senior scientist position should be created to permit self-motivated people the opportunity to publish. In the past, the attainment of senior scientist status was one of the career goals providing incentive for seeking government employment. Apparently the senior scientist category no longer exists.

It was our impression that the Center was not meeting its capability and responsibility to the scientific community by not publishing more in scientific journals. The staff appeared to be withdrawn from the rest of the scientific community and possibly had developed a negative or frustrated attitude toward publishing.

We suggest giving a senior staff member the responsibility for getting accumulated information published. This might require establishing a group of senior people outside the Assessment Group. The senior staff member given this responsibility would have assistant or deputy laboratory director status.

RESOURCE ECOLOGY PROGRAM

As noted above, the mission of the Center was "conservation of the living resources of the Northwest Atlantic." The approach of the Center in seeking to fulfill this mission had developed a two-stage process. The first stage--resource assessment--was made necessary by the urgent need to develop estimates of parameters for stock assessment, providing information necessary to ensure maintenance of the stocks of fish. The second stage was the resource ecology program.

The resource ecology program was planned along the ecosystem concept with the intent of developing a capability for longer-range prediction of the production of fish stocks in the Northwest Atlantic. As the ecosystem approach is developed, the prediction capability should be extended to include abiotic factors as well as interactions between biological components of the system. All the individual programs therefore contributed to the resource ecology program. The individual programs examined were benthic ecology, recruitment and production in fishes, oceanography, inshore ecology, multispecies survey, and trophodynamics.

The Resource Ecology program has not developed for two primary reasons. The first is the lack of a program leader to set the stage and start drawing information together. The scientist in charge of the program should be primarily trained in ecosystems modeling. Without such a person the program is not likely to succeed. Secondly, all component parts of the systems, once identified, must have study

programs to provide estimates of necessary parameters. The whole will be no more reliable than the reliability of the least precise estimate.

Moderate amounts of information necessary for this program were available or in the process of collection and evaluation. Strong points were the statistics for individual stocks of fish. The sampling program for groundfish stocks was particularly well developed but needed further analysis for verification and documentation. All other studies were too preliminary for judgment.

If this program is to be carried forward, other deficiencies will require correction in addition to the obvious problems mentioned above. The system for handling data was inadequate and will be critically overloaded when additional necessary information is collected. The capability of computing facilities was marginal for simulating the ecosystem efficiently by the solution of mathematical models.

CIRCULATION AND WATER MASSES

The Center had recently added a full-time professionally trained, physical oceanographer to its staff. Although this seemed to be a step in the right direction, the review team asked why physical oceanography was needed at the Center, and found that the answer could be justified only if work in this field were well related to the fishery research program. We were not convinced that the physical oceanographic activities were sufficiently well integrated with the fishery research needs. In addition, the group seemed underequipped to do an effective job. That is, the group, as supported, could play only a secondary role supportive to fishery needs, and it was unlikely at the time of our review to be able to do first-quality physical oceanography.

FISHERY ENGINEERING

The review team was left with doubts concerning the overall coordination of fishery engineering needs within NMFS. We were uncertain as to the extent to which fishery engineering work carried out at Woods Hole was duplicating work at other centers. We suggest that many problems in techniques and solutions are common problems and that the effectiveness of fishery engineering could be improved by better communication and centralization. This question needs to be reviewed at other centers.

The work of the engineering group was mostly development rather than research. It was highly mission oriented, as perhaps it should be. The only research appeared to be the hydroacoustic resource assessment project, which was contracted out to MIT.

The U.S.-U.S.S.R. joint experiment, which was being carried out by MIT, was a respectable research program. It was surprising that the data were processed manually, but that may have been made necessary by language problems. Another experiment on the application of hydroacoustic methods to obtain quantitative measurements of acoustic biomass done in Bay St. Louis, Mississippi, under contract with MIT,

had been well written up. This was good engineering work, with sensible objectives, and was properly analyzed.

The NEFC engineering group had recognized their own limitations and had taken appropriate action by contracting to have certain necessary work done. If similar research needs arise in the future, contracting probably will be more cost-effective than building up a larger staff of engineers.

ICHTHYOPLANKTON GROUP

This group, located at Narragansett, Rhode Island, was making laboratory and field studies of life history, distribution, and physiology of larval fishes. The objectives of laboratory studies were to evaluate the environmental conditions that determine survival of larvae and ultimate recruitment to the fish stocks. Laboratory breeding experiments were conducted to obtain early life stages and study conditions that might affect survival. Included were studies of salinity and temperature, trophic relationships, quality and abundance of food, and general feeding behavior. The field work had consisted of analysis of larval fishes collected on MARMAP and ICNAF surveys and relating the observed distributions to oceanographic conditions, predators, and available prey as food. The group was clearly enthusiastic about the program, which appeared to be well thought out and conducted. The main thrust of environmental studies was reductionistic. This should be tied to an overall holistic concept, to explain how the parts relate to the whole.

The Ichthyoplankton Group felt that there were advantages to conducting their studies at the Narragansett Laboratory that outweighed some minor disadvantages. The Narragansett facility consisted of about 50 people. Included were programs under MARMAP and the Atlantic Environmental Group, both of which report to Washington, and the Icythyoplankton Group of about 20 people, which reports to the NEFC. The Narragansett scientists felt that they had greater freedom to develop and pursue their scientific program without interruption than did the scientists in Woods Hole.

The Narragansett Laboratory is located on the Oceanographic Campus of the University of Rhode Island, adjacent to the EPA Laboratory. Relationships with University personnel seemed to be excellent. The University conducted some aspects of the research program, and contract and graduate students from the University of Rhode Island participated directly in research. A further advantage was that NMFS personnel could take courses at the University, either informally or formally. The group should take greater advantage of opportunities for association with the University by serving on graduate committees or directing graduate research. Direction of student research has advantages over contract research with the University because it offers more opportunity for control.

The general fiscal restraint that Narragansett felt most strongly was the small amount of funds available for operating expenses such as equipment and laboratory supplies. Some felt that this forced them to

beg for funds from other sources in the Center to maintain the operation. Others pointed out that help had been received to complete the equipping of laboratories and that the Center Director had been responsive to the needs of the Narragansett group. They also felt somewhat limited in their ability to attend national meetings at which subject matter of direct interest was being discussed.

There were complaints that it was easier to get money to make field collections than to work up the data. This is a general phenomenon in oceanography, not unique with this particular group. Methods were being developed to speed sorting of samples, and several recent publications describe a new density gradient technique. The scientists recognized that it would be desirable to analyze invertebrate plankton, as well as fish larvae, but limited funds and personnel have made this impossible. Plankton samples were stored at the Smithsonian Sorting Center, and the Sorting Center had provided personnel and assistance in working up the information.

The group felt that they were in good condition concerning publication and that NMFS as a whole had improved in the speed with which publications can be cleared to submit to journals.

The Narragansett group seemed to be doing good work and seemed to be content with their lot. They felt that NMFS is an appropriate organization for career development in this field of scientific study.

GENERAL EVALUATION OF CENTER

The Center was dominated by managerial rather than research functions. This was not true for all individual projects since some are clearly research. However, the overall thrust was clearly to provide management data for ICNAF. Scientific data provided by the Center to support the mission of conservation of stocks of fish in the Northwest Atlantic had been good. Success of the mission had been hampered by international political constraints.

Personnel interviewed repeatedly reported pressure to get data and documents prepared for ICNAF or bilateral meetings. There was little serious concern over the lack of opportunity to publish in refereed journals. Most people expressed the desire to publish but were not taking any initiative to change the operation or to do work on their own time.

Lack of publication, other than in the ICNAF series, leaves little basis for judgment of the scientific quality of the work at the Center. If research is to be a function of the Center, research personnel must be committed to the complete process and must be supported in that commitment.

There was little communication with other groups either within NMFS or in other institutions in the United States. Communication was directed to ICNAF. This might be helped by greater attendance at national meetings and by working visits to other laboratories.

Perhaps in common with many other NOAA laboratories, there did not seem to be enough technical support for the professional people. This was noticeable particularly with electronics, programming, coding,

and computer operating technicians. We found many examples of professional-level people performing jobs that could have been handled by technical people at a lower grade. Although at first glance this seems to be a cost-saving situation, in actual fact it must, in the long run, increase the costs of the research program or decrease output or both.

The review team found numerous examples of investigators who were not so familiar as they should have been with the work of their colleagues. To improve this and, in addition, to improve intellectual exchange at the Center, it is recommended that attempts be made to set up a regular scientific seminar series.

Strengths

1. The Center has a prominent international reputation in fishery science.
2. The Laboratory had a strong stock assessment program.
3. Competent work was under way on life history studies.
4. Good experimental studies were under way on ichthyoplankton.

Weaknesses

1. Although there was some good work on ecosystems analysis, this program was generally weak and had a poor publication record.
2. The work of the Center was dominated by the preparation of U.S. inputs to the International Council of North Atlantic Fisheries. Thus much of the work of the Center was "published" in ICNAF reports and proceedings. This may account for the poor record of publication by the senior staff in refereed scientific journals.
3. The Center computer facilities were not adequate.
4. The senior staff of the Center includes a rather large number of disgruntled middle-level, long-time employees.

Recommendations

1. Develop a better balance between ICNAF-type research and other Center responsibilities.
2. The Center Director should delegate more authority so that fewer people report directly to him.
3. Greater emphasis on publication in refereed journals is needed.
4. Improve interaction with the U.S. scientific community.
5. Accelerate the analysis of data outside of the stock assessment program.
6. Provide a program leader for the ecosystems analysis programs, and consider a shift from the reductionist to the holistic approach in ecosystem analysis.

7. Re-examine the priorities for continuing the fishery engineering program.

8. Improve technical support facilities.

15. Middle Atlantic Coastal Fisheries Center (MACFC)*
NOAA National Marine Fisheries Service
Sandy Hook, New Jersey; Oxford, Maryland; and Milford, Connecticut

Site visit: July 13-16, 1975

Review team members: M. Grant Gross (leader), W. Mason Lawrence, R. Winston Menzel, J. L. McHugh, Richard C. Vetter, and Ferris Webster

Center director: Carl I. Sinderman

1975 Budget: $3,534,000

NOAA-defined function: *Conducts an integrated, multidisciplinary research program on the biology and ecology of the living marine organisms of the North Atlantic Ocean, especially in the zoogeographic area known as the Middle Atlantic Bight, in cooperation with other interested agencies and institutions. Ultimate objectives are (1) the effective conservation and allocation of fishery resources of interest to the United States and (2) assurance that adequate consideration and protection are given to living marine resources requirements in proposed environmental alterations.*

SUMMARY

The Middle Atlantic Coastal Fisheries Center carried on research in four major program areas at three laboratories. These programs were on ecosystems, resource assessment, experimental biology, and pathobiology. The Scientific Staff was judged to be adequate for the research programs as they were presented. Scientific programs generally had a strong emphasis on routine surveys and sampling operations. Because collecting operations were dominant, many temporary help were engaged in sorting and identifying specimens collected during survey operations.

The MACFC staff was relatively young, enthusiastic, and aggressive and were heavily engaged in sampling and in surveys of the mid-Atlantic Bight. Most individuals seemed to take pride in their work and expressed general agreement with the overall objectives of MACFC programs and the leadership of their specific investigations.

Some frustration was expressed by staff members that MACFC had not been able to recruit scientists as easily as other NMFS laboratories. They perceived this as caused by the relative isolation of the laboratory locations, relatively low GS ratings for positions, and the greater prestige of the four offshore fisheries centers. The Center Administration recognized past staff morale problems but felt that staff support had increased greatly and was not now a problem.

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*Now laboratories of the Northeast Fisheries Center.

A program of educational leaves for MACFC to upgrade their capabilities is highly recommended. This is needed to improve skills of middle- and upper-level staff members and to complete the education of younger staff members.

FACILITIES

Several scientists indicated that their work was handicapped by insufficient technical support. Among the specific items mentioned were:

Lack of electronic technician
No machine shop
Inadequate automatic data-processing facilities and too few computer programmers
Lack of central graphic arts staff
Insufficient typists for manuscripts

Ship support was judged to be generally adequate, although some investigators indicated that their programs could use more ship time for sampling. Examples were cited of ship diversion that interrupted scheduled survey operations and piggybacking of operations that caused problems for some surveys.

PUBLICATIONS

The emphasis in the Center on publication of results in the open scientific literature is commendable. But lack of support for manuscript typing, graphic arts, and slow data processing may have inhibited publication. Delays of four months in getting approval for page charges were mentioned, as well as six-month delays in manuscript typing. According to the Center Directorate, the situation had improved in the first half of 1975.

We were told of data collected by MACFC staff that was published by individuals or groups outside NOAA. This may have been caused, in part, by slowness in publication by center scientists. Regardless of the cause, it had a damaging effect on staff morale. The Directorate indicated that a Data Report Series had been instituted to alleviate the problem by providing early dissemination of data and preliminary findings.

COMMUNICATIONS

Communication among the four major investigations and the individual scientists involved in them appeared to be deficient in some areas. While we were unable to determine what effect the communication problems might have on program results, several individuals indicated that closer coordination among investigations might avoid overlap and facilitate more timely response to the many demands on the Center from NOAA and

other agencies, federal and state. Others were frustrated by their lack of involvement in project planning, involvement that might have avoided subsequent problems in data interpretation or questions of sample contamination.

There was no evidence of significant contact with other Coastal Fisheries Centers. The Center Administration indicated that they had tried to initiate contact but had found little programmatic similarity with activities at the Beaufort or Galveston centers. Close ties to the Atlantic Oceanographic and Meteorological Laboratories in Miami were apparent in the program structure and activities.

Contact with local universities and colleges was mentioned by several staff members. In large measure, these contacts seemed to involve students working on Sandy Hook projects or staff members teaching courses at the various schools. We found no evidence of university scientists coming to the Sandy Hook Laboratory to use its collections, data, or facilities.

Several junior scientists indicated that they were frustrated and that their work suffered because they were unable to attend major meetings in their specialties and to communicate their findings. Such support is particularly critical for the continued professional growth of the relatively young MACFC professional staff. Problems of limited travel funds may well involve the distribution of funds. Some individuals, especially Investigation Chiefs and some highly active staff members, seemed to have adequate travel funds; others felt that they had too few travel opportunities.

Criteria for soliciting, accepting, and integrating reimbursable research into the MACFC were not well understood by the professional staff at Sandy Hook. Several staff members indicated they thought that reimbursable research diverts support from NMFS-funded research programs. Several scientists indicated that they do not have enough input into program formulation and priorities. This raises the question of establishing priorities for MACFC programs.

The Directorate felt such criticisms were unfounded and claimed that projects, including reimbursable work, generally originated with the investigators involved.

The apparent problems, while difficult to resolve during a short visit, seemed to indicate lack of communications between the research staff and the senior Center Directorate regarding:

- NMFS and Center plans and policy regarding long-range Center development;
- Relationship between Center activities and those in other parts of NOAA, such as Sea Grant.

The Center should establish scientific seminars to promote communication among the staff, including scientists working in investigations located at the Milford and Oxford laboratories.

On the programmatic level, there was an expressed need for improved scientific communications. Long-range program development plans were not familiar to most staff members. For example, planning for investigations of possible impacts of extended fisheries jurisdiction on the

MACFC programs was not obvious. Furthermore, most staff members seemed to have little appreciation for the magnitude (or difficulty) of the long-range aspects of the problems they were working on. When asked about the length of time required to get satisfactory answers, the most common answer was five years. However, many staff members indicated some frustration in that they were not "left alone" for five years to solve their assigned problems.

OXFORD LABORATORY

The staff had a high level of morale and seemed to be well motivated. Good rapport and strong loyalties to the laboratory and the studies under way were apparent. Laboratory equipment and the library seemed well suited for the work. The group had strong ties to local universities and research groups but relatively little contact with other NOAA activities aside from some local Sea Grant programs.

Some project parsonnel indicated that their support budgets were too small to achieve their objectives. For example, one scientist indicated that continued work on an assigned project was possible only by using up supplies from previous projects, borrowing from other groups, and seeking outside support (such as reimbursable contracts). Increasing support to a mutually agreeable level, redefining the task, or phasing out the activity would seem to be called for. Continuation of the situation could result in lowered morale.

NOAA and NMFS objectives and program limitations seemed to be poorly understood. Several individuals expressed a concern that they were somewhat less effective than they might be because they were unaware of the total picture.

On a scientific level, communication among investigations seemed deficient. Results of the work of other groups in MACFC should be presented, perhaps in an expanded seminar series. Some of the survey work under way at Sandy Hook might have implications for the work of the Oxford group, and the work of both groups could be facilitated by improved communication.

MILFORD LABORATORY

The quality of the research was judged to be generally good and the leadership competent. Staff morale seemed generally good. Committee members were particularly impressed with the papers of fundamental significance that have come out of the laboratory.

The staff expressed uneasiness and frustration at the continual need to define and justify programs. In short, several individuals felt strongly that the very existence of the Milford Laboratory was continually questioned by NMFS headquarters. This, in turn, caused substantial morale problems.

Better definition of the laboratory mission and a better balance in setting priorities and allocating resources among the various programs might alleviate some of the problems. For example, some staff members

felt that their programs were too small and had too little support to permit them to do even a small amount of research on questions of fundamental importance. The long lead time in preparing program documents was felt to reduce program flexibility.

Support for individual research programs was considered generally inadequate. Two examples were cited. In one case, professionals had to clean and wash glassware because of a lack of technicians. In another case, a heavy dependence on Work Study aides was found to hamper the program. Too much time was spent locating and training students, who then worked only for brief periods before being replaced (unlike the Sandy Hook Programs, where the aides seemed to work well).

The distance between the Milford and Sandy Hook laboratories seemed to cause some communication problems. It was expressed that scientific direction from Sandy Hook was ineffectual, detracting from the quality of the research carried out at Milford. Communications between laboratory staff, NMFS Headquarters, and other components of NOAA were considered inadequate; poor communications with NMFS and the Sea Grant Program were cited as examples. In the case of the Sea Grant Program, the Milford staff felt that communications were only one way.

Finally, the feeling was again strongly expressed that MACFC received less support from NMFS than did the four larger offshore Centers.

Strengths

1. The Center had a strong program of shellfish research.
2. Some excellent fundamental studies were under way.
3. The Center had been a leader in developing shellfish aquacultural techniques.
4. For the most part, staff morale was reasonably good.
5. There was a commendable emphasis on publication in peer-reviewed journals.

Weaknesses

1. The Center had a relatively small number of top-level scientific staff.
2. There was lack of adequate technical support in the field of electronics, no machine shop, no data-processing equipment, inadequate graphic arts support, and insufficient stenographic help.
3. There was poor communication between the three laboratories of the Center.
4. Many of the younger scientific staff were frustrated by a lack of opportunity to attend scientific meetings.

Recommendations

1. Provide educational leaves for scientific staff.
2. Improve communications among the four major investigations.

3. Consider bringing university scientists to work at the laboratory on a temporary basis.

4. Provide more opportunities for junior scientific staff to attend scientific meetings.

5. Improve the knowledge of the scientific staff of broad advances in the sciences by seminars and other means.

16. Atlantic Estuarine Fisheries Center (AEFC)*
NOAA National Marine Fisheries Service
Beaufort, North Carolina

Site visit: November 17-19, 1975

Review team members: M. Grant Gross (leader), John J. Magnuson, Richard C. Vetter, Ferris Webster, Herbert L. Windom, and William D. Youngs

Center director: Theodore R. Rice

1975 Budget: $1,167,000

NOAA-defined function: *Conducts research and assessment on the fisheries productivity and ecology of estuaries and the coastal zone. Includes structure and function of ecosystems, cycling and distribution of trace metals and radionuclides, and the biological effects of contaminants. Research on the status of Atlantic and Gulf menhaden resources, including monitoring the purseseine fishery, predicting future abundance, and describing the role of menhaden in the coastal environment. Other research includes designing, constructing, and evaluating artificial reefs for the improvement and management of marine recreational fisheries and an investigation of fisheries on subtropical stocks of groupers, snappers, and porgies along the Continental Shelf of the Carolinas.*

SUMMARY

The Atlantic Estuarine Fisheries Center was a small, highly integrated, relatively sophisticated research group. The Center's research and development programs were oriented toward local and regional fisheries problems and estuarine ecological problems. The Atlantic and Gulf Coast menhaden fishery was a prime focus for much of the work. The R&D programs were in the forefront of their fields, with notable successes in predictive models for menhaden catches.

The oceanic R&D programs were carried out by well-trained and generally well-informed scientists who had a high level of university interaction. Some research programs were in a state of transition, because of losses of senior personnel.

Staff morale was high, and facilities seemed generally adequate. Analytical facilities may need upgrading to support continued program development.

*Now a laboratory of the Southeast Fisheries Center.

RESEARCH AND DEVELOPMENT PROGRAMS

The Center had an intensive research and development program dealing with estuarine systems and fisheries. The research programs seemed well formulated on a scientific basis and appropriate to the results expected from them. The Ecology and Fisheries Divisions had achieved a remarkably high level of programmatic and staff interactions, thereby strengthening both. The small size of the staff, the long period of service for most staff members (10-15 years), and its historical focus on estuaries and estuarine processes had doubtlessly facilitated these interactions.

Many staff members and several of the programs had had extensive interaction with university faculty members and their students, primarily from the North Carolina region. The results of these interactions were clearly evident in the generally high scientific level of the programs involved and the enthusiasm of the staff working on them. Such interactions should be continued, and the relationships with other universities might well be broadened to include campuses not presently involved with AEFC. The few programs lacking such faculty-student involvement might well be strengthened scientifically by developing such interchanges. Strengthened ties with the staff and students of the Duke University Marine Laboratory on Rivers Island would also strengthen some programs.

The success of the Center staff in developing a predictive model for Atlantic and Gulf Coast menhaden fisheries was commendable. Other parts of the fisheries programs at the Center, such as the Pelagic Gamefish Program, were far from achieving their stated goals. It was clear to the review team that the present resources are adequate for the job at hand.

Some programs, such as Cycling of Contaminants, were clearly in a state of transition because of the recent loss of key senior personnel. Prompt filling of these positions with qualified personnel and support for the new staff members is essential to prevent the programs from drifting because of a lack of support.

SCIENTIFIC STAFF

The staff was highly trained and relatively scientifically sophisticated with a strong professional pride in the Center. Most staff members felt that they were able to develop research plans in a logical and reasonably free way and to receive support for well-formulated programs.

Professional advancement was enhanced by the Center administration's interest in their professional development through support for academic training and encouragement of their participation in academic programs of universities in the region. The staff was stimulated through attendance at scientific meetings and through publication of results in regionally oriented peer-reviewed journals. They were reasonably aware of the progress of their scientific specialty through scientific literature.

It was our impression that the results of the Center's research were more generally applicable and of wider scientific interest than was reflected in the rather local or highly specialized journals in which the results were published. We suggest that staff members be encouraged to publish in a greater variety of journals in order to reach a wider audience.

While the Center Directorate had encouraged and actively promoted professional leaves for the staff, the program was limited by the lack of support from NMFS. Beneficial results of such leaves to the staff are sufficient to warrant serious consideration by other centers and to encourage NMFS to establish a general program to lessen the programmatic burden on the individual center when key personnel take such leaves.

Career development programs for NMFS scientists were suggested by some staff members as a desirable personnel benefit that would assist scientists in making appropriate midcareer choices such as continuing in science or gradually moving into administrative roles. Staff members generally felt that they could move up only into administrative roles and that senior scientific positions were generally unavailable.

FACILITIES

Facilities available to support the AEFC's oceanic R&D programs were generally adequate. Although there were some areas where improvement might be made, no serious problems were identified.

The laboratory had been nearly level funded for several years. This was evident in the laboratory equipment, which was somewhat outdated, and in technical support, which was judged to be skimpy in some areas. Increased support for new equipment will be needed in the near future if AEFC is to avoid a serious slippage in its analytical capabilities.

The computer capability and usage seemed above average in comparison with other fisheries centers of comparable size. Several scientists expressed appreciation for staff support in biometrics and programming.

The library, too, seemed remarkably good for a center of this size, and the librarian recieved high marks from staff members. A serious space problem for the library was clearly evident; additional space is required so that library collections can be properly housed and protected.

There was no direct ship access at AEFC for deep-sea work or for extended work on the continental shelf. The estimated need for about 20 to 30 days per year makes an assigned ship unwarranted.

Strengths

1. Research under way at the Center was highly integrated and relatively sophisticated.
2. The menhaden R&D programs were in the forefront of their fields, and the Center had developed sophisticated models for predicting menhaden catches.

3. Oceanic R&D scientists at the Center were well trained, generally well informed, and interacting well with scientists at universities.
4. There was strong professional pride at the Center, high staff morale, and excellent leadership.
5. Attendance at scientific meetings was good, and professional leaves were encouraged.
6. The Center had an excellent library.
7. The capabilities of the Center computer and its usage were above average.

Weaknesses

1. Analytical facilities may need upgrading to support continued program development.
2. Some programs might be strengthened by closer ties with the adjacent Duke University Laboratory.
3. Resources of manpower and facilities may have been inadequate to reach goals.

Recommendations

1. Continue the present policies that have led to the strengths identified above.
2. Replace positions vacated among the senior personnel as soon as possible.
3. Publish more widely in a variety of scientific journals.
4. Modernize laboratory equipment and increase technical support of scientific staff.

17. Southeast Fisheries Center (SEFC)
NOAA National Marine Fisheries Service
Miami, Florida, and Bay St. Louis and Pascagoula, Mississippi

Site visits: January 8, 9, and 28-30, and March 3, 1976

Review team members: John J. Magnuson (leader), Henri Berteaux, Gordon Broadhead, Peter J. Colby, J. L. McHugh, Foster H. Middleton, Jerome H. Milgram, Henry A. Regier, Claes H. Rooth, Richard C. Vetter, and Ferris Webster

Center director: Harvey R. Bullis, Jr.

1975 Budget: $2,119,000

NOAA-defined function: *Conducts studies in the fields of fishery biology, chemistry, physical science, oceanography, engineering, gear technology, and remote-sensing technology in the Atlantic Ocean (south of Cape Hatteras), through the Gulf of Mexico and the Caribbean. Research programs, national and international in scope and impact, are designed to provide information on which to base national policies regarding (1) conservation of the oceans' living resources inhabiting waters adjacent to the United States; (2) allocation between international users of such resources; (3) multiple-use conflicts of estuary and oceanic areas; (4) protection of resources from environmental degradation; and (5) development of harvesting systems compatible with conservation goals of managing living resources.*

The Southeast Fisheries Center is the major vehicle for fishery research in the Caribbean. It is responsible for fishery research in the oceanic area from Cape Hatteras through the Gulf of Mexico to South America. Numerous fishery resources have been explored and developed in the region, and the value of the fisheries is high.

Major program areas were fishery engineering (25 percent of budget) located at Bay St. Louis; resource assessment surveys (35 percent of budget) on the continental shelf and slope in West Central Atlantic located at Miami and Pascagoula; fisheries investigations (35 percent of budget) of populations in response to fishing pressure; and environmental investigations (5 percent of budget), concerned with the effects of man-induced environmental changes on living marine resources.

In the rapidly changing pattern of fishery resource use, fishing pressure may cause serious overexploitation problems in this region where work to date has been concerned primarily with fishery development. International exploitation will become an increasingly important aspect, and the need to consider whole systems of interacting resource populations is now critically important.

These pressures and changes may require rapid and major reorientation of SEFC research programs.

PROGRAM PLANNING AND MANAGEMENT

The Center Director was limited in his flexibility with respect to movement of people and funds within his organization. He had administrative authority to stop programs but apparently not to build programs. NMFS headquarters seemed to exert heavy control over the Center. Time and funds seemed wasted on formal paperwork, and insufficient time and effort was devoted to actual work toward goals.

The Center director had authority over all local activities and ran the Center and facilities with a strong hand. Personalities seemed to play an important role in planning and decision making. Many senior staff related well to the director and seemed to share his views. Communication (up, down, and laterally) in the organization was spotty. We found conflicting points of view on the program as a whole, the ways in which decisions are made, and how things get done. Meetings among the staff were called "as needed" and seemed too infrequent. Some planning occurred from the bottom, but it did not seem to be led and developed constructively. The research program of the Center and even individual units of it were uncoordinated and thus did not make optimum use of talents in the Center.

Interaction and feedback from commercial and sport fishermen seemed high, and their needs were extensively incorporated into research planning.

PROFESSIONALISM

Staff professionalism at the Center was not high. Few Center personnel believed they were scientists or associated with the wider scientific community as their peer group. Promotion and research support were not well associated with research productivity. Few activities or programs seemed aimed at increasing the scientific capabilities or credibility of the staff. Some researchers placed no priority on publishing in peer-reviewed journals. Recruitment of staff was aimed primarily at the technician level, and people worked their way up. On-the-job training in methods and techniques and in broadening scientific scope was not available from senior staff. Highly trained fishery scientists qualified to lead and conduct science on resource and ecosystem management were apparently not being attracted to the laboratory. The proportion of the Ph.D.-level staff in the Center was low, as was the publication activity. Professional staff were not encouraged to participate in the broad planning of the Center's Programs, except piece by piece. Seminars and scientific meetings were given little emphasis, and their lack contributed to isolation of researchers from each other, adjacent laboratories, and science as a whole.

FACILITIES

The Center is housed in a well-equipped building across the street from the University of Miami's Rosenstiel School of Marine and Atmospheric Science and adjacent to NOAA's AOML. They form a useful research cluster. The laboratory contains a fine research library, and an excellent marine research library is available across the street. An aquarium facility is available in the laboratory but not kept too well or used extensively. No computer facilities are located at the Miami laboratory, but a UNIVAC 9200 digital computer is located at Pascagoula, and contractual services can be obtained in Miami through AOML. Data management, computer programming, and computer access are inefficient.

The Center had available and used a great deal of ship time--time needed to carry out its objectives. However, vessel operation appeared to be rigid from the point of view of research work. Investigators may need more flexibility during the latter phases of planning and during a cruise to make best use of the vessels.

DETAILED REVIEW OF SEFC PROGRAMS

A. Fisheries Engineering Laboratory (FEL), Bay St. Louis, Mississippi

NOAA-defined function: *Provides Center with long- and short-range technical capability by advancing the state of the art of living marine resources technology through development of data-acquisition systems (remote sensing, hydroacoustics, etc.) and data-management systems.*

1. General Comments

This group possessed a capability for the application of advanced engineering technology to NMFS problems that may be unique. The group was dominated professionally by people with an engineering background; only the director was a professionally trained biologist. The mission of the Technology Division was to develop the prerequisite technology for achieving goals of the Southeast Fisheries Center.

The technical ability of the Laboratory was high by NMFS standards, although perhaps less so by the standards of many other federal and academic engineering groups. The engineering ability may have been adequate for most tasks identified by the NMFS. However, there was the danger of attempting to carry out advanced research without adequate in-house competence. This may have occurred in some of the satellite and remote-sensing applications. There was little engineering competence elsewhere within the NMFS to apply critical judgments on the quality and direction of the work at the FEL.

Fisheries engineering in general within the NMFS has not been well defined. The need for fisheries engineering and the existing means for achieving it did not seem to be well appreciated by the NMFS

leadership. A primary justification for the physical location of the FEL at Bay St. Louis was its access to expertise and facilities that are *national* in scope. In view of its special abilities, it was our opinion that the talents of the FEL should be turned to serve a more broadly based national need for fisheries engineering rather than simply those of the Southeast Fisheries Center. The apparent duplication in some engineering programs within NMFS (e.g., hydroacoustics) seemed inefficient. Perhaps some way should be developed that would encourage wider use of FEL engineers and their results throughout the NMFS. The rivalries between regional centers should not be such that the NMFS loses the ability to take full advantage of existing talent.

The morale of the FEL seemed high. This may be attributed to a general feeling of having a well-defined mission and to the management style of the director. He "gives you a job and then lets you get on with it" according to one of the engineers.

On the negative side, the interaction that took place between engineers and biologists may not always have been sufficient. Several individuals noted that there was a gap between the disciplines that needs to be bridged. The biologists at Pascagoula played an important role in helping to create that bridge. However, on a wider scale, there seemed to be insufficient contacts between the two groups. This works both ways: if fisheries biologists further afield were more aware of the potential of engineering to aid them in their tasks, it is likely again that more effective and demanding use could be made of the FEL.

2. Remote Sensing from Aircraft and Satellites

The applications of remote sensing to fisheries problems ranged from immediate guidance of fishing activities to resource assessment and predication of resource development. The Fisheries Engineering Laboratory was engaged in several projects pertaining to both satellite and aircraft-based approaches.

The availability of National Aeronautics and Space Administration and contractor expertise allowed the laboratory to undertake technically ambitious projects with limited in-house personnel. There was, however, some serious question of whether the breadth of competence available in this laboratory was adequate to develop appropriate contractual arrangements and to monitor contractor performance. From a broader perspective, we would like to see somewhere within the NMFS an effort to provide the behavioral or ecological links between physical observables and the assessed abundance or distribution variations. This is of particular concern in the area of satellite applications to resource assessment as well as for tactical fishing fleet guidance in pelagic fisheries. Aircraft applications to local (coastal) fish detection represent successful technique developments. There is, on the other hand, a definite problem in technology transfer as well as in effective cooperation between the different Centers.

3. Hydroacoustics Developments

Although hydroacoustics efforts in the NMFS did not seem to be centered in the FEL, more academically trained engineers were involved at FEL than at other centers. Some of the hydroacoustics work, such as in fish target strength, was not well coordinated between the various NMFS Centers. For example, some acoustic studies at FEL were well coordinated with the NWFS but not with the NEFC. The individual projects seemed to stop and go, and in some ways the separate centers only communicated via the newsletters that are broadly circulated.

4. Conservation Engineering

The review team was impressed by the beneficial aspects of conservation engineering for preventing the possible decimation of certain species, for increasing the efficiency of existing fishing techniques, and in reducing the percentage of nontarget fishes taken. The value of this work should be emphasized, and resources should be alloted for its continued support.

5. Harvesting Technology Group

As a small, detached, element of the Technology Division, this group appeared well adjusted to its task. It communicated directly with resource assessment-oriented activities at Pascagoula, while at the same time receiving technical support from the FEL at Bay St. Louis. While its limited size did not allow a parallel pursuit of several significant projects, the group seemed to be broad enough in its interests to respond sequentially to new requirements.

We noted with special interest that development of gear with minimal impact on nontarget species was a central goal for this group.

The group appeared to receive adequate support from Bay St. Louis in most of its technical needs, but some problems in the area of heavy-equipment engineering seemed to exist in the electrical gear development effort.

B. Resource Investigations

1. Phyllosome and tuna recruitment

This activity involved two investigators working with limited support. Even so, progress was good in identifying larval fish, and their findings were published at a high rate in peer-reviewed journals. Major accomplishments have been the identification of 300-400 larval fish species including the blackfin tuna and location of nursery areas. Although fundamental, the program is necessary to relate larval abundance and recruitment to environmental conditions and to

identify spawning and nursery grounds for future assessment of the impact from man-induced perturbations. This project could use more support to increase its efficiency. There is a need to identify the various life stages and to understand the life history and factors affecting abundance and distribution. They seemed to have a good working relationship with the University of Miami.

2. Multispecies and shellfisheries

This activity involved locating fishery resources for the U.S. fishing industry (commercial and recreational) and estimating size of standing stocks for the more important species. Survey results were radioed to shore twice daily. This information appeared to have had more real-time value several years earlier than at the time of the review. The data were archived for possible future synthesis. Little data analysis was being published in peer-reviewed journals.

The activity at Miami was oriented toward monitoring scallops. Yields were spotty, and little attempt was being given to identifying relationships between distribution and abundance and environmental conditions for predictive purposes. No new stocks had been identified recently. There was some concern outside the program that the scallop industry was not large enough to justify the service provided by NMFS. The service may not have been of much value in reducing search time by the fleet. Surveys could be more scientifically meaningful if additional information were collected simultaneously (e.g., fecundity, temperature, salinity, and bottom type). The value of the stocks may have been overemphasized, and biological, economic, and social implications were not being considered.

C. Fishery Investigations

1. Miami Laboratory

Fishery investigations had the responsibility of population dynamics and yield studies on fish and shellfish in the Gulf and Caribbean, with special emphasis on billfish and Atlantic bluefin tuna. Our evaluation of these programs was hampered by the absence of several key personnel.

Most studies concentrated on the short term and were focused on service to industry, to the extent that research on the effects of environment on fish stocks was absent. In some programs, e.g., shrimp fishery investigations, biological research was limited or apparently lacking. There appeared to be a large recreational shrimp fishery, but no research was being done on it. Some staff members who were less mission oriented were not happy with the general direction of the laboratory and their role.

Money, people, and resources were inadequate to meet the task objectives. To achieve a major improvement, an injection of new senior staff was needed. Several senior additions brought in from

outside could broaden the technical scope, strengthen technical planning, encourage the efforts of individual scientists, increase productivity, and increase scientific discussion of the programs.

2. Pascagoula Laboratory

NOAA-defined function: *(same as for SWFC, Miami)*

The staff emphasized the descriptive approach to its tasks; they seemed well equipped in background and skills for this. However, the review team was uncertain that the staff were equipped or even aware of the quantitative research that is needed for future resource management.

Strengths of the laboratory were its awareness of the resources and opportunities in the Gulf of Mexico, the apparent excellent relations with the Gulf commercial fishing industry, and the generally high morale of its research people.

The principal weakness was a lack of professionalism in the staff, in background and in outlook. We noted that no employee of this laboratory has a Ph.D. degree. While we do not hold this advanced degree to be essential for good research, nevertheless, the total absence of people with this level of higher education reflects an imbalance in staffing. We noted with approval the staff members with extensive practical fisheries knowledge, but they should have been complemented with others having professional academic training.

Other examples of lack of professionalism were low scientific productivity in general, no seminar series (or even a room in which to hold seminars!), weak ties with neighboring laboratories and universities, and what, it was our impression, was inadequate encouragement by Center management to rectify these shortcomings.

The laboratory was one of the most crowded in NMFS, and additional space was needed for the existing personnel if they were to work well creatively. This laboratory had poor library facilities and holdings. This is especially a problem at a location remote from adequate libraries. Another complaint heard here was shortage of technical and secretarial help.

D. Environmental Investigations

The broad objectives were to (1) develop a systems description of a tropical marine ecosystem interactive with man, (2) evaluate environmental effects on ecological balance, and (3) develop environmental impact statements.

The group was best trained to evaluate environmental effects of particular pollutants and was not sufficiently funded, staffed, nor trained to develop systems descriptions of tropical marine ecosystems. They received few if any requests to develop or comment on environmental impact statements. The commitment of NOAA to these studies seemed low.

The review team noted that the objectives of the environmental investigators were not clearly defined. There seemed to be hesitancy to get fully involved in new programs to study environmental alteration effects. The group was thus not making full use of its potentialities in this field or being stimulated to develop new capabilities and recruit new talent to make significant progress on these problems.

The group was not productive, judged by publications; there was little substance to show for recent work. This investigation would have benefited from a clearer statement of SEFC objectives in this field, from the designation of a leader who could create a single cooperative team, and from a management declaration that productivity must be demonstrated if support is to be continued for the work.

Strengths

1. The Center maintains close liaison with industry.
2. The Center has seagoing facilities.
3. Fishery engineering and gear development under way at the Center were unique and good.
4. There were a large number of young and able technicians.
5. The Center is at a favorable location for work in the tropical Atlantic and Caribbean.
6. The Center has an opportunity to develop remote-sensing techniques with aircraft and satellites.
7. The work under way on conservation engineering was impressive and relevant.

Weaknesses

1. In general, the program of the Center was not heavily research-oriented, and the planning and professional atmosphere required for creative fishery science was weak.
2. Much of the work of the Center was not current in terms of modern fishery science or responsive to the needs of the geographical area being studied by the laboratory.
3. Internal and external communications seemed poor.
4. With some individual exceptions, productivity, as measured by publication in refereed journals, was generally low.
5. Computer facilities were inadequate.
6. The hydroacoustics development research was not well coordinated with similar projects elsewhere in NMFS.

Recommendations

1. Improve staff qualifications by
   (a) Recruiting additional Ph.D.-level fishery scientists,
   (b) Promoting qualified technical people to higher scientific grades.

2. Improve communications and interactive planning in the Center.
3. Encourage increased scientific productivity.
4. Delegate more authority to research teams.
5. Broaden the Center's approach to respond to a wider community of interests and needs in addition to the fishing industry.

18. Gulf Coastal Fisheries Center (GCFC)*
NOAA National Marine Fisheries Service
Galveston and Port Aransas, Texas, and Panama City, Florida

Site visits: January 23, March 2-5, 1976

Review team members: J. L. McHugh (leader), Lloyd M. Dickie, Richard C. Dugdale, M. Grant Gross, John Ryther, Richard C. Vetter, and Ferris Webster

Center director: Joseph W. Angelovic

1975 Budget: $1,345,000

NOAA-defined function: *Develops, implements, and administers a sound research program on the environment and selected commercial and recreational marine species of the Gulf of Mexico. Long-range national goals will serve as guidelines. Coordinates research activities with similar efforts carried out by other federal agencies, states, and universities. Constituencies are kept informed of all activities and called upon to take an active role in research evaluation and long-range planning.*

GENERAL COMMENTS

The Gulf Coastal Fisheries Center included three laboratories. The research program at Galveston was the largest of the three, and it was concerned with commercial fishery problems. The other two were primarily sport fishery laboratories, except that members of the Division of Environmental Research, with headquarters at Galveston, are located at all three facilities.

The review team noted that at this Center, as at all centers that include research on both recreational and commercial fisheries, there were separate programs on the two types of fisheries. The rationale for this separation was historical and political rather than scientific. Because most recreational fishery resources are also harvested by commercial fishermen, research should be determined by the living resources and their environments. Continued segregation of the sport and commercial fisheries research will be a scientific handicap to both.

We noted that there was fundamental research under way in the Galveston Center, some of it of good quality. In some divisions, individual scientists were free to choose their own research projects and priorities. This is healthy up to a point, but complete freedom in research direction may be a luxury that NMFS cannot afford in view of the practical responsibilities of NMFS mission, which are becoming even more urgent with extended jurisdiction.

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*Now laboratories of the Southeast Fisheries Center.

In some programs, the team found that scientific productivity was low, as was the educational level of many members of the scientific staff. The objectives of some programs were not clear, and this affected the quality and productivity of research. Some scientists appeared to have given up and had not published for several years. Geographic isolation caused problems for some laboratories. Division chiefs generally were bogged down with administrative tasks and were not doing research or publishing. A search for ways of correcting this situation should have high priority.

There was an urgent need for adequate computer facilities, including basic equipment at the laboratories and access to a sophisticated computer center.

The title "Gulf Coastal Fisheries Center" did not encompass the work of the center. The Center also had research responsibilities for high-seas fisheries and was doing research in relatively distant waters.

The directorate of the Galveston Center was energetic, dedicated, and aware of its problems. The Center was hampered, as are all NMFS centers more or less, by past events--administrative changes, what appear to have been frivolous and abrupt changes in policy and funding, undue pressure from constituencies, too much bureaucracy, and less opportunity than most centers to develop strong associations with other segments of the scientific community. The Center had fewer personnel than formerly, yet appeared to have more responsibilities. It was developing closer relationships with universities and other scientific institutions in the general area with the object of creating a strong and diversified oceanographic program for the Gulf of Mexico. This objective should be supported.

DIVISION OF SHRIMP AQUACULTURE

The work on penaeid shrimp culture was of generally high quality. Approaches to problems of reproduction, nutrition, pathology, and systems engineering showed considerable originality and creativity. Most of the research was fundamental, justified by the fact that much was unknown about the basic biology of the organisms. The outstanding example of this was the fact that penaeid shrimp could not be brought to sexual maturity and mated in captivity, making the supply of juvenile animals for culture dependent on capturing gravid, fertilized females from the wild. The approach to the solution of this chronic problem in shrimp culture had been an intensive study of the reproductive biology of the animals. This high-quality work was not being duplicated elsewhere in the United States as far as we were aware.

The general approach taken by the aquaculture group was focused on the ultimate development of an intensive aquaculture process involving a closed, recycled water system; close control over the physical, chemical, and biological environment including disease prevention; and heavy feeding of a high-quality artificial diet. Since many large-scale commercial attempts had been made to culture shrimp, using much simpler and less costly methods that had failed largely for economic

reasons, it would seem prudent to subject the entire concept of shrimp culture being developed at this laboratory to a thorough economic evaluation, even though such a projection must be based on a number of assumptions and approximations.

While the quality of the research in aquaculture was generally high, there appeared to be a lack of overall direction of the program. As a result, this research had tended to become broad and diffuse, in some cases deviating from what might be considered the primary mission and objective of the laboratory.

DIVISION OF FISHERIES RESOURCE ASSESSMENT

Our main impressions were that there was competence, mutual respect, a sense of direction, and an underlying optimism about the immediate opportunity for interesting and relevant work. This was largely because of the availability of a relatively untouched 15-year series of detailed shrimp fishery and environmental data and the decision to give its analysis overriding priority as a division activity. To this end, the last two years had been devoted, apparently productively, to reforming the group, locating and editing data series, and establishing contacts and credentials with cooperative agencies (state and federal) and the Gulf States Marine Fisheries Commission.

The scientific approach to the work seemed to be objective, careful, and well planned. There was clearly a talent and propensity for successive hypothesis testing in conjunction with data compilation and generalization. However, the program was almost totally inhibited by the absence of computer facilities. Such facilities were required on an almost emergency basis.

The group appeared potentially strong, capable of good scientific planning, technically competent, and well oriented with a sense of direction. It seemed an effective base for further expansion and should be strongly supported over a trial period of at least two years. An attitude of first loyalty to management concerns appears healthy at present but could inhibit objective analysis and publication record if too long or emphatically sustained.

DIVISION OF RECREATIONAL FISHERIES

Panama City Laboratory

The laboratory was carrying out work in the Recreational Fisheries and Environmental Research Divisions of the Gulf Coastal Fisheries Center. The facility was new and sparkling, and there seemed to be adequate space for the programs under way and perhaps room for some future growth.

Morale was high in the laboratory. Their mission in recreational fisheries was clearly perceived, and there was enthusiasm for the work. The location at St. Andrew Bay was well suited for many of their environmental studies.

Productivity was generally low (with some exceptions), particularly considering that the isolation of the laboratory from many of the administrative interruptions and diversions should allow the scientists to devote more time to scientific output.

There were indications of isolation from other colleagues. Some individuals had developed ties with the nearby Naval Coastal Systems Laboratory, although university ties were few. There needs to be an awareness of the special problem of fostering communication with other scientific groups. The review team was concerned with the apparent insufficiency of travel funds for this purpose.

The educational level of the staff was low in comparison with outside groups doing research in the same field.

Port Aransas Laboratory

The Facility was housed in a small, relatively new building (completed in 1973) on the Corpus Christi ship channel near the University of Texas Marine Sciences Institute. The staff were concerned with problems of importance to the western Gulf of Mexico.

The Facility staff was small (3 scientists, 4 support people), young, and enthusiastic. Aside from a well-operating circulating seawater system, small boats, some field equipment, and microscopes, the Facility was virtually devoid of scientific equipment. Some inoperative surplus chemical laboratory equipment was in evidence. Nonetheless, the staff had developed a research program in rearing locally important fishes (sciaenids and bothnids) and was planning programs to use fish eggs and larvae in environmental and pollution studies. If the staff expands as they hope to, the research program should be greatly enlarged in the next few years.

Apparently the scientific programs were largely developed by the staff with NMFS funds. Reimbursable funds had been used to expand these programs in the last year.

Integration of the work at Port Aransas with other Center programs apparently was loose. A recent Center reorganization had also left the staff uncertain about mission goals. Nevertheless, staff morale seemed good.

In summary, the group seemed isolated but with good morale. Scientific productivity was not high, and strong steps should be taken to encourage publications in the scientific literature.

DIVISION OF ENVIRONMENTAL RESEARCH

This Division had recently been reorganized to incorporate work going on at all three facilities of the Gulf Coastal Fisheries Center. Most work was concentrated at Panama City, Florida, where three subtasks are located. The Division Chief was at Galveston, and one subtask was split between Galveston and Port Aransas.

The work included baseline data studies and dredge spoils research in St. Andrew Bay, Florida, impact studies in the Buccaneer oil field, and collection of baseline data in offshore south Texas waters.

The locations of Center laboratories were appropriate for this work. There was clearly a need to have work of this kind done, as evidenced by the extensive reimbursable funding available.

There were, however, a number of evident weaknesses in the research program. Foremost was the almost general poor productivity. Most of the senior staff members were involved in management tasks that seemed to guarantee low research output. The review team was concerned by the apparent high ratio of bureaucracy to research.

The geographical split of the Division into three facilities did not seem to be conducive to developing the sense of purpose and productivity that is needed to develop research quality.

The division had recently obtained new leadership. Perhaps by recruiting some fresh scientific strengths, the current low productivity can be corrected.

Strengths

1. The Center Directorate was energetic, dedicated, and aware of current fishery problems.
2. A reasonable amount of fundamental research was under way at the Center, some of it very good.
3. The shrimp research was generally of high quality.
4. The quality of the research on the reproductive biology of shrimp was very good.
5. The Center had a good resource assessment program.

Weaknesses

1. The scientific productivity and educational levels of some staff members were low.
2. The productivity and quality of the environmental research program needed improvement.
3. The separation of the recreational and commercial fisheries programs imposed a handicap on scientific productivity.
4. Some programs at the Center were isolated.
5. Computer facilities were inadequate.

Recommendations

1. Develop a strong and diversified oceanography program for the Gulf of Mexico.
2. Combine, where possible, programs that have been split geographically or administratively.

3. Develop better integration or coordination of the recreational and commercial fisheries research.
4. Establish a career development program for the scientific staff.
5. Improve the scientific productivity of some staff members.
6. Examine, and if possible reduce, the administrative workloads of division chiefs.
7. Improve computer facilites.

19. Southwest Fisheries Center (SWFC)
NOAA National Marine Fisheries Service
La Jolla and Tiburon, California, and Honolulu, Hawaii

Site visits: November 30-December 4, 1975

Review team members: Scott Overton (leader), Peter J. Colby, Richard C. Vetter, Ferris Webster, Frank Williams, and William D. Youngs

Center director: Brian J. Rothschild

1975 Budget: $3,938,000

NOAA-defined function: *Utilizing worldwide sources of data on tunas and billfishes, conducts scientific and economic studies of the commercial and recreational fisheries in support of the U.S. commitment to the International Commissioners on the Inter-American Tropical Tuna Commission, and to assist industry in arriving at optimal tuna fishery management strategies; in support of the management of coastal pelagic fisheries, conducts studies on the biology and population size of the important recreational and commercial fish species of the California Current; and in implementation of the provisions of the Marine Mammal Protection Act of 1972, provides data and recommendations on the status of the porpoise populations associated with the tuna fishery of the eastern tropical Pacific.*

The organization of Southwest Fisheries Center program into two divisions created four programs, two at La Jolla and one each at Tiburon and Honolulu. The basic mission of the Center was to describe the various options for managing the Pacific/Coastal fisheries and world tuna fisheries and to determine the future biological, environmental, economic, and social impacts of these management options.

The development of two separate programs within the La Jolla laboratory was the source of some staff discontent. However, we believed that this was an effective way to have developed a new program. The Coastal Division was essentially the earlier laboratory program somewhat reduced in total budget. Under the direction of an effective and respected leader, this group had retained a sense of unity and purpose and had maintained a high level of productivity.

The Oceanic Division represented the new programs developed for tuna and porpoise, and was oriented to an appraisal of the status of stocks and the effectiveness of regulation. These relied strongly on external sources of data--catch statistics, for example--and on the technology of quantitative analysis. The Division was productive and proficient. Its primary weaknesses were a lack of experience, a lack

of an integrated program in population and resource theory, and a lack of systems orientation.

As a summary overview, the current research program of the Center appeared to be moving toward more complete fulfillment of its mission objectives. The Coastal Division represented a center of excellence, the Oceanic Division appeared to be moving toward that status. Orientation to options and impacts and to appraisal for timely action were evident. Individual statements regarding conservation were strong; there appeared to be some conflict with regard to the basis of the appraisal of options (income for the U.S. industry is a frequent objective variable), but this did not necessarily imply any lack of conservation concern. Response to change was apparent; most problems identified were associated with the reorientation of the Center, and particularly La Jolla programs. This reorientation was in clear response to the need for a broader orientation and to the concern with problems not covered under the earlier structure.

An apparent gap: one cannot address national (or international) goals without some national statement. Such a goals statement must provide the focus of the Mission of the SWFC. This should be provided from above, perhaps at the NMFS or NOAA headquarters level.

The laboratories at Tiburon and Honolulu appeared to be in comfortable association with La Jolla. Attention to Honolulu had greatly increased (by testimony of the Honolulu director) under the current Center leadership, with considerable benefit to the program.

SCIENTIFIC FREEDOM, LIABILITY, AND PUBLICATION POLICY

A considerable amount of discussion was generated among a variety of individuals and the review team on this collection of topics. Concern with censorship and inhibition of free expression of scientific findings was balanced against the director's position that programs in the Center demanded a level of responsibility on the part of the Center. The exercise of such responsibility might take the form of inhibitions.

Additionally, several investigators expressed concern that the nature of certain programs could lead to civil action and liability, if the position taken by the investigator led to economic losses by an element of industry. Whether or not civil action is a possibility, one must rule capricious positions undesirable. At the same time, it may be necessary for an economically damaging position to be taken if there is truly valid scientific support for this position with regard to some other value.

These concerns appear to be so closely related that they must be treated simultaneously. Perhaps the Center could issue a policy statement governing the proper treatment of the results of an investigation. Such a statement could provide for a review of those results having potential impacts for which the investigator might be held liable. Liability follows responsibility; such a review could shift responsibility from the investigator to the Center and go far toward resolution of the problem.

At quite another level, scientific reporting of the scientific basis for such results will take another course. Normal scientific review and publication in scientific journals does not have the same risk of liability or the same immediate management implications. This form of publication requires less (or no) inhibition by organizational review.

In general, the review team was favorably impressed with the volume and quality of publications. Outlets were variable and appropriate, a substantial number appear in the *Fishery Bulletin*, and publication time was short. One point, however, seemed to deserve attention.

The Center program ranged from basic science to management monitoring. The appropriate form for information dissemination ranged similarly from publication in the formal scientific literature through publication in trade journals to publication in bulletins and house documents.

This may be the source of the response by members of the Oceanic Group at La Jolla with regard to the publishability of the results on which their management recommendations were made. If we interpret their response as meaning that the formal scientific literature, or even a trade journal, is inappropriate for documentation of the data base for a recommendation, then the position is reasonable. But there must be an appropriate place for such a data base to be documented and made available to scrutiny by an interested person.

Further, the protocol, rationale, and scientific basis for development of management recommendations from a defined data base can and should be published in the more conventional literature. It is the *basis* that is properly criticized in the open literature not the details of each application.

The director attends numerous national and international meetings and was involved with the interaction of the Center with the national and world fisheries communities. This brought heavy criticism from a number of individuals in the La Jolla laboratory. During an open meeting, the need for such trips was raised by a question from the review team. The director explained the importance of this activity in terms of his views of the goals and missions of the Center and the responsibilities of the director. It was evident that this topic had not previously been discussed with the entire senior staff. Perhaps more group discussion of laboratory goals and missions is indicated.

This point was also addressed by the directors of the satellite laboratories; the center director had little contact with the individuals in those laboratories. Delegation of authority within La Jolla had released him to maintain closer ties with the directors of the other laboratories, as well as allowing contact outside the Center. This delegation of authority did not imply isolation from the programs. The director read all publications and reviewed all programs. We believed that he was doing an outstanding job.

The general Center atmosphere was excellent. There was a relaxed academic air about the place, in spite of the high level of productivity and several fierce controversies. It appeared to be a good place to work.

COASTAL FISHERIES RESOURCES DIVISION

This Division was the older of the two major divisions at La Jolla. It included many of the long-term established programs and, perhaps for this reason, had undergone adjustment problems in the evolution to changed priorities. A conflict between the objectives of fisheries management and basic science was perceived by many of the staff members in this Division. New priorities had not yet been fully accepted.

The Division had a high scientific awareness, much talent and enthusiasm, and was doing some excellent research. The problems being addressed were in many cases fundamental to science in general, not simply to the California Current area. In some groups, the publication record did not adequately reflect the good quality of people and their work.

ALBACORE FISHERIES PROGRAM

This group had established good relations with the fishing industry. This may have resulted sometimes in research objectives that were in conflict with resource conservation in the broad sense.

The research had the worthwhile aim of merging oceanographic and fisheries research. This had had some success, although the program might have realized more of its potential through more effort to understand phenomena. Publications in oceanography have been slow in appearing.

ECOLOGY OF THE CALIFORNIA CURRENT

This group had an appreciation of the value of extended time series in the understanding of environmental variability. The impact of this variability on the ecological systems is of basic importance to the fishery. The California Cooperative Fisheries Investigations data, on which this study is based, provide an excellent opportunity to show how such a study can be undertaken. The magnitude of the data base presents a particularly difficult (and worthwhile) challenge of extracting interpretation from the data.

The publication record of this group may not have fairly reflected the excellence of the staff members. Efforts should be made to improve this.

OCEANIC FISHERIES RESOURCES DIVISION

This Division had two objectives:

1. Estimate and develop procedures to prevent porpoise mortality.
2. Assess global tuna stocks.

They were not themselves impressed with the quality of their own research. One analysis was that it is too poor for publication yet good enough for making management recommendations. This logic is not good for conservation of the resource. Their programs were too new to have contributed much to science, but they may be able to within the next few years. They also felt that given more time they could have a positive effect on their international colleagues to develop a good or at least a satisfactory international assessment program. They were the leaders in this endeavor. Given more manpower they probably could even develop some good yield concepts.

It was our impression that there was need for long-term research goals in this Division. Among these might be the development of conceptual models of multispecies fisheries, studies of how environmental data can be effectively put into models, the effects of environmental fluctuations with time, and socioeconomic effects.

Individuals in the Division needed to be better buffered from Washington pressure on critical matters such as the porpoise issue. They needed to get the material that they have prepared for Commission and treaty obligations out into the refereed scientific literature. There was not enough time to do a good job in such programs under pressure for quick results. Possibly, published data reports and analyses might avoid problems in those cases where outside interests suggest suppression of literature. It appears that the Division could use a few more experienced scientists to absorb some of the pressure for providing immediate results from their ongoing work.

FACILITIES

Computer access was reported to be adequate for the research needs of the Center. Programming support was perceived differently according to the group; there evidently were have and have-not groups, perhaps reflecting changing center priorities.

Ship support appeared good. The *David Starr Jordan* and its experienced crew received high marks from staff members.

Technical support seemed to reflect a NOAA-wide problem: funding stringency resulting in technical support cuts. This tended to produce professional-level people doing technical jobs. This shortage of support was noticeable in marine technicians and electronic technicians. Perhaps as an outgrowth of this, concern was found for the adequate maintenance of scientific equipment.

TIBURON LABORATORY

NOAA-defined function: *Conducts research related to coastal California fishes, their ecological relationships, and their associated recreational and commercial fisheries. Carries out pollutant research that involves studying the physiological effects of pollutants on fishes as well as researching the physical processes that determine the distribution and concentration of pollutants in the coastal zone.*

The Tiburon Laboratory staff had almost reached the number needed to do effective work. This was particularly true when viewed from the academic level of the research personnel. Personnel in research-level positions had the following academic levels: four bachelors, two masters, and two Ph.D.'s. The addition of two doctoral-level scientists would enhance the laboratory program. One was to come on transfer from La Jolla and should add to the expertise at the laboratory in the area of quantitative biology.

The research program was conducted under three investigations: physiology, coastal fish communities, and coastal fisheries. The physiology investigation was a new area concerned with sources of early mortality of striped bass. This investigation was a redirection of the group that was working on oil pollution. The quality of research was difficult to judge since results of former work were being reviewed in manuscripts. The ability to redirect effort with little personnel change was commendable.

The coastal fish communities investigation was an excellent program of basic biological value, which was necessary for the establishment of meaningful management. This group was working on the ecology and behavior of inshore fish communities. The publication record of this group was outstanding. The relevancy of the work outside of the laboratory should be better appreciated.

The coastal fisheries investigation consisted of three tasks; two were new and one was ongoing. The new tasks were rockfish analysis and recreational fisheries improvement. The carryover task was coastal fisheries technical development, which was concerned mainly with developing new commercial fisheries for presently unexploited species of marine life. The functions of this investigation appeared to be management rather than research. However, the public-relations value to the laboratory may justify the existence of this investigation. In general, the quality of the work was above average for the academic level of the biologists involved.

The scientific personnel at the laboratory were up to date with regard to statistical procedures being used. They were up with current literature in the field. Technical support was not sufficient, however, to make best use of the scientific expertise, and scientists were doing a large amount of technical and labor work.

Facilities at the laboratory were adequate for the tasks being undertaken. The wet laboratory for physiological work was excellent, allowing both temperature and salinity gradients with automatic control

and warning systems. The laboratory library was modest, but the close proximity to university libraries at San Francisco and Berkeley makes excellent research material available. These were used by the laboratory staff. The interactive computing facility was adequate and provides keyword library search references. The computing facility allowed card reading for data input.

There was a surplus of space at this facility; some was declared excess by the General Services Administration and will be taken over by some other agency. This should not hamper operation of the present research program even with the addition of two scientists.

HONOLULU LABORATORY

NOAA-defined function: *Provides U.S. commercial and recreational fishing interests with information and assistance in the management and development of fishery resources of U.S. concern in the central and western Pacific Ocean, particularly the development of the skipjack fishery. Efforts also directed to such facets of fishery management and development as the assessment of commercial and game fish stocks and the development of bait resources for the tuna fishery. Conducts a major study to determine the limits of temperature and oxygen conditions that may determine the distribution of tropical pelagic fishes, chiefly tunas.*

The scientific personnel and resources of the Honolulu Laboratory appeared to be spread too thinly for the extent of the present scientific progams. There appeared to be a need in many instances for improved scientific management at the program/project level, and this might be accomplished by realizing the full scientific potential of several existing staff members.

The morale of the laboratory appeared to be rising under the leadership of the current Director. However, in many of the scientific projects this had apparently not yet resulted in a striving for research excellence. This might be remedied, in part, by regular opportunities for input of ideas by all scientific personnel into new and existing laboratory programs. Certainly, problems in funding at the laboratory in the recent past may have been due to the diffuse nature of the objectives of many of the proposed projects.

There were obvious signs of the isolation of many scientists at the laboratory from each other, from scientists at the University of Hawaii and outside the Hawaiian Islands. External stimuli could be a most effective way of helping upgrade the overall quality of the scientific programs and the state-of-the-art knowledge of the scientific personnel.

The Fisheries Environmental Investigations had had some noteworthy success in relating oceanography to fisheries problems. The combination of physical oceanography and fish physiology was an excellent and exciting example of how this can be achieved. The physiological

studies were doing well, and there was general staff enthusiasm for them. Excellent facilities were available for this work.

The Tuna Assessment and Development Investigations included a variety of research activities: MARMAP III appeared to be a group of mainly minor and unrelated projects without any aspects of quality science. Some outputs may have been valuable in a technical development sense. Tuna monitoring and assessment was a relatively low-profile activity; it appeared that much more scientific information could be derived from an in-depth study of the existing data base on tuna fisheries. Until recently, publications have been slow in coming out of this project. The scientific competence in the handling of the North Pacific Albacore project was of a high order, and there appeared to be excellent relationship with the albacore program at La Jolla, as well as with researchers in Japan. The objectives of the Insular Program were unclear, and it appeared to lack scientific direction. The program could be a major one for the laboratory and should involve many of the other scientific personnel. However, there is a definite need for decisive scientific planning and execution if it is to succeed.

The technical services staff at Honolulu, although small, was of high quality and provided excellent support to the scientific personnel, who considered them indispensable members of the laboratory team. The computer facility, although modest, was adequate and should be improved when the planned backup with the University of Hawaii computer facility is completed.

Strengths

1. The administration of the Center was effective.
2. Of the two separate programs, the coastal program had developed into a center of excellence with a high sense of unity and purpose and high scientific productivity. The oceanic program was new but promising.
3. The Center had an impressive record of publication, both in terms of volume and quality.
4. Authority was well delegated and the Director kept informed of laboratory activities.
5. The physical facility and the academic atmosphere combined to create a good place for research.
6. The fisheries environment investigation at Honolulu had had noteworthy success in relating oceanography to fisheries problems.

Weaknesses

1. The Oceanic Fisheries Resources Division lacked experience and needed an integrated program in population and resource theory with a systems orientation.
2. There were some indications of inhibitions of freedom of expression--possibly caused by external pressures.

3. Long-term research goals were needed, and conceptual models of multispecies fisheries should be developed incorporating environmental and socioeconomic effects.
4. The staff of the Honolulu Laboratory appeared to be spread too thin for the extent of scientific resources available, and there were signs of a sense of isolation at this laboratory.

Recommendations

1. Identify goals and objectives for the Center and broaden the participation in this process.
2. Develop a more visible structure for translating data into recommendations.
3. Give more attention to resource decisions strategies.
4. Put greater emphasis on systems analysis, theory, and modeling.
5. Insulate Center scientists from decision-making without isolating them from this process.

20. Northwest Fisheries Center (NWFC)
NOAA National Marine Fisheries Service
Seattle, Washington, and Auke Bay and Kodiak, Alaska

Site visit: September 29 to October 3, 1975

Review team members: Peter J. Colby (leader), L. Lee Eberhardt, James M. McKim, Foster H. Middleton, Michael M. Mullin, Scott Overton, Douglas S. Robson, Richard C. Vetter, and Ferris Webster

Center director: Dayton L. Alverson

1975 Budget: $7,741,000

NOAA-defined function: *Conducts research programs to understand better the living marine resources in the North Pacific Ocean and Bering Sea, the environmental quality essential for their existence, and to describe options for their utilization. Two types of research are conducted to meet this obligation: (1) applied research, which is seeking solutions to problems, and (2) fundamental research, which provides input needed for solutions to practical problems.*

GENERAL OVERVIEW

The Northwest Fisheries Center was doing a satisfactory job conducting short-term applied research to solve modern fishery technical problems such as:

1. Developing aquaculture for commercially important marine species, including treatment of diseases;
2. Solving problems concerned with dredge disposals;
3. Impact assessment of dams, turbines, and irrigation structures;
4. Identifying the gas-bubble disease problems and working out alternatives to overcome this problem;
5. Identifying and solving problems concerned with entrainment, impingement, and thermal effects on
   (a) Aquatic and marine organisms,
   (b) stock surveys, and
   (c) gear development, conservation, and other related activities.

The scientific staff concerned with these activities were employed primarily in the Environmental Conservation and Coastal Zone and Estuarine Studies Divisions. They were competent, published their work in pear-reviewed journals, and many had good working relationships

with universities--some being on university staffs and directing graduate studies in their disciplines and areas of responsibility. Their responsibilities were well identified and oriented to technological problem-solving. Their work responded to environmental problems. Most of them were heavily involved with scientific meetings, seminars, and interagency exchanges and public relations. Communication with scientists outside the Center was one of their strengths. Most researchers were dedicated, motivated, and highly satisfied with their jobs. Much of this satisfaction and success resulted from their being protected from administrative red tape and diversionary projects by a staff of senior scientists who had accepted administrative responsibilities.

Lack of understanding of broad goals and objectives among many researchers was noted. Also, within many tasks, there seemed to be no thread holding the work together toward meeting a specific objective involved with environmental protection--this was noticed both at Seattle and Auke Bay. The work in many instances was oriented toward individual projects aimed at technological development, with little emphasis on solving specific environmental problems, i.e., developing methods but not evaluating or developing their use in solving environmental problems. Identification of scientific problems was not strongly emphasized, and the capacity to evaluate the economic or social importance of a problem was sometimes questionable.

Although problems that lie ahead were identifiable, there were no explicit plans for phasing out currently successful (hence, to be terminated) projects and beginning new ones. There did not appear to be sufficient Division autonomy in working these transitions--possibly because of lack of attention by division leaders. The lack of local autonomy was further indicated by the requirement that Task Development Plans had to be approved in Washington, D.C., rather than at the Center, a situation considered undesirable by the reviewers.

As previously mentioned, many of the short-term applied researchers were being protected from administrative overload by senior staff. It was the reviewers impression that this has been costly and at the expense of developing long-term applied research programs needed to meet NMFS's obligation and goal of effectively conserving and allocating fisheries resources; more specifically, this means, in addition to identifying stocks for harvesting, understanding the response of these stocks to exploitation, and developing realistic estimates of maximum sustainable yield and optimum yield.

Our general assessment was that the quality of research in the Marine Mammals Division was adequate, considering the history of the group and the low funding relative to the mission assigned. An effort to improve knowledge of the northern fur seal by launching a long-term behavioral study was under way on St. George Island following cessation of harvest.

In favor of the Center's long-term applied research program, a number of senior staff members believed there was a need to take a holistic approach to understand the interrelationship of the marine communities and planned to organize a unit within the Center to do

this in the future. They had interviewed for an ecosystem analyst and had an ecosystems dynamics group, which apparently disintegrated. However, it is the reviewers' task to evaluate actions rather than intentions. In fairness to the senior staff, they may have been so busy with administrative matters, being buffers between staff and outsiders, and keeping the Center operating that they lost sight of the big picture or suppressed it when responding to more immediate and externally generated demands.

In the Marine Mammals Division, there was a long history of excellent cooperation and consultation with an outstanding expert on population studies and quantitative methods. Overall there was an expressed interest and an opportunity for an ecosystems approach to understanding fur seals. Administration and administrative support appeared good. The Division had a problem because national and international resources for studying marine mammals were few and scattered. They were making an effort to overcome this problem by having a technical conference with Mexico, maintaining contacts with the Marine Mammal Commission, and cosponsoring an international symposium on marine mammals.

In the past, there was an excellent program in fishery oceanography from which information on the physical oceanography of the Bering Sea and its relationship to faunal abundance and distribution was gained. Funding for biological investigations was drastically cut in 1974.

Stock "assessment" or surveys seemed to be concerned with distribution and abundance rather than with processes. There was relatively little work on prerecruitment ages or reproduction, benthic food supply (one major literature review was completed, however), and productivity of the overlying water column.

Although the relationship with the University of Washington College of Fisheries appeared to be moderately good, there was little evidence of contact with oceanography, zoology, or other departments, which, if true, reduces awareness of trends in theoretical ecology or nonfisheries ecology. Many researchers have had additional schooling since joining NMFS, but this appeared to have been directly job-related rather than conceptually broadening.

There was also an apparent lack of coordinated research effort between NWFC Divisions. For example, there was a curious mismatch between the Fish and Shellfish Division and the work on migrating salmon within the Coastal Zone Division, which may have been brought about by the shift of attention in the former Division to Alaska Salmon and then to demersal species. The result of this apparent confusion within the Center was that salmon were carefully tended from the hatching hour to the ocean, then were largely ignored in a research sense, then were again tended once they had re-entered the Columbia River.

In contrast to the short-term applied research groups with fairly well-defined, semitechnological problems (aquaculture, diseases, dam mortality) the group dealing with demersal fish seemed less enthusiastic, less aware of economic and social implications, less organized around concepts, and less convinced of the merit of what they were doing.

The quality of science was further jeopardized by the lack of emphasis on the nonfish components of the ecosystem and a feeling by certain senior people that there was no need for a systems analyst or modeler or for an ecosystem approach to problem solving. The review team was concerned about the low priority given to meaningful long-term research programs. The reduction of the fishery oceanography program was an example. We realize that relating the influence of the physical environment on the distribution and abundance of living resources for an area as large as the northeastern Pacific is no easy task. However, once relationships are established they are valuable in understanding and managing a resource. The quality of the work in this task was high, but the vitality of the work was less than it could or should have been. This lack of vitality (evidenced by strong cutbacks in personnel and funding in recent years) seemed to be a manifestation of decreasing support for fisheries oceanography in NMFS.

In the Marine Mammal Division there was a distinct impression of uncertainty concerning the vitality and health of their programs. Enthusiasm and esprit were not evident, which was probably a reflection of inadequate funding and facilities and insufficient talent. The output of published papers was undesirably low. The likelihood of achieving objectives was questionable, because they were too broad, especially in view of the low funding and available resources.

There was a major need to integrate the Center strengths, including data collection on Bering Sea fisheries and stocks. A particular example was the pollack fishery needs as they relate to the needs of fur seals. This was a major opportunity, and the outcome could be a major influence in management of the Pribilof fur seal. Also desirable would have been the integration with work on plankton in the Bering Sea that was being conducted by PMEL.

The Outer Continental Shelf work (contract with the Bureau of Land Management) may have been handicapping the Marine Mammals Division by overextending the staff, i.e., getting newly hired and inexperienced people initiated, especially in view of the state-of-the-art limitations of census methods.

SUPPORTING ACTIVITIES

The Fishery Data and Management Systems (FDMS) Division provided computational and statistical consulting service for other Divisions of the Center and also had responsibility for preparing data analyses and reports for international commissions.

Statistical competence at the Master's Degree level, together with some training in quantitative fishery science, was sufficient to meet most of the consulting needs of the Center, and statistical practices were adequate. The Division was well balanced in terms of expertise in statistics, quantitative fishery biology, and use of the computer. Morale was good under fine leadership, and funding was adequate for the existing staff. The independent budget of the Division

without the need for interdivisional exchange of monies for consulting and computing costs was an excellent and unusual arrangement, which relieved pressures and promoted good quality work.

All of the staff, excluding the director, received their statistical training at the University of Washington and in this sense were copies of one another. Capabilities were limited to the Master's Degree level of training and were clearly reflected in the depths to which their consulting problems were pursued. The types of consulting problems that arose at the Center generated many research problems in biometry, and with some guidance from a senior biometrician several members of the staff could have been producing biometric research. In addition to contributing to the field of biometry, this activity would further improve job satisfaction within the FDMS Division and enhance the image and credibility of the entire Center.

There was some internal dissatisfaction with Center emphasis on the maximum sustainable yield concept and the associated yield models. These reservations were directed toward the international commission reports emanating from this Division and reports from the Marine Fish and Shellfish Division. There was also some criticism of the Center for being too keyed in on catch-per-unit-effort as stock indicators rather than growth, age structure, age to maturity, and other related factors. There was concern as to the rate at which stocks can collapse without warning and that research efforts were not being sufficiently directed toward establishing criteria to forewarn management to take remedial action before it is too late to save a stock. There was some feeling that evaluation of some of the expensive data collected in the past by NMFS (e.g., the large haddock and menhaden scale collections) will provide clues to develop such criteria. There was also concern that established models are not satisfactory predictive tools and require further work. This expression of self-criticism is healthy.

Engineering Services: Evaluation of this group's engineering capabilities was difficult because of the absence of three important people.

Conservation Engineering is an artificial name for gear development engineering. The staff was smaller than a few years ago, and there was difficulty in keeping engineering staff. Consensus was that at least one expert should be available as an internal consultant. This group wanted an experienced person to consult. The pay or grade level may be inadequate to keep people of high caliber.

The prime project in hydroacoustics is the towed acoustic fin under development by contract with the Applied Physics Laboratory/University of Washington. This is a wide-narrow beam sonar that is devoted to reducing bad effects of pattern on fish target strength measurements.

FACTORS INFLUENCING THE QUALITY OF RESEARCH

Research Funding: The method for financing research programs was having a negative effect on the quality of research. Many of the previously thought-out and financed programs had had their base funds

consumed by salary increases, resulting from inflation. Consequently, they had continuously had to depend more on reimbursable funds to survive. Reimbursable funds are usually short term (e.g., 15 months) and directed toward objectives that may be other than originally intended. Consequently, the direction of research shifts away from longer-term, possibly more difficult and meaningful objectives, to short-term research.

Personnel Problems: There were indications of lack of motivation and innovation among many NMFS scientists, especially in more difficult research areas. There were few GS 14 or 15 *scientists*. Staff members with these grades were generally administrators, and their pay seemed to depend more on how many people they supervised, how much money they managed, or how much administrative details they handled rather than their scientific ability. Financial rewards were not adequate for good science *per se*, and there were no obvious criteria for promoting scientists unless they left the field of science. This suggested that scientific talents were less needed than administrative talents, a view that is certainly questionable. More effort should be given to understanding what motivates scientists and not necessarily what motivates technicians or government employees in general.

The hiring system was felt by some permanent staff to be unfair to their part-time and temporary employees, many of whom were rehired year after year so their expertise was not lost.

AUKE BAY LABORATORY

NOAA-defined function: *Plans, develops, executes, and reports research required by state and federal resource management agencies and, as assigned to the Auke Bay Laboratory, in the interests of the important fish and shellfish resources of Alaska.*

The Auke Bay Laboratory was isolated, in respect to nearness to universities, to other colleagues in the field, and to the administrative structure of NMFS. This insularity had a strong effect, both positive and negative: the pace may have been slower than at units more directly exposed to administrative problems. Consequently, the atmosphere was pleasant, there were colleague relationships, and there was less feeling of frustration with administrative burdens than evidenced at other laboratories.

However, complacency may develop in such a case, and there was some evidence that researchers were not always up on the latest scientific literature and techniques. Sabbatical leaves and travel to other research centers should be continued and encouraged.

Many advantages of the proximity of the laboratory to the fisheries resources were apparent: the basic biological description of the vast Alaskan marine region was still incomplete; important environmental and economic problems need research attention that can be provided by NMFS. In such a situation, the work can be exciting and rewarding.

This point of view was expressed by several of the scientists. Furthermore, relations between the NMFS and the Alaska Department of Fish and Game were a good model for federal-state cooperation in the application of research results to management.

The leadership of the laboratory, while good, was seen by several scientists as in need of strengthening for longer-range research direction.

The decline of the salmon stocks to about 20 percent of their original yields and the apparent feeling of futility in overcoming the socioeconomic barriers to rational management had motivated the Anadromous Fisheries group to decide on aquaculture technology as the more pragmatic solution to meeting demands for the resource. This group had good vitality and attempted to provide what appeared to be good technological support to the industry. This approach may be selling short long-term solutions, which depend on enhancing natural production through experimental management programs and developing alternate management solutions. There was concern, however, that this group was in danger of intellectual complacency, which could be expensive in the long term.

We were concerned about the ability of the Environmental group to think about the relevancy of their programs and their apparent neglect in not taking advantage of the literature. They appeared to have difficulty in relating the results of the work to actual environmental problems or situations. Much of the work was routine laboratory bioassays and descriptive field surveys that provided limited information for assessing environmental impacts. The sudden development of this program was causing a space and logistics problem at the Auke Bay Laboratory and probably was at the expense of the other programs.

The work of the Marine Studies group was concerned with limited biological measurements and some life history and taxonomic studies. They had plans to expand their program and outlook, but this had not been realized.

The Biometrics program seemed to have a good technical capability. As at Seattle, the review team was concerned about the possibility of the staff being too ingrown; all professionals are graduates of the University of Washington. Surely the statistical methods and techniques that can be brought to bear on fisheries problems could be enhanced by a more heterogeneous staff background. Again, conscious efforts should be made to keep the professional biometricians up with state-of-the-art developments.

The laboratory library seemed particularly good. Computer support, on the other hand, did not seem to be adequate for research needs. In view of the existing biometrics and programming staff, consideration should be given to acquiring a more solid computer capability. This perhaps could be done by obtaining a small computer at the laboratory.

KODIAK LABORATORY

NOAA-defined function: *Conducts research and provides information on the biology, ecology, and utilization of marine resources within the areal purview of the Center. Provides a technical information base for (1) the development of management policy or negotiations of preferential positions for the U.S. fishing industry by the Department of State; (2) resource management decisions by the federal government and West Coast states; (3) decisions on capital investment by fishery-related business; (4) rehabilitating the domestic fishing industry by increasing the operational efficiency of U.S. fishermen; and (5) the development of policy on man-caused effects on the distribution and abundance of marine resources.*

Again, as at Auke Bay, we were struck by the dominating effect of geographic isolation of the laboratory. The research laboratory had the advantage of being near the resource and the client, and maintained excellent cooperation with the Alaska Department of Fish and Game. Also, there may be an advantage of the laboratory serving as a more direct information source to NMFS regarding the industry.

The major disadvantage was that the work and results of the laboratory were dangerously sensitive to local industry pressures. We were also concerned about the problem of intellectual complacency that occurs with isolation.

The research program was primarily oriented toward the collection of data on Alaskan shellfish resources and some research on life history and systematics of that resource. The research quality was not high by academic standards, although competent to meet the pressing needs of short-term resource management problems.

The research library facilities were excellent. A problem with computer accessibility was found, although steps were being taken to bring the problem under control.

Strengths

1. The Center had a good performance record for short-term applied research.
2. The Center was staffed with dedicated, motivated, and competent scientists with good publication records.
3. Responsibility for programs was well identified.
4. There was good communication with outside scientists and particularly good working relationships with the University of Washington.
5. The Center had a balanced and competent data and management systems group.

6. Self-criticism was well developed in the statistical group. The morale of the recreational fisheries group was high, although funding was small.
7. The Auke Bay Laboratory had useful proximity to regional fisheries resources.

Weaknesses

1. There was a lack of understanding of broad goals and objectives.
2. Specific objectives for environmental protection were not well defined.
3. There was a reluctance to terminate programs and start new programs.
4. The fishery oceanography program had suffered a substantial reduction of priority.
5. Long-term research priorities were too low.
6. The need for a holistic approach was recognized but not funded adequately. The stock assessment program was oriented toward distributions and abundance rather than processes.
7. The demersal fishery group was less organized around concepts and less convinced of the merits of their work than was the short-term applied research group.
8. The dominance of University of Washington graduates on the staff of the fishery data management system division had the effect of reducing the breadth of conceptual inputs to the work of the division. A Ph.D. leader for this group was needed.

Recommendations

1. Continue with the task of solving short-term applied research problems but, in addition, support at least a small research group of systems analysts, systems ecologists, and a senior scientist to develop the capability of predicting the response of oceanic communities to perturbations.
2. Sponsor an ecological workshop or series of seminars to ensure that researchers are cognizant of recent ecological advances and theory.
3. In the fishery data and management systems division, create a senior position for an experienced Ph.D. biometrician with competence in both theory and application to serve as advisor to the present staff in their consulting and research activities.
4. Develop a program that allows a certain segment of the scientific staff to pursue studies concerned with determining various characteristics of the marine communities, such as productivity, environmental constancy, community persistency, and stability (resistence and resiliency). These longer-term applied research studies should aid in developing management strategies for the future.

21. National Systematics Laboratory (NSL)
NOAA National Marine Fisheries Service
Washington, D.C.

Site visit: February 2, 1976

Review team members: John J. Magnuson (leader) and Ruth D. Turner

Laboratory director: Daniel M. Cohen

NOAA-defined function: *Carries out basic studies on the taxonomy and distribution of living marine resources. Documents the distribution and abundance of these resources. Assists in the development of programs in all parts of the world ocean as required.*

This small laboratory, with four professional scientists, including the director, had the responsibility for research on the systematics of important marine and freshwater organisms. They have played an essential role by clarifying the taxonomy and distribution of important or potentially important species. Studies were under way on epipelagic fishes, benthic and deep pelagic fishes, pandalid shrimp, crabs, and other decapod crustaceans.

The quality of research done by the four specialists (two in fish and two in crustaceans) was comparable with the best work coming from universities and museums. That each was in demand as a lecturer, as a member of *ad hoc* committees, on graduate student committees, and as an adjunct professor attests to the esteem with which they were held in the academic community. In addition to comprehensive and useful technical publications, they had also participated extensively in preparation of less technical material such as the Food and Agriculture Organization Species Identification sheets for fishery purposes.

Research had centered on commercially important species, but expertise was also maintained in other groups by active work. Their papers are important tools on which fishery biologists and the scientific community in general depend for species identification, and their papers are in demand in laboratories around the country.

Weaknesses and problems were associated primarily with the small size of the laboratory. Only by their close association with Smithsonian scientists were they able to carry out their studies. Systematic studies on pelecypods are needed and would require a new staff member. The clupeid fishes as well as planktonic invertebrates need serious attention. Because of the technical nature of the material, the group was not flexible to change.

Additional technical staff are badly needed to make adequate use of the four professionals. Each of the scientists could be better used by NOAA if they had a minimum of one technician each. It was disturbing that there was a large backlog of collected fisheries material that had not been sorted or properly curated because of lack

of supporting staff. The staff could successfully increase their productivity by supervision of graduate students. They would like to do this and could do it well. They also need support for field work--little or none was provided.

The director of the laboratory spent about 40 percent of his time in administrative activities, which seemed excessive for such a small laboratory. He felt that a great deal of time had to be assigned to administration because the laboratory seemed continually threatened for its existence and because it had to contend with much of the same paperwork assigned to larger laboratories with far different missions. Many of the submissions for future support were structured in such a way that this small, specialized laboratory did not seem to contribute to NOAA. The processes for justifying the laboratory's existence and for reporting progress seemed excessive.

Strengths

1. The Laboratory was highly productive, its work was well known, it had a staff of authoritative scientists whose publication record was significant.
2. Good support was provided by the Smithsonian Institution.
3. Its work was responsive to a specific need for improved knowledge of taxonomic strains of important species and groups.

Weaknesses

1. The support staff was inadequate.
2. Much of the administrative load imposed on the Director seemed excessive and unnecessary.
3. The Laboratory suffered from a repetitive need to justify its existence.
4. NMFS scientists generally were not aware of the capabilities and products of the laboratory.

Recommendations

1. Provide better technical support.
2. Consider an increase in scientific staff in order to cover important groups such as clupeoids and pelecypods.
3. Increase the awareness among NMFS scientists of the competence of, and the services available from, the laboratory.

22. Atlantic Environmental Group (AEG)
NOAA National Marine Fisheries Service
Narragansett, Rhode Island

Site visit: June 23-26, 1975

Review team members: J. L. McHugh (leader), M. Grant Gross, Richard C. Vetter, and Ferris Webster

Group chief: Merton C. Ingham

1975 Budget: $249,000

NOAA-defined function: *Prepares portrayals and interpretations of environmental and biological data as part of monitoring and research programs of NMFS, conducts broad-scope and long-period oceanographic and bio-environmental research, expedites the flow of NMFS data through EDS, serves as interface between NMFS units and NODC when necessary, advises NMFS programs in the design and execution of oceanographic field studies and monitoring activities, locates relevant data sources outside of NMFS, and operates some ship-of-opportunity programs.*

The Atlantic Environmental Group was a small group of highly motivated oceanographers who seemed to work well together. Formed within the past five years, AEG had recently moved to their present Narragansett location, where they worked closely with the MARMAP field office and with staff members of the Northeast Fisheries Center. It was clear that AEG had modeled its programs and general structure after the older Pacific Environmental Group (PEG). Direct contact between the staffs of the two groups had apparently been limited by lack of travel funds, especially during FY 1975.

The AEG staff expressed a clear concept of their missions:

1. Support of MARMAP.
2. Coordinate, monitor data acquisition, and compile data from the Atlantic and Gulf of Mexico with an overall goal of developing environmental monitoring data into formats that can be used to solve biological problems.

This sense of their mission, the history of the group, and the apparently strong leadership had helped produce a highly interactive and productive group.

With only five professionals, the group was at or just below the size needed to become effective. A disproportionately large fraction of each individual's effort was apparently required for operational chores (programming, servicing field programs, writing program documents), leaving insufficient time for more thoughtful and innovative activities.

Considering the small size of the staff and the funding level, AEG seemed to be involved in too many activites. In FY 1975 only two projects had been assigned as much time as one professional; six had half or less than half the time of a professional. Several of these activities were of fairly large scale (e.g., compiling a Mid-Atlantic Bight sea-surface temperature climatology). With such a low level of professional activity per project, it is questionable that the results will be professionally satisfying to the scientist involved or available soon enough to be useful to the MARMAP or other NMFS activities. Either funding and personnel allocations should be increased, or AEG's activities should be tailored more carefully to fit available resources.

In spite of the good morale of the AEG staff, there was a strong sense of frustration. They clearly felt that they were not supported--in fact actively hindered--in their task of coordinating interagency monitoring efforts and developing useful products based on such data. The problem may have been due to jurisdictional problems within NOAA.

Several AEG projects will lead to large-scale monitoring operations and eventually to environmental assessments. AEG staff were carrying out near-operational-level programs at substantial personnel sacrifice. This situation, if continued, will further dissipate AEG resources. One of the explicit objectives for AEG should be to develop monitoring procedures and to hand them over to the other groups when they have reached an operational stage.

Strengths

1. The staff was highly motivated and the morale was good.
2. The set of problems were, on the whole, well defined.

Weaknesses

1. Many professionals were doing their own support work.
2. The professional staff was spread too thinly over a large number of activities, several of which are of fairly large scale.
3. Coordination of data and use of data not generated by the group was a problem exacerbated by the administrative and coordination weaknesses of the larger NOAA structure.

Recommendations

1. Increase interaction between the AEG and the Pacific Environmental Group.
2. Re-evaluate the set of AEG programs and cut back to those of highest priority.
3. Transfer monitoring responsibilities to operational NOAA groups.

23. Pacific Environmental Group (PEG)
NOAA National Marine Fisheries Service
Monterey, California

Site visit: August 12, 1975

Review team members: Ferris Webster (leader), Russ Davis, and Pearn P. Niiler

Group chief: James H. Johnson

1975 Budget: $297,000

NOAA-defined function: *Directs research programs in marine environmental monitoring and prediction for fishery forecasting purposes; directs and participates in the study of ocean-atmosphere interaction and general circulation, including the effects on productivity of the ocean; prepares general atlases; and determines possible application of new technology for fishery purposes. Responsible for coordination of biological environmental surveys from platforms of opportunity (ships, aircraft, etc.).*

The Pacific Environmental Group was young, both in terms of the age of its staff and of the time since its formation, having been fully staffed for only about three years. The group was located in Monterey, on the grounds of the Naval Postgraduate School. This proximity to the Navy's Fleet Numerical Weather Central provided the group with two unique facilities: a vast historical data file of oceanic and atmospheric environmental data and the computer facilities with which to make use of these data.

The primary emphasis on PEG activities was directed to the production and dissemination of a number of environmental indices and to research aimed at discovering new indices useful in explaining environmentally caused variability of fisheries. Examples of the indices produced routinely are wind stress, surface heat flux, and variables describing atmospheric forcing of the upper layers of the ocean. These products are of value in fisheries research, such as the prediction of variations in the Atlantic menhaden, Pacific mackerel, and dungeness crab.

The research of the group was focused on exploring the variability of environmental factors that may affect fisheries. It was, for example, recently found that fluctuating wind forcing produces large changes in the strength and structure of the Pacific North Equatorial Current. Theoretical modeling suggests that this should affect the distribution of Skipjack tuna in the Hawaiian area. Recent studies had documented anomalous variations of environmental factors that fisheries researchers might apply to fluctuations in fisheries

productivity. In addition to benefits to fisheries research, the group's activities provided significant aid to NOAA and university research in oceanography and climatic variability.

The quality of the work of the group was generally high. This seemed to be the result of a combination of a number of factors: good people, an environment that sets up a productive research atmosphere, effective leadership, a group size that was small enough for good interaction but large enough to function efficiently and effectively, and the adjacent data bank and computer facility of the Fleet Numerical Weather Central. There was a healthy balance between science and mission orientation. There was a consistent and adequate flow of publications. The young staff was maturing professionally, and the quality and quantity of publications should continue to improve.

Reimbursable work seemed to be in a healthy proportion to NMFS-funded work. The reimbursable activities followed the goals of the main research program and reinforced the primary research objectives of the group.

However, it was the review team's impression that the ideas and products of the PEG, with some notable exceptions, were not being effectively exploited by other NMFS programs. We note that this may be part of the more general problem of effectively incorporating environmental information to provide an understanding of biological and fisheries problems.

The PEG was relatively isolated geographically. On one hand, this may impede interaction with other NMFS elements. On the other hand, the isolation of the group from short-term pressures appeared to be a factor in maintaining continuity, focus, and relatively high-quality research. There were relatively few disruptions of the kind that can be seriously distracting to research productivity.

Strengths

1. The research staff was young, composed of good research people, operates in an environment that is productive to research, enjoys effective leadership, and was small enough for good interaction while large enough to work efficiently and effectively for research programs.
2. The morale of the group was good, and the quality of work was high.
3. Proximity to the Navy Fleet Numerical Weather Center and the cooperation with that group was a valuable asset in terms of data availability and computer facilities.
4. The group provided significant research of aid to both NOAA and university programs.

Weakness

1. The ideas and products of the PEG, with some notable exceptions, were not being effectively exploited by other NMFS programs.

Recommendation

1. Review and strengthen the interactions between PEG and other NMFS groups in terms of the use of PEG research.

APPENDIX A

November 14, 1974

Dr. Robert W. Morse
Chairman, Ocean Affairs Board
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D. C. 20418

Dear Bob:

I have instituted a policy of periodic independent peer reviews of the National Oceanic and Atmospheric Administration's R&D programs in order to provide authoritative assurance of their scientific and technological quality. A triennial cycle of evaluations should be sufficient for our three main program areas: nonfishery oceanic R&D, fishery R&D, and atmospheric R&D. I plan to begin the cycle this year with the evaluation of the nonfishery oceanic R&D, to be completed by June 1975. Because of its professional preeminence, the Academy clearly is our first choice to conduct this year's review of nonfishery oceanic R&D, and I should appreciate your consideration of this possibility. I would like to have a joint Ocean Affairs Board and Marine Board review of our activities.

The specific program areas which require attention in a review of our nonfishery oceanic R&D involve the oceanographic activities at our Atlantic Oceanographic and Meteorological Laboratories in Miami, the Pacific Marine Environmental Laboratory in Seattle and Honolulu and the recently established Great Lakes Environmental Research Laboratory in Ann Arbor. In addition, in the Washington area are our satellite oceanography, marine technology (buoys, engineering development and charting systems development), marine predictive research (storm surge, air-sea interaction and coastal erosion) and GATE oceanography programs. We now have peer reviews and formal advisory committee reviews of our Sea Grant and Marine Ecosystems Analysis (MESA) programs so that it would not be necessary to include these programs.

If the Ocean Affairs Board were to undertake this review, the specific mechanisms would of course be at your discretion; but it is not my intention to require a program-by-program, scientist-by-scientist evaluation. Rather, I am interested and need a straight forward evaluation of the quality, vitality and health of the research and development being conducted by NOAA, particularly in comparison with the rest of the ocean science community. As for the responsiveness of our research

to meet NOAA and National needs, I look to other groups such as NACOA and our Marine Fisheries Advisory Committee for these assessments rather than from a review of the type we are requesting.

I would be pleased to have Don Martineau and others of our staff meet with you and discuss in more detail the types of programs we have, and the mode in which you would propose to conduct such a review. Any comments you or the Board may offer concerning this evaluation would be most appreciated.

Sincerely yours,

[signed]
ROBERT M. WHITE, Administrator
National Oceanic and Atmospheric Administration

cc:
Dr. Morse at Woods Hole
Mr. Vetter - OAB

APPENDIX B

NRC Review of NOAA Oceanic R&D
Purpose and Procedures

PURPOSE

The National Oceanic and Atmospheric Administration has instituted a policy of periodic, independent peer reviews of their research and development program in order to provide authoritative assurance of their scientific and technological quality. NOAA wishes to begin this year with a review, carried out in parallel, of non-fishery oceanic R&D and fishery R&D. The Ocean Science Committee of the Ocean Affairs Board, with the cooperation of the Marine Board, will organize the review.

NOAA has asked for a straight-forward evaluation of the quality, vitality, and health of the research and development being conducted by NOAA, particularly in comparison with the rest of the ocean science community. This will not require a program-by-program, scientist-by-scientist evaluation. Furthermore, the question of the responsiveness of NOAA research to meet NOAA, and national needs, will be assessed by other groups.

The National Research Council proposal to carry this study out stated that:

> "The Ocean Science Committee will, in cooperation with the Marine Board, organize a small group of individuals to conduct in-depth reviews of NOAA Fishery and Non-fishery oceanic research and development programs. The objective of these reviews will be to prepare an evaluation of the vitality, health, and quality of these programs. Because a number of technical and advisory committees periodically review NOAA's mission-oriented programs, the proposed reviews will not specifically address such programs. However, the general quality of research under way at laboratories conducting mission-oriented programs will be assessed and the review teams will consider all matters that affect the quality and effectiveness of NOAA oceanic research.
>
> "The evaluation of fishery and non-fishery oceanic research and development programs will include, but not be limited to, the following:
>
> 1. An assessment of the relative quality of research and development with respect to the scientific and engineering state of the art,
> 2. An assessment of the strengths and weaknesses of each area,

3. An assessment of the likelihood that research and development efforts will achieve the objectives; and of the adequacy of resources to properly support the effort toward the objective, and
4. An assessment of the adequacy of communications between NOAA scientists and engineers and others conducting similar or related research and development activities."

THE STEERING COMMITTEE

A Steering Committee has been set up to plan, guide, and present the final report of this study. The members of this committee are:

Ferris Webster (Chairman)
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

M. Grant Gross
Chesapeake Bay Institute
The Johns Hopkins University
Baltimore, Maryland 21218

John V. Byrne
Dean, School of Oceanography
Oregon State University
Corvallis, Oregon 97331

J. L. McHugh
South Campus, J-141
Marine Sciences Research Center
State University of New York
Stony Brook, New York 11794

Foster Middleton
Department of Ocean Engineering
University of Rhode Island
Kingston, Rhode Island 02881

Richard C. Vetter (Steering Committee Staff)
Executive Secretary, Ocean Affairs Board
National Academy of Sciences
National Research Council
2101 Constitution Avenue
Washington, D.C. 20418

SITE REVIEW TEAMS

The Steering Committee will establish site review teams to evaluate and prepare a report on the research and development program in each of the NOAA Oceanic R&D Centers. The members of each site review team will be chosen to cover the variety of expertise required to review the research and development programs at each center. Each site review team will have a chairman chosen in advance by the Steering Committee.

The site review team members are evaluators and not inspectors. As evaluators they will study and evaluate the quality and effectiveness of the oceanic research and development at the laboratory in the light of its purpose and objectives. They will use information obtained from both interviews and documents. Throughout their visit, the review team will keep in mind that it has a responsibility for assisting the laboratory in its growth and development as a component of NOAA.

SCOPE OF THE STUDY

The non-fishery oceanic R&D review will involve oceanic activities at the Atlantic Oceanographic and Meteorological Laboratories in Miami, the Pacific Marine Environmental Laboratory in Seattle, and Honolulu, the recently established Great Lakes Environmental Research Laboratory in Ann Arbor, and the National Data Buoy Office in Bay St. Louis. In the Washington area, work is being carried out on satellite oceanography, marine technology, marine predictive research, and GATE oceanography programs. NOAA now has peer reviews and formal advisory committee reviews of their Sea Grant and Marine Ecosystems Analysis (MESA) programs so that it is not necessary for these to be included in this study. However, any R&D being done on these programs at NOAA labs visited will be reviewed.

The fishery R&D program involves activities at 19 separate laboratories and facilities. In order to carry out the review within the time required, site review teams will be established to review the major centers only, at Woods Hole, Sandy Hook, Beaufort, Miami, Galveston, La Jolla, and Seattle. Other laboratories which are under the administrative direction of the above-named centers will be combined with the centers to which they report. All laboratories, ultimately, will be visited by at least one member of the Steering Committee, possibly with other individuals chosen for their appropriateness to help in the review.

ADVANCE PREPARATIONS

The dates for each site-review visit will be arranged by the Steering Committee in consultation with the laboratory director. In cases where a single director does not represent all activities at one site, NOAA will identify a single, authoritative contact person. The chairman of the site-review team will make arrangements with the

laboratory director for the visit. This will include insuring that facilities are available and drawing up a draft schedule for the visit. The visit may normally include a dinner meeting with the director and research heads and another dinner meeting with the staff members carrying out the research and development work at which the directors and laboratory heads are not present. The intention of both of these dinners is to insure that there are adequate informal means of communication between the members of the site review team and laboratory staff. The site review team will insure that the review of the R&D programs is carried out with as many visits to working laboratories as is possible. It is the policy of the Steering Committee that there be the maximum number of opportunities for NOAA staff to present their views to site review committees privately and in confidence.

Members of the site review team will receive descriptions of research activities, lists of publications, background on staff scientists and engineers, and other material prior to the visit. Supplementary material will be available at the laboratory for review team use. Before arriving at the laboratory, each member of the team should read the information that has been received. Special attention should be given to specific assignments made in advance by the chairman of the site review team.

Before the visit, each member of the site review team will receive memoranda concerning the schedule of the visit, transporation, time of the initial and final meetings, and a listing of the committee personnel. Each team member will make his own travel arrangements. The NRC will reimburse review team members for travel and living expenses.

SITE REVIEW PROCEDURES

The review team should begin its "formal" review with a brief meeting during which the chairman will present an outline of activities for the entire visit. There should be a brief conference of the site review team with the director of the laboratory. During the period of the visit, the team will usually split up to cover the research areas of the laboratory. Near the conclusion of the site visit, the team will meet to review its separate findings and agree upon the various recommendations. At that time, the team will consider the drafts of various sections of their report prepared by individual members, so that their report in rough form can be approved by all members of the team while they are still at the laboratory.

The site review team will have an informal discussion with the laboratory director at the end of the visit. The director is free to include other key personnel from the laboratory if he wishes. The main findings, which may be incorporated in the report of the team, and other observations, will be discussed.

REPORTS

Before the review team leaves the site, each member must provide the team chairman with a rough draft of his part of the report. A rough draft constitutes a nearly-completed report and is not just a series of notes. The draft should have attached to it the name of each person interviewed.

The chairman will prepare the full site review report either before leaving the site or soon after return to his own institution. The chairman will edit and possibly rewrite the report to assure a consistency of presentation. He may circulate the final draft among the site review members by mail if their review is desired, but the draft need not be sent to the NOAA laboratory for review.

The report of the review team, in final form, should be submitted to the chairman of the Steering Committee within one month following the site visit. The report for each laboratory will be reviewed by the Steering Committee and incorporated into the full report.

The Steering Committee will prepare the full report on the overall evaluation of oceanic research and development in NOAA. In addition to the section reporting the findings at each laboratory, the report will also incorporate findings from interviews with key NOAA administrative personnel. It will be the intent of this report to provide a broad perspective on the health, vitality, and future prospects for NOAA R&D. It is intended to serve as a basis for constructive changes in NOAA's Oceanic R&D Programs. This report will be submitted, after National Academy of Sciences review, to the NOAA Administrator.

APPENDIX C

Participants
NOAA Ocean Research and Development Review

Steering Committee

CHAIRMAN: Dr. Ferris Webster
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Woods Hole, Massachusetts

Dr. John V. Byrne
School of Oceanography
Oregon State University

Dr. M. Grant Gross
Chesapeake Bay Institute
The Johns Hopkins University
Baltimore, Maryland

Dr. J. L. McHugh
Marine Sciences Research Center
State University of New York

Dr. Foster H. Middleton
Department of Ocean Engineering
University of Rhode Island

SECRETARY: Mr. Richard C. Vetter
Ocean Sciences Board
National Research Council
Washington, D.C.

Other Reviewers

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La Jolla, California

Mr. Henri Berteaux
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts

Dr. Gordon Broadhead
Living Marine Resources, Inc.
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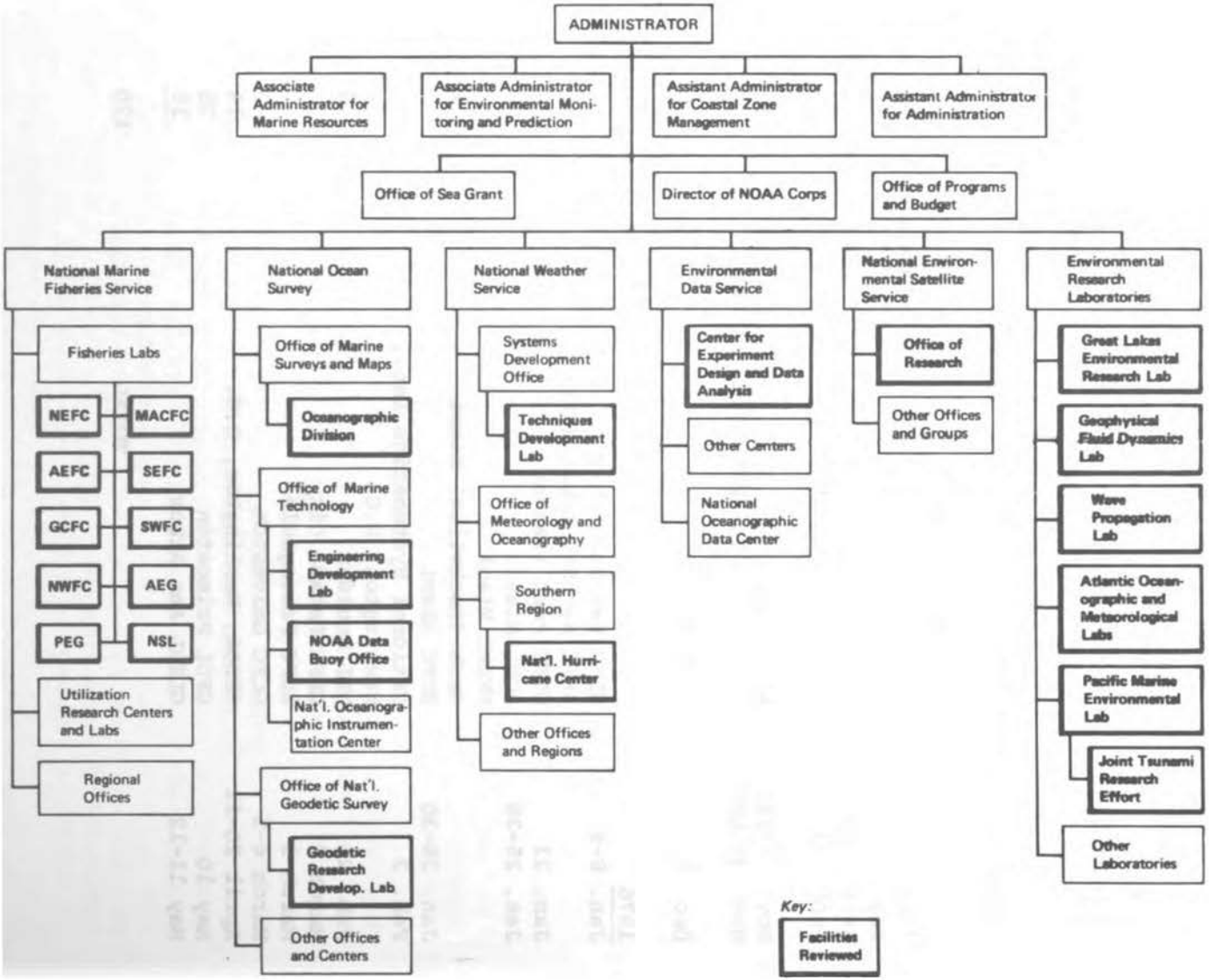
Cornell University
Ithaca, New York

APPENDIX D

Dates, Locations, and Approximate Numbers of Individuals Interviewed

Date	Location	ERL's and Technical Labs.	NMFS Labs.
1975			
May 28-30	OR/NESS Suitland	7	
	TDL/NWS Silver Spring	4	
	OD/NOS Rockville	4	
	EDL/NOS Rockville		6
June 22-25	NEFC Woods Hole		35
	NEFC Narragansett		10
	AEG Narragansett		5
July 13-16	MACFC, Sandy Hook, Milford and Oxford		20
Aug. 12	PEG Monterey		6
Sept. 28-Oct. 1	PMEL Seattle	22	
Sept. 29-Oct. 3	NWFC Seattle (45), Auke Bay (13), Kodiak (4)		62
Nov. 17-18	AEFC Beaufort		29
Nov. 30-Dec. 4	SWFC La Jolla (27), Tiburon (8), Honolulu (13)		48
Dec. 5	JTRE Honolulu	11	
1976			
Jan. 8-9	NDBO Bay St. Louis	11	
	SEFC Bay St. Louis (FEL)		12
Jan. 23	GCFC Port Aransas		3
Jan. 25-28	AOML Miami	40	
	NHEML Miami	2	
	GRDL (Rockville) Miami	1	
Jan. 28-30	SEFC Miami		31
Feb. 2	National Systematics Lab., Washington, D.C.		4
Feb. 26	WPL Boulder	6	
March 2	GEFC Panama City		7
March 2	SEFC Pascagoula		8
March 4-5	GCFC Galveston		17
April 20-21	CEDDA, Washington, D.C.	14	
May 10	GFDL Princeton	26	
May 11-12	GLERL Ann Arbor	16	
	TOTAL	170	297

The Organization of Research and Development in NOAA (1975-1976)



APPENDIX F

ABBREVIATIONS USED

AEFC	Atlantic Estuarine Fisheries Center (of NMFS/NOAA), Beaufort, North Carolina
AEG	Atlantic Environmental Group (of NMFS/NOAA), Narragansett, Rhode Island
AOML	Atlantic Oceanographic and Meteorological Laboratories (of ERL/NOAA), Miami, Florida
BOSS	Base Operation Support Services (at PMEL)
CEDDA	Center for Experimental Design and Data Analysis (of EDS/NOAA), Washington, D.C.
DOMES	Deep Ocean Mining Environmental Studies (at PMEL)
EDL	Engineering Development Laboratory (of NOS/NOAA), Rockville, Maryland
EPA	Environmental Protection Agency
ERL	Environmental Research Laboratories (of NOAA)
FDMS	Fishery Data and Management Systems Division (at NWFC)
FEL	Fisheries Engineering Laboratory (of SEFC), Bay St. Louis, Mississippi
GARP	Global Atmospheric Research Program
GATE	GARP Atlantic Tropical Experiment
GCFC	Gulf Coastal Fisheries Center (of NMFS/NOAA), Galveston, Texas
GFDL	Geophysical Fluid Dynamics Laboratory (of ERL/NOAA), Princeton, New Jersey
GLERL	Great Lakes Environmental Research Laboratory (of ERL/NOAA)
GRDL	Geodetic Research and Development Laboratory (of NOS/NOAA)
ICNAF	International Commission for the Northwest Atlantic Fisheries
IFYGL	International Field Year for the Great Lakes
JTRE	Joint Tsunami Research Effort (of PMEL), Honolulu, Hawaii
MACFC	Middle Atlantic Coastal Fisheries Center (of NMFS/NOAA), Sandy Hook, New Jersey
MARMAP	Marine Resources Monitoring, Assessment, and Prediction (a NOAA program)
MARLAGS	Marine Life and Geochemical Studies (at PMEL)
MASS	Modeling and Simulation Studies (at PMEL)
MESA	Marine Environmental Systems Analysis (a NOAA project)
MGGL	Marine Geology and Geophysics Laboratory (of AOML)
NDBO	NOAA Data Buoy Office (of NOS/NOAA), Bay St. Louis, Mississippi
NEFC	Northeast Fisheries Center (of NMFS/NOAA), Woods Hole, Massachusetts
NESS	National Environmental Satellite Service (of NOAA)

NMFS	National Marine Fisheries Service (of NOAA)
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey (of NOAA)
NRC	National Research Council
NSL	National Systematics Laboratory (of NMFS/NOAA), Washington, D.C.
NWFC	Northwest Fisheries Center (of NMFS/NOAA), Seattle, Washington
NWS	National Weather Service (of NOAA)
OAB	Ocean Affairs Board (of NRC)
OARS	Ocean-Atmosphere Remote Studies (at PMEL)
OD	Oceanographic Division (of NOS/NOAA), Rockville, Maryland
OR	Office of Research (of NESS/NOAA), Suitland, Maryland
ORSL	Ocean Remote Sensing Laboratory (at AOML)
PEG	Pacific Environmental Group (of NMFS/NOAA), Monterey, California
PhOL	Physical Oceanography Laboratory (at AOML)
PMEL	Pacific Marine Environmental Laboratory (of ERL/NOAA), Seattle, Washington
R&D	Research and development
RSMAS	Rosenstiel School of Marine and Atmospheric Science, University of Miami
SAIL	Sea-Air Interaction Laboratory (at AOML)
SCENE	Studies of Coastal and Estuarine Natural Environments (at PMEL)
SEFC	Southeast Fisheries Center (of NMFS/NOAA), Miami, Florida
SWFC	Southwest Fisheries Center (of NMFS/NOAA), La Jolla, California
TDL	Techniques Development Laboratory (of NWS/NOAA), Silver Spring, Maryland
USCG	United States Coast Guard
WPL	Wave Propagation Laboratory (of ERL/NOAA), Boulder, Colorado