Requirements Identification for the NOAA Center for Ocean Analysis and Prediction

Volume 1
Study Results

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1.0 INTRODUCTION

1.1 Purpose of the Study

NOAA is facing a number of critical environmental issues such as marine pollution, fisheries depletion, and global climate change. To address these and other issues of importance, NOAA is establishing a NOAA Center for Ocean Analysis and Prediction (COAP) in Monterey, California. The COAP will build upon the work now being carried out by two groups that are co-located in Monterey: the Pacific Fisheries Environmental Group (PFEG) and the Ocean Applications Group (OAG). This Center will address problems related to fisheries productivity, coastal pollution, ocean climate variability, and marine habitat monitoring. The COAP will not unnecessarily duplicate the functions of established centers. It will only overlap the work of others to the extent that collaborative projects are identified or a common function supports different goals/products, or there exists a different approach of merit to address a problem. The Center will augment the existing ocean service and product portfolio and modify/develop products to meet the needs of the COAP user community.

It is not intended that "services and products" be defined in a narrow sense, e.g., "off-the-shelf commodities." The vision for the Center includes both operational and research components with strong linkages between the two. The linkages would ensure that users of the Center's services/products would have their needs communicated to the researchers/developers, and experts would be available to support and interpret products for users interacting with the operational unit of the Center.

The goals of the Center as described in its Mission Statement have a natural foundation in NOAA's Climate and Global Change Program, and Coastal Ocean and Data Management Initiatives. Separate from any political or fiscal consideration, the formation of the Center is timely from a technical perspective.

The expressed purpose of this study was to identify the user constituency of the COAP and to document their requirements for support from this Center. The ultimate constituency for the Center are those individuals and groups, both within and outside NOAA, who can utilize the research and research-derived operational products of the Center. The main thrust of this study was a clarification of what the core programs of the Center should be. Because the proposed agenda for the Center is broad-based and not precisely defined, it was difficult for respondents to be very specific in their recommendations without their knowing more about the development plan for the Center. The respondents were able to address, in general terms, in which areas the Center should focus its attention.

This survey undertook two primary tasks: 1) the identification of those services and products that are currently offered by some of the Line Organizations (LOs) within NOAA and relate to COAP's mission, and 2) the respondents' opinions about what the core program of the COAP should be. This survey represents one element in a broad effort to define the functions of the Center.

1.2 Methodology

The list of potential users of the Center's services/products encompasses both the public and private commercial sectors. The public sector includes government and university scientific entities that are engaged in physical, biological, chemical and fisheries assessments of the ocean and coastal environments. The private sector is composed of many groups such as the 1) offshore oil and gas industry, 2) marine transportation, 3) fishing, 4) geophysical survey industry, 5) coastal and ocean engineering, 6) port and harbor authorities, 7) power plants, and 8) value-added industry (e.g., ocean-routing). This survey principally addresses the opinions of a cross section of the public sector. With time, as the Center responds to the needs of the government and university communities, "spin-offs" to the private sector will likely occur.

The survey was conducted through personal and telephone interviews. The use of a questionnaire that would be sent through the mail was initially considered but was discounted for several reasons. For the type of respondent identified for this study, a questionnaire was considered to be only marginally effective since questionnaires are often viewed as intrusive and a waste of a respondent's time. In addition, the questionnaire would have to be tailored to the individual or a specific group in order for it to be effective. Since the specific plan of action is still evolving for the Center, and not many people are aware of the Center's concept and goals at this time the use of a detailed questionnaire was judged to be inappropriate for this study. Therefore, it was decided to concentrate study resources on making personal contacts.

Interviews were conducted from the first part of April to the beginning of June 1989. Our goal was to interview a representative cross section of the scientific community within and outside NOAA, including researchers, data processors, and technical managers. Either telephone or personal interviews were conducted with individuals associated with:

Ocean Products Center (OPC)
Joint Ice Center (JIC)
Climate Analysis Center (CAC)
National Oceanographic Data Center (NODC)
Information Processing Division of the National Environmental Satellite, Data and Information Service (NESDIS)
Satellite Services Division of NESDIS
Pacific Marine Environmental Laboratory (PMEL)
Atlantic Oceanographic and Meteorological Laboratory (AOML)
National Marine Fisheries Service (NMFS) - headquarters
Northeast Region - Narragansett Laboratory (NMFS)
Southwest Fisheries Center in La Jolla (NMFS)
Alaska Fisheries Center in Seattle (NMFS)
Southeast Region - Beaufort, N.C., Laboratory (NMFS)
Southeast Region - Bay St. Louis, MS, Laboratory (NMFS)
Pacific Fisheries Environmental Group - Monterey (NMFS)
Office of Oceanography & Marine Assessment/Ocean Assessments Division (NOS)

Ocean Applications Group - Monterey (NOS)
Hopkins Marine Laboratory - Monterey
Monterey Bay Aquarium Research Institute - Monterey
Moss Landing Marine Laboratories - Monterey Bay
National Science Foundation (NSF)
Environmental Protection Agency (EPA)
Minerals Management Service (MMS)
U.S. Navy - Institute of Naval Oceanography
Various Universities/Research Institutes

The objective of these interviews was to sample the diversity of opinion that exists and to do it with a sufficient number of interviews that any consensus that developed would have some legitimacy. We recognize that, because of the limited nature of this study, it is likely that we will not be able to uncover all of the information relevant to the operation of the Center and that some individuals that should be interviewed will not be included. Therefore, this report is not intended to be a definitive treatise on the COAP but rather a first step toward identifying its proper role in the scientific community. It is expected that this report will be reviewed, critiqued, and modified as time passes and more information is collected.

Section 2.0 of this report is a brief overview of the operations at the PFEG and OAG in Monterey. Section 3.0 contains the Mission Statement for the COAP. Section 4.0 is a summary of the types of data, technical services and research activities in which selected NOAA Line Organizations are engaged. Section 5.0 is a synthesis of the results of the individual interviews. Individual interview summaries are contained in a separate document. In Section 6.0, a set of recommendations by our project team is presented.

2.0 PACIFIC FISHERIES ENVIRONMENTAL GROUP (PFEG) AND OCEAN APPLICATIONS GROUP (OAG)

This section presents a brief overview of the activities in which the PFEG and the OAG are currently engaged.

2.1 Pacific Fisheries Environmental Group

PFEG is a laboratory of the Southwest Fisheries Regional Center. As such, it has developed a mutually beneficial relationship with that Center that facilitates the two-way flow of information. A key objective of the laboratory is to originate ways for incorporating information on natural environmental and biological variability in fisheries considerations, i.e., the natural variability that controls the population dynamics of fishery resource populations. The group is fisheries-oriented (for which data are available) rather than nutrient-oriented (for which the data are poor).

There are presently ten technical personnel, mostly full-time, spread among four main sub-groups: Fishery/Environmental Linkages which includes Fishery Data Base Management; Physical Oceanography; Biological Oceanography; and Mathematical Modeling and Data Analysis. Principal research areas include: (1) development of environmental index time series, (2) diagnostic studies of marine environmental anomalies, e.g., El Niño, (3) identification of environmental-biological causal linkages, e.g., interregional comparative studies, (4) development of environment-dependent fishery modeling methodology, and (5) development of appropriate biological time series for calibration and verification.

Current and projected work includes: (1) production of environmental index series for the California Current and other ecosystems, (2) development of surface and subsurface temperature time series for the California Current ecosystem analyses, (3) time series analysis of fisheries and population dynamics of fishes in the demersal and littoral complexes, (4) cooperative (with California Fish & Game) California pelagic fishery data base update and analysis, (5) cooperative identification and interregional comparative evaluation of empirical environment/recruitment models, and (6) completion of development and evaluation of environment - dependent albacore fishery forecast model.

The results of these research endeavors include research papers, technical reports, standard data products (Ekman transports, upwelling indices), specialized data products/analyses and interpretive services.

The clientele for PFEG's research and products are NMFS fisheries research projects, various NOAA laboratories, fishery councils, federal and state regulatory agencies and other federal, state and university research projects.

2.2 Ocean Applications Group

OAG is part of NOS under the Office of Ocean Services. Both PFEG and OAG are co-located with the Navy's Fleet Numerical Oceanography Command

(FNOC). OAG has drawn upon the considerable data resources of FNOC to support product development and analysis guidance for both the government and private industry. There are presently seven technical staff at OAG.

Routine products that are generated include: (1) sea-level pressure and surface, marine wind fields every three hours; (2) selective FNOC products, e.g., weekly collection of quality-controlled bathythermograph soundings, transferred to the OAG system for subsequent access by subscribers (the Civilian Navy/NOAA Ocean Data Distribution System - CNODDS); (3) specialized FNOC data such as GEOSAT wind speeds, significant wave height along a daily orbit and Digital Ice Forecast and Analysis System (DIFAS) products.

Climate-related products taken from FNOC are: (1) weekly Northern Hemisphere 7-day mean fields of sea surface temperature and ocean thermal heat content expressed as anomalies from the seasonal mean; (2) weekly integrations of Northern Hemisphere sea level pressure rise and fall due to cyclones and anti-cyclones; (3) weekly mean fields of Northern Hemisphere 500-mb large-scale (planetary) circulation features and patterns; (4) on a monthly basis, the orbits of the planetary-vortex circulation center, Northern and Southern Hemisphere; (5) on an annual basis, updates of cross-equator mass transfers.

Specialized product quality assessments in connection with numerical weather prediction model performance presently include: (1) monthly and ad hoc verification scores of 48-hour prognostics based on measures of synoptic similarity for FNOC, NMC, and ECMWF models (diagnostics on strengths, weaknesses and biases; reliabilities; how to systematically improve the models); (2) evaluations of comparative wind fields (diagnostics of bivariate samples of measured winds versus winds extracted from product fields).

Some archived historical sequences are: (1) thirty-five years of six-hourly sea level pressure retrospectively analyzed, for the Northern Hemisphere; (2) thirty-five years of five-day window sea surface temperature retrospectively analyzed, with global arctic-to-antarctic circle coverage; (3) the ocean thermal structure distribution defined by 26 parameters from the surface to the 400-meter depth (various regions of the globe; various grid resolutions; various time spans and as frequent as once daily).

Some future service/product developments are: (1) enhanced marine/surface wind field products (marine wind indices including fields of wind stress, and turbulent wave-action mixing; the curl of the wind stress for open-ocean and coastal upwelling; wind fields to drive ocean-wave, surge, and circulation models); (2) enhanced ocean thermal structure products, e.g., the topography of the 14-degree-C-temperature depth, satellite-derived sea surface temperature in marginal ice zones; (3) CNODDS expansion for collecting ad hoc physical oceanographic observations in near real-time, for hauling and use by all contributing field projects/programs and by other agencies; (4) graphics/animation of historical parameter-field sequences for studying weather and climate evolutions.

Periodic review of the atmospheric products of the Center, in consultation with the Climate Analysis Center and other relevant groups, would be appropriate.

It should be also noted that there is currently one NESDIS person at the COAP who assists in the quality control of oceanographic data.

3.0 MISSION STATEMENT FOR COAP

The Mission Statement, a copy of which was obtained from the NOS Office of Ocean Services, is presented below and is followed by some summary remarks.

3.1 The Mission Statement

MISSION - TO BE A NATIONAL NOAA CENTER FOR THE DEVELOPMENT, EXCHANGE, INTEGRATION, AND DISSEMINATION TO GOVERNMENTS, INDUSTRY, AND ACADEMIA OF BIOLOGICAL, CHEMICAL, AND PHYSICAL OCEANOGRAPHIC PRODUCTS AND SERVICES FOR EFFECTIVE MANAGEMENT OF LIVING MARINE RESOURCES. IN ADDITION, THE CENTER WILL PERFORM SELECTED TASKS IN SUPPORT OF CLIMATIC AND GLOBAL CHANGE, AND COASTAL OCEAN PROGRAMS.

NOAA must address critical environmental challenges facing this nation and the world over the next decade and beyond. These include interannual, decadal, and longer climatic variation and global change, as well as short-term regional variations and their impact on the quality and productivity of the U.S. coastal and the global ocean environments.

To help meet this challenge, NOAA has established COAP in Monterey, California.

The Center builds upon existing NOAA and other institution capabilities already located in Monterey and complements activities being carried out in other NOAA Centers. Through a national communications network and the collocation of representatives from all NOAA elements, the Center will take advantage of real-time and delayed real-time data and information.

Its particular focus will be to develop and disseminate a unique series of environmental and living marine resource analyses, forecasts, and assessments that describe and predict the condition and variability of biological, chemical, and physical oceanic phenomena as well as the processes affecting them. The Center will also provide and/or facilitate access to existing information which has been or is being produced by other parts of NOAA or Federal/state/academic institutions that provide information concerning living marine resources, habitat, coastal zone management, offshore dumping and pollution, and ocean climate processes.

To develop capabilities for all decision-makers, the Center will focus on the following tasks:

(1) assisting in the development of formats and protocols for the routine exchange of chemical, biological, and physical oceanographic data, utilizing international standards where they exist;

(2) ensuring the timely quality control of chemical, biological, and physical oceanographic data;

(3) exploiting outputs of state-of-the-art interactive analysis and numerical modeling capabilities for global, regional, and local ocean processes;

(4) providing two-way access to high-priority oceanic information and products;

(5) performing a continuous review of requirements for new products/information sets;

(6) providing interpretative services to support Federal, state, and local operations;

(7) providing data assimilation, processing, analysis, and graphic display systems to handle ocean environmental data and information, and to disseminate products and services to NOAA and other users;

(8) collaborating in regional, national, and international scientific programs to define key environmental-biological linkages; and

(9) making integral ties to existing/planned NOAA initiatives relevant to global change, the coastal ocean, and information management to promote a "total ecosystem" view.

3.2 Some Remarks on the Mission Statement

The core program of the Center addresses the spatial and temporal variability of the oceans and marine environment with attention to special aspects of the Coastal Ocean and Global Change Programs. Variability may arise from either natural or anthropogenic causes. Depending on the stage of development of a fish, there are varying degrees of influence exerted on the fish by the physical, dynamic, chemical and biological properties of the host water mass. Therefore, increasing our understanding of fisheries and improving fisheries resource management requires a multi-disciplinary approach. Information on climate and ocean circulation on various time scales is a cornerstone of this effort. On a long time scale, the study of fisheries also provides an independent means for uncovering information about oceanic and atmospheric climatology over hundreds or thousands of years.

This mission places the Center within a growing mainstream movement that recognizes the importance of the linkages between the biology and the physics of the ocean. An example of this movement is the proposed major research program GLOBEC (Global Ecosystem Dynamics) which has the goal of understanding the association between physical processes and ecosystem dynamics so that the predictability of population fluctuations can be put in the context of global change.

4.0 DATA/SERVICES/RESEARCH PROVIDED BY SELECTED NOAA LINE ORGANIZATIONS

An overview of the types of products, services, and scientific activities that are ongoing in a selected set of NOAA organizations is provided here. Although this description does not cover all of NOAA's activities, it is presented to provide a benchmark against which the proposed activities at COAP can be compared. No interviews were conducted with, for example, NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) or the Great Lakes Environmental Research Laboratory (GLERL). GFDL has been a world-renowned research institution for numerical weather and climate predictions, with pioneering work in ocean modeling. It is currently engaged in ocean-atmosphere coupled-system experiments for climate simulation studies. GLERL is also an internationally known, interdisciplinary research institution for environmental sciences in the Great Lakes region. A detailed description of the activities of these research institutions is not included as part of this document.

4.1 Ocean Products Center (OPC)

The OPC opened in 1985 with a directive to develop and disseminate marine meteorological and oceanographic guidance products to NOAA field forecast offices and the civil sector for warning and forecast purposes. The products are issued in near real-time based on marine forecast models that are designed to improve weather prediction and that address time scales of 0-72 hours. The proposed activities for the COAP encompass marine environmental forecasts on longer time scales. Organizations participating at the OPC include the National Weather Service (NWS), the National Ocean Service (NOS), the National Environmental Satellite, Data, and Information Service (NESDIS) and the NOAA Corps (NC). The OPC is co-located with the National Meteorological Center (NMC) of NWS at the World Weather Building, Camp Springs, Maryland. The proximity to NMC facilitates the use of NMC databases, meteorological model outputs and communication networks.

The OPC is comprised of two divisions: (1) Operations (the Ocean Products Division - OPD) within the NOS Office of Ocean Services, and (2) Development, within the NWS.

Mr. Richard Barazotto is the Chief of the OPD. The OPD uses a system called the Combined Oceanographic and Marine Product Analysis and Scheduling System (COMPASS) that is a combination of software, hardware, and communications equipment to acquire and present surface and subsurface marine observations and numerical model predictions for subsequent Quality Control (QC) and delivery to various centers. For example, model output is received from the NMC Central Computer Facility, then interactively quality controlled by meteorologists and returned to the NMC. COMPASS also provides automatic exchange of data products between the Joint Ice Center (JIC) and Fleet Numerical Oceanography Command (FNOC). Observations are obtained from and sent to the Global Telecommunications System (GTS). Integrated data networking allows rapid acquisition of raw data and turnaround of quality controlled data. There is also access to NASA's Space Physics Applications Network (SPAN) which is connected to NSF Net which, in turn, permits OPD/OPC

to exchange data sets with universities and government researchers in near real-time.

Marine surface and subsurface observations from ships, buoys, and C-MANS are checked by QUIPS (Quality Improvement and Performance System). Observations that deviate too much from analyses/forecasts derived from an NMC first guess field are flagged for further inspection by meteorologists. Currently, surface pressure and surface and subsurface temperatures are checked using QUIPS. This service will be expanded in the future to include a full suite of parameters (air temperature, waves, boundary layer winds, water levels).

There is an ongoing contract to monitor the operational QC process and determine the feasibility of installing an Artificial Intelligence (AI) QC system. The benefits of this type of QC activity are several: (1) improved output from NOAA's oceanic and atmospheric prediction models, (2) the creation of a "clean" data set for archival and research applications, (3) real-time availability of a quality controlled data set for satellite calibration, and (4) informational feedback for repair of ocean data collection platforms upon identification of malfunctions through the QC process.

Recently introduced or updated products include: (1) the Ocean Features Analysis, (2) the Marine Significant Weather Chart, and (3) the Computer-Worded High Seas Forecast. The Features Analysis is generated for the northeast U.S. Atlantic coast showing the Gulf Stream from Cape Hatteras, North Carolina to the Grand Banks of Newfoundland, with updates three times each week; and for the southeast U.S. Atlantic Coast showing the Loop Current and the Gulf Stream from the Yucatan Peninsula to Cape Hatteras, with updates twice each week. Features depicted include SST, Gulf Stream location, warm and cold core eddies, frontal location, shelf water, and slope water. These charts, which are analyzed subjectively, are now being generated in a test mode on a personal computer using satellite measured SST fields. The ultimate objective is a computerized system, including Quality Control, for the charts.

The Significant Marine Weather Chart depicts hazardous ocean areas. The output from several OPC numerical forecast models is used to show areas of high wind (greater than 25 kts), high seas (greater than 8 ft), ice accretion, fog, and restricted visibility (less than 3 nm), and ice edge. The Computer-Worded High Seas Forecasts are computer-generated forecasts whereby a worded forecast (text) is automatically created from a matrix of environmental parameters extracted from the NWS forecast models, e.g., type of weather system, central pressure, storm movement, maximum wind speed, and maximum wave height.

The OPC has additional responsibilities in connection with the designation of the NMC as a World Oceanographic Data Center and a Specialized Oceanographic Center by IGOSS. Its normal activities of receipt, quality control, archival, and transmission of data sets are carried out for subsurface temperature and salinity data collected by Voluntary Observing

Ships, ships of opportunity, naval vessels, aircraft (AXBT), and research ships.

The "Oceanographic Monthly Summary," distributes monthly summaries of ocean-surface properties. Included are contoured monthly mean SST and SST anomaly charts on a global and regional basis, descriptions of the movement and features of the Gulf Stream and Loop Current and West Coast circulation, and sea/ice conditions for the Bering Sea and North Slope area.

On the developmental side of the OPC, the Marine Products Branch (Chief: Dr. D.B. Rao) addresses synoptic meteorology/oceanography and has two primary functions: (1) the development of new products as needed, and (2) making these products available for distribution in near real-time (time scale of hours/days). The principal users of these products are the National Weather Service offices. The following broad areas are covered: (1) marine meteorology, (2) ocean thermal structure, (3) ocean waves, and (4) polar seas and Great Lakes ice. This group also generates PC-based programs for local forecast offices for specialized applications.

Examples of products in each of these four categories are daily global ocean surface wind forecasts (with statistically generated forecasts for the coastal winds); various SST analyses with resolution as fine as 14 kilometers provided twice a week; deepwater global and regional spectral wave model forecasts (with a shallow water wave forecast for the Gulf of Mexico); and ice extent on global, regional, and local bases once a week or more often if required. The ice analysis and forecasting activities are primarily conducted through the Navy/NOAA Joint Ice Center which is currently a part of the Naval Polar Oceanography Center.

4.2 Climate Analysis Center (CAC)

Dr. David Rodenhuis is Director of the CAC. The staff at the CAC is responsible for examining atmospheric variability on climatic time scales (climate versus weather). Some effort is directed toward ocean modeling of the equatorial regions. Models generated at GFDL are adopted for CAC's use in this equatorial modeling. Work proceeds in a hindcast mode with interest on time scales of a month or more. Climatology on equatorial dynamics exists for six to seven years.

Data products from this group, which include in-house model output and analyses as well as data supplied by other investigators, are displayed in CAC publications. A "Climate Diagnostics Bulletin" is published in two modes: a near real-time mode monthly and a delayed mode bimonthly. Samples of the types of products, several of which are provided by external sources, that are included in this bulletin are:

(1) tropical drifting buoys from Don Hansen of AOML;

(2) equatorial wind, temperature, and current observations from Paul Freitag and Michael McPhaden of PMEL;

(3) GEOSAT altimeter sea-level analysis from Robert Cheney and Laury Miller of NOS;

(4) Surface Pseudo-Stress Vectors and Anomalies from Jim O'Brien and David Legler, Florida State University;

(5) Sea-level anomalies from Klaus Wyrtki, University of Hawaii;

(6) Surface dynamic height anomalies in the near-equatorial zone; time series of the depth of the 20 degrees Celsius isotherm along the equator from the ocean model of Ants Leetmaa, CAC; and

(7) Other CAC products such as rainfall estimates, hemispheric sea-level pressure and surface temperature.

4.3 Joint Ice Center (JIC)

The Naval component of the JIC is the Naval Polar Ocenography Center currently under the command of Capt. Don Hinsman. Three NOAA line organizations are active in the JIC. NOS is the lead agency providing personnel and resources in advanced computer technology; NWS provides personnel and meteorological data; and NESDIS provides personnel and high resolution satellite imagery. Mr. Frank Kniskern is the senior NOAA representative.

The JIC was formed in 1976 by merging Navy and NOAA assets to provide routine and specialized ice products to the Department of Defense, NWS forecast offices, and the civil weather and marine research sectors. Data sources for the center include satellites (TIROS, DMSP, GEOSAT), drifting buoys, ship reports, shore reports and aerial reconnaissance. Products are provided on a daily to annual basis. Global, regional and local ice analyses with resolution on the order of a few kilometers are available. With the introduction of the Digital Ice Forecasting and Analysis System (DIFAS) manual methods of ice analysis are being upgraded. The system allows for interactive analysis of digital data (multi-band spectral satellite data, NMC fields, FNOC fields) and enhancement of satellite imagery. Capabilities include graphics/imagery overlay, looping, zooming and roaming, and the ability to assimilate 26 sources of data. There is also a climatology database on the system.

4.4 Ocean Assessments Division, Office of Oceanography and Marine Assessment

Dr. Andrew Robertson is Chief of the Ocean Assessments Division. There are three branches and one program office in this division: 1) the Strategic Assessment Branch (SAB), 2) the Coastal & Estuarine Assessment Branch (CEAB), 3) the Hazardous Materials Response Branch (HMRB) in Seattle, and 4) the Alaska Office - Outer Continental Shelf Environmental Assessment Program (OCSEAP).

The SAB conducts interdisciplinary assessments of multiple ocean resource uses for the nation and its major coastal and oceanic regions. The SAB publishes a series of data atlases of physical, chemical, biological, and economic characteristics of the nation's coastal zone and Exclusive Economic Zone.

The CEAB conducts a national program of measurements of toxic compounds in shellfish, bottomfish, and sediments at selected estuarine and coastal locations to determine the status and trends of the levels of these indicators of environmental quality; coordinates a NOAA-wide program of quality assurance for environmental measurements to determine and evaluate confidence levels and enhance inter-regional comparability among data sets; and conducts a program of applied research to assess the consequences to living marine resources of contaminants in marine and estuarine environments.

The HMRB provides and coordinates scientific support to the Federal On-Scene Coordinators under the National Oil and Hazardous Substances Contingency Plan - including environmental characterization, hazard evaluation, and spill trajectory modeling - to minimize environmental and economic damages from spills of oil and other hazardous materials. The Branch also provides technical support to the U.S. Environmental Protection Agency during emergency response and remedial actions at hazardous waste dump sites.

The Alaska Office provides scientific information on marine issues affecting arctic and subarctic regimes. Its major emphasis is on the management of the OCSEAP, a multidisciplinary research program designed to provide environmental information to the Minerals Management Service and to support decisions on the exploitation of oil and gas resources on the outer continental shelf.

Examples of products or services recently generated by each of these groups include: 1) SAB provided EPA with a dataset on living marine resources off the West Coast, with associated Computer Mapping and Analysis System application software, 2) CEAB published a report, based on data collected by in-house personnel as well as by other investigators, evaluating geographic and temporal trends in contaminant concentrations and their biological effects within San Francisco Bay, 3) HMRB provided on-site support and spill trajectory modeling in connection with the 1989 oil spill in Prince William Sound, Gulf of Alaska, and 4) OCSEAP completed a report which describes six years of effort to develop three-dimensional numerical models of water movements in Alaskan waters.

4.5 National Oceanographic Data Center (NODC)

The Director of NODC is Mr. Gregory Withee. NODC archives physical, biological and chemical data with the largest segment by far being physical data. Physical data include buoy wind and waves, currents, ocean station data, subsurface temperatures, salinity/temperature/depth. Biological data include fish/shellfish, benthic/intertidal organisms, marine birds, and plankton. Chemical data can be classified as marine chemistry (oxygen, nitrite, phosphorus, chlorophyll, suspended matter) and pollutants/toxic substances. A complete listing of NODC data holdings is contained in its product catalog.

NODC has become increasingly involved in the planning for the archiving of datasets from international research programs, e.g., WOCE and GOFS. NODC has initiated a NODC Ocean Science Information Exchange (NOSIE) whereby users can use the NASA SPAN network or OMNET to directly access information on NODC data holdings. NODC was part of a joint effort by NOAA's Line Organizations to develop the "Coast Watch" concept. This program involves the routine monitoring of SST imagery and other data to predict the onset of any unusual events in coastal waters, e.g., the outbreak of red tide. A pilot program was conducted for the NMFS Beaufort, North Carolina Lab. An interactive PC-based system allows the satellite data to be transmitted from the Suitland, Maryland computer through the OPC to a PC-AT system at Beaufort. Lab personnel can then perform ground truth measurements after identification of a feature of interest in the satellite imagery. Six to seven images a week are transmitted. This program of near real-time satellite observations will likely be expanded in the future to other regions of the country.

4.6 Pacific Marine Environmental Laboratory (PMEL)

Dr. Eddie Bernard is the Director of the PMEL. The PMEL conducts interdisciplinary scientific research investigations in oceanography, marine meteorology, and related subjects. Current PMEL programs focus on climate, marine observation, marine resources, and marine environmental assessment. Studies are conducted to define the forcing functions and the processes driving ocean circulation and the global climate system; to improve environmental forecasting capabilities for marine commerce and fisheries; and to improve understanding of the physical and geochemical processes that determine the extent of human effects on the marine environment.

Examples of recent work are briefly described here.

In the area of climate, PMEL has conducted ocean circulation model hindcast sensitivity studies of the 1982-1983 El Nino. In support of the TOGA program, PMEL maintains an array of moored sensors in the vicinity of the Pacific equator.

PMEL's Fisheries Oceanography Coordinated Investigations (FOCI) is a joint effort with the Northwest and Alaska Fisheries Center to study recruitment variability of commercially valuable fish and shellfish in the Gulf of Alaska and Bering Sea. This research is aimed at determining (1) what meteorological, oceanographic, and biological conditions are correlated with historical year-class success, (2) whether there are interannual variations in transport that affect larval concentrations, and (3) how small-scale physics, food availability, and predation affect mortality. Analysis of long-term records indicates that seasonal transitions in the Alaska Coastal Current could affect larvae and cause declines in pollock stock in a given year.

A Beaufort Sea Mesoscale Circulation Study has included measurements of currents, winds and ice velocities. The objective is a better understanding of shelf circulation and its forcing. In another study, a laterally averaged hydrodynamic model provided current fields for a preliminary model of the distribution and transport of suspended solids in Puget Sound.

4.7 Atlantic Oceanographic and Meteorological Laboratory (AOML)

Dr. Hugo Bezdek is the Director of the AOML. The mission of NOAA's AOML is to conduct a basic and applied research program in oceanography and tropical meteorology. The program seeks to understand the physical characteristics and processes of the ocean and the atmosphere, both separately and as a coupled system. Oceanographic investigations center on the fluxes of energy, momentum, and materials through the air-sea interface; the transport and composition (thermal and chemical) of water in the ocean volume; and hydrothermal processes of mineralization at seafloor spreading centers. Meteorological research is carried out to improve the description, understanding, and prediction of hurricanes.

The AOML organizational structure features four research divisions, organized according to scientific discipline as follows: (1) Hurricane Research Division (HRD); (2) Physical Oceanography Division (PhOD); (3) Ocean Chemistry Division (OCD); and (4) Ocean Acoustics Division (OAD). Hurricane research and physical oceanography are the major disciplines represented at AOML.

Some of the current research programs underway at the AOML are described below.

As part of TOGA's Equatorial Pacific Ocean Climate Studies, AOML conducted a cruise designed to study 30-day tropical instability waves and their role in oceanic transport of heat out of the tropics. The NOAA ship Researcher completed a set of transects supplying conductivity, temperature, and depth (CTD) data, and measurements by expendable bathythermographs (XBTs) and acoustic Doppler current profiles (ADCPs) for the eastern equatorial Pacific Ocean. A major application of the wave characteristics data is comparison with waves generated by the Climate Analysis Center (CAC) equatorial Pacific Ocean General Circulation Model (OGCM) in an effort to understand the waves better and improve model performance.

A continuing field program was conducted to document the oceanographic currents and other conditions and their variation in the Straits of Florida and along the western boundary of the North Atlantic Ocean between about 27^{o}N and 5^{o}N. Large variability in currents east of Florida on short time scales indicates the need for new in-situ or remote observing systems to collect the long-term data required for climate research.

A two-month field program encompassing the entire North Atlantic basin was conducted in FY 1988. The first portion of the cruise, which extended from the east coast of the United States to the oligotrophic central gyre of the North Atlantic, was conducted with coordinated aircraft operations. This portion of the cruise examined the potential transport of biologically-fixed carbon from nearshore shelf water offshore to the Gulf Stream.

A data-assimilating version of the GFDL general circulation model will be completed in FY 1989. The GFDL-GCM is considered to be a premier general circulation model and is being applied to research problems at some 20 locations in the U.S. and abroad. A data-assimilating version of it will be

of value to those research efforts and may become part of such large programs as TOGA and WOCE.

4.8 National Marine Fisheries Service (NMFS)

Several centers and laboratories comprise the NMFS. A substantial fraction of the interviews were conducted with NMFS personnel. Consequently, the description of the NMFS activities is more extensive than discussions in previous sections.

Mr. Jim Brennan is the Director of the NMFS. The NMFS is that part of NOAA which is charged with the responsibility to manage and conserve the nation's living marine resources -- fish, shellfish and marine mammals. A major responsibility of this organization is to carry out a research program directed at 1) assessing and reporting on the status of the nation's fish and shellfish stocks, 2) assessing and reporting on the interactions of commercial and recreational fishing on marine mammal stocks, and 3) documenting trends in the quality of the habitat in which these stocks breed and grow, and how habitat degradation is affecting living marine resources. In all three of these areas the Agency has specific regulatory responsibilities to take actions which will protect and maintain these resources and the habitat in which they live.

NMFS Structure and Orientation

NMFS is organized with a headquarters office based in Silver Spring, Maryland and five regional offices located in Gloucester, MA (Northeastern Region), St. Petersburg, Florida (Southeastern Region), Long Beach, California (Southwest Region comprising California, Hawaii and the Pacific Islands), Seattle (Pacific Northwest Region), and Juneau (Alaska Region). Each of the regional offices has specific regulatory and research responsibility for the living marine resources within its region, as well as for certain national or international assignments that may be NMFS or NOAA-wide in scope.

Each regional office has attached to it a research center and associated laboratories that carry out the research needed for the fisheries management and other missions for which NMFS has responsibility. This regional structure and orientation leads to a research and policy focus which is directed primarily to the fisheries and marine mammal stocks of that region. With the exception of migratory species like tuna, most of the research activities being undertaken by NMFS scientists are geared towards understanding the status of the stocks (and the conditions of their habitat) within their respective regional boundaries. Thus, in the Alaska Center (headquartered in Seattle with laboratories in Auke Bay and Kodiak, Alaska), fisheries biologists deal primarily with Pacific salmon, Alaskan groundfish, King, Snow and Dungeness crab, and Pacific herring. In the Southwest Center, however, where tuna is a major commercial species, much of the scientific research is directed towards understanding albacore and other tuna behavior, the results of the center's research being applied to tuna stock assessment elsewhere in the U.S. The Southwest Center is also concerned with stock

assessment of local species such as anchovies, sardines, West Coast groundfish, and certain species in the Hawaii/Pacific Islands areas.

Research Methods and Data Needs of NMFS Biologists

In carrying out their main responsibility to assess the status of the fishery stocks in federal waters, NMFS biologists use a variety of research methods. In gathering information on the recruitment dynamics of a given stock they rely to a significant extent on their own surveys (either directly or via contract) to determine the volume of eggs spawned by that stock, and the fate of the larvae hatched from these eggs. This necessitates examining the biotic factors which affect the larvae -- the predator-prey relationships and the abundance of nutrients in the area where the larvae are transported.

Most of the biologists interviewed also collect or try to obtain abiotic information as well. This includes changes in surface and subsurface temperature, in the salinity of the area and in local circulation patterns. Since these and other types of oceanographic or climatic parameters can be obtained only for the narrow area within which the survey vessel operates, and since the larvae of many species move in much larger spheres, there is frequently inadequate information about abiotic factors to satisfy the biologists' desire to understand how these factors impact on the recruitment process.

In addition to egg and plankton surveys, biologists carry out their own exploratory trawl surveys to assess catch per unit of effort (CPUE), year class variability within a particular stock, and to some extent, migration patterns. Since these surveys can target only limited areas and stocks, the biologists also rely on analyses with commercial landings and catch statistics, and on observer reports where available. In some cases, their own research findings are supplemented by foreign data sources. In the Pacific, Japanese research and catch statistics are often used. In general, however, most NMFS scientists rely primarily on their own survey information for the bulk of their research; estimates given range from 50% to 90% of the data used on a regular basis.

Several of the laboratories use satellite imagery to measure oceanographic and biological variables which are included in their forecasting models. For example, at the Beaufort (N.C.) Laboratory of the Southeast Fisheries Center, satellite imagery is used to help identify sea surface temperatures, wind drifts, fronts and eddies. Ocean color variables are not now available through the NESDIS satellite network, but previously this information was used to assess the nutrient quality of the areas being studied. Satellite information is also used regularly by the Mississippi Laboratories for both tuna and butterfish research, and by scientists at the Southwest Fisheries Center in their albacore migration work.

Fisheries oceanography research is conducted at several laboratories where a multidisciplinary focus has been developed. The Narragansett (R.I.) Laboratory of the Northeast Fisheries Center has a small number of scientists who are exploring the relationship between oceanographic and climatic variables and how that affects coastal temperatures, the transport of

pollutants from ocean dumping sites, and ecosystem analyses of New England groundfish, etc. The Beaufort Laboratory conducts habitat research, examining how larvae use habitat systems, how habitat degradation affects recruitment, and how oceanographic processes affect recruitment and the health of the stocks. Work is conducted primarily on a regional basis.

All of the research centers sponsor some type of research effort examining trends in habitat quality and their effect on living marine resources. Research projects have looked at historical variations in stock sizes of certain species and the historical inputs of contaminants. The Northeast Center has published studies examining the impact of contaminants on the reproductive success of winter flounder in Long Island Sound, and has conducted surveys of PCBs in Atlantic Coast bluefish. The Alaska Center has conducted research on rearing habitat requirements of juvenile King crab in OCS lease areas, and the Beaufort Lab has carried out a variety of studies aimed at understanding the relationship between habitat characteristics and recruitment success in species found in the South Atlantic and Gulf of Mexico. Most of this habitat work is estuarine and coastal related, since that is where the larvae and juvenile fish spend much of their time and face major survival risks. Most of the data used in these studies is collected directly by the researcher involved or by NOAA vessels engaged in a variety of research activities.

Many of the scientists interviewed for the study use an inductive approach to their research. As more data become available, the scientists examine them to infer relationships that may not have been previously recognized. Several scientists acknowledged that their recruitment models were inadequately specified in terms of the impact of oceanographic variables, but the difficulties involved in getting access to needed information prevented them from designing more accurate prediction models, and left them to rely primarily on traditional models.

Application and Use of NMFS Research Activities

A great deal of primary data is collected in the course of NMFS research activities. Most of it focuses on a particular species or stock found in a specific geographic area. Commercial catch statistics cover a wider geographic area, and are frequently organized on mainframe computers where they are archived in large files broken down into small area grids. These data are generally not made available to the public in this form. Instead they are used in research studies and modeling efforts that are published for general or targeted audiences.

Much of the NMFS research ends up in a published paper or monograph and is disseminated. Center research briefs, the NMFS journal and other scientific publications are the usual vehicles to disseminate research findings that are not directly intended for the fisheries management process. NMFS monographs on the status of specific stocks, frequently in the form of NOAA Technical Memoranda, generally appear annually with detailed information on the current status and trends of those stocks, as well as the methods used to arrive at the estimates. In only one or two instances does NMFS make available for other research purposes secondary data sets that integrate one

or more primary data collections. The monthly publication put out by the Pacific Fisheries Environmental Group at Monterey on Ekman transport and upwelling indices is a case in point. This information is sent monthly to a number of users, most notably other researchers at the Southwest Fisheries Center in La Jolla.

The most important applications of NMFS data and research activities are for the Regional Fishery Management Councils. NMFS scientists prepare the data and most of the analyses (Resource Assessment Documents or RADs) used by the Planning Teams and the Councils to prepare specific fishery management plans. These RADs describe the status of the stocks and their acceptable biological catch quotas.

Other uses of NMFS data and research findings are for industry analyses, government agencies, consultant studies, academic research projects, and international organizations like FAO, the Fur Seal Commission, and international fisheries management groups. According to the interview results, however, very little of NMFS data and analyses appear to be used to any great degree by the other NOAA Line Organizations.

5.0 RESULTS OF INTERVIEW PROCESS

This section presents our synthesis of the points of view expressed by the respondents regarding the functions of the COAP.

There were recurring themes that emerged from the interviews. Discussion of these themes is broken down into two areas according to the primary area of interest/responsibility of the respondent: fisheries oriented and non-fisheries oriented. Workshops to discuss the COAP concept had been conducted prior to our interview process. However, it became evident that information generated in the workshops had not been disseminated in any appreciable degree to the people that we interviewed. There was a perception that the Center had been created without consulting the scientific community. This negative view was compounded by a lack of knowledge and sense of unease about the mandate for the Center. It was unclear to the respondents what the area(s) of concentration of the Center would be, i.e., whether it was supposed to be a service organization for other parts of NOAA or a separate entity with its own agenda that would ultimately compete with these other parts.

The view of the Center as being something threatening led some of the respondents to comment that the Center should continue to perform those tasks that had occupied it in the past. Along these same lines it was mentioned with some regularity that the PFEG had the reputation of consistently performing solid fisheries research. The OAG, which is a much younger group, is principally known for its data access and analyses in connection with FNOC products.

The opinions of the respondents, as described below, should be interpreted with the understanding that they had limited access to information about the Center prior to the interview.

5.1 Synthesis of Opinions of Physical Oceanographers/Data Managers/ Environmental Regulators

There was a sense that the mission of the Center was ambitious and that short-term success would be more assured if the Center followed up on the successes of the past and instituted new programs in a gradual fashion. The Center should have a broad vision for the long-term; however, these broad, long-term goals should be tempered by available resources and short-term needs. This approach could also defuse some of the early reluctance/ resistance to the Center concept.

Some of the specific views of the respondents can be summarized as follows:

1. If there is one new area where COAP should focus initially, that one area is the Coastal Ocean.

2. COAP should not emphasize the study of ocean climatology via basin-wide numerical modeling independent of similar efforts at other institutions.

3. COAP should be capable of receiving additional satellite data and should organize these data into useful packages.

4. COAP should retain and extend the types of analyses that have been performed historically at the PFEG.

5. COAP should pull together long datasets that are normally not available in order to establish the correlation between pertinent physical/biological parameters.

6. COAP should provide selective datasets on mixed layer depth, high resolution SST, subsurface temperature, and bottom type.

7. COAP should have a visiting scientist program.

Comments on these points follow below.

Coastal Ocean

The increased national interest in the coastal zone by the public and by various research institutes and the NOAA Coastal Ocean Program are strong incentives for making this area one focus of Center activities. The Coastal Ocean is a biologically fertile area which is subject to various adverse stresses. Numerical modeling is a feasible way to proceed and is needed because of the limited observations that are available. There is the opportunity to interface with other groups who are performing modeling on a large scale in ocean basins or continental shelf areas (e.g., the Navy and the MMS) and on a smaller scale in estuaries (e.g., the EPA). Modeling should help elucidate the important process of cross-shelf transport. There is also a need to more accurately predict regional meteorology to drive the oceanic models. COAP has sponsored the acquisition of a mesoscale meteorological model for prediction of nearshore winds. Ecosystem modeling is viewed as a long-term and complex endeavor. It was suggested that the Center use existing hydrodynamic and other models to the extent possible and modify them as needed.

Numerical Modeling for Ocean Climatology

Several people felt that significant work was ongoing in this area at more than one reputable organization. This fact, combined with the expense of starting up such a program, would dictate a slow and deliberate approach by COAP for this activity. Cooperative efforts with other programs would be the preferred way to accomplish this objective.

Satellite Data

Activities in both near-real time and hindcast modes could be undertaken. Liaison with the Navy (FNOC, NPS) should facilitate this endeavor. Additionally, a strong role by NESDIS is warranted. There is a link between numerical modeling and the availability of satellite data for both nowcast and forecast tasks. Also, satellite data archives, e.g.,

Coastal Zone Color Scanner data, could be accessed for retrospective analyses.

Extension of Analyses - PFEG

PFEG has enjoyed some success and recognition with its investigations of the links between fish and their physical environment i.e., the correlation between ocean dynamics and the ecology of pelagic fish. For example, operational albacore predictions based on wind and sea surface temperatures will be supplemented in the future by analysis of the time series of physical parameters to understand the collapse of the albacore population. These types of analyses are considered compatible with the Mission Statement and signify that the Center can benefit from a "hot-start" in this area.

Long Time-Series

The use of historical data series of long duration is supportive of several of the Center's initiatives: (1) the correlation between the physics and biology of the ocean, and (2) the paleo-biological indicators of climate change. The comment was made that there probably exists many high quality datasets within the files of individual scientists that should be accessed and made available to a wider audience of scientists.

Selective Datasets

Mixed layer depth was mentioned frequently as a dataset that is difficult to access. It was felt that the Center's connections with the Navy might expedite this type of data recovery. Related datasets were SST on a fine spatial scale and the vertical temperature profile. Ben Watkins of the NESDIS Information Process Division mentioned that there are special arrangements now in effect for certain geographical areas to provide SST at 3.5 km resolution and there is also a pilot project underway to ship data through a PC in a real-time mode. In other words, a location like Monterey Bay could benefit from these developments. It was mentioned, additionally, that NOAA has a wealth of bottom type data and that these data could be combined with fish type data to create overlays of information given the recognized relationship between these two parameters.

Visiting Scientist Program

This issue is discussed in detail in the following section.

5.2 Synthesis of Opinions of Fisheries Biologists

Although very little of the data collected and analyzed by NMFS is used by other parts of NOAA, virtually all of the scientists interviewed indicated an interest in accessing oceanographic, climatic and chemical data for their activities. They were all aware of the establishment of the Center for Ocean Analysis and Prediction and had ideas as to how it might make a useful contribution to their scientific interests. Scientists on the West Coast, particularly those attached to the Southwest Fisheries Center in La Jolla and Monterey, were the most knowledgeable about current activities at the COAP;

the most specific set of recommendations about the purpose and organizational structure of the Center was obtained in the interview with senior scientists at the Pacific Fisheries Environmental Group, a laboratory of the Southwest Fisheries Center located in Monterey.

The views of the interviewees regarding the role of COAP can be organized into four general categories. It is likely that some combination of these four themes will be incorporated in the Center. These are:

1) COAP should be a provider of secondary and tertiary data and information sets for other NOAA scientists;

2) COAP should serve as a training and educational center for NOAA scientists;

3) COAP should be a multidisciplinary research/data center in the areas of fisheries biology and oceanography, i.e., provide a total, advanced ecosystem approach; and

4) COAP should serve as an institute for visiting scientists on a sabbatical- type basis.

These four functions were seen as mutually compatible, with the only real difference of opinion being exactly what form the Center should assume. Comments concerning each of these roles are summarized below.

COAP as a Data and Information Service Center

As discussed above, most of the scientists interviewed were either currently using or hoping to use various types of oceanographic and climate data to develop more fully their models about recruitment dynamics and the status of the stocks. To the extent there was any "consensus" position about COAP's role here, it was that COAP should be primarily a data and service-oriented organization. Its purpose should be to make available on a regular basis, either for free or at a nominal cost, secondary and tertiary data sets which combine certain types of oceanographic, climatic and, in some cases, chemical variables which describe the marine environment in terms useful for fisheries biologists. This means that COAP staff would be responsible for obtaining the primary data sets held by NESDIS, the Weather Service, NOS and the Navy, and integrating those data sets into files which could be readily accessed (preferably on-line) for inclusion in fisheries models and research activities on specific stocks in designated geographical areas. COAP should also perform an archival function since long-term time series data are seen to be as important as data on current conditions in analyzing trends.

The most important variables identified are indicated in the chart, along with the spatial, frequency and time lag requirements, where they were specified. The most important variables mentioned are:

- Water surface temperature
- Salinity
- Vertical temperature gradients

THE MOST FREQUENT OCEANOGRAPHIC AND CLIMATIC VARIABLES CITED IN INTERVIEWS WITH FISHERIES SCIENTISTS

Spatial Requirements
Frequency Requirements/Allowable Time Lag

	Water Surface Temp	Salinity	Water Depth	Barometric Pressure	Dissolved Oxygen	Vertical Temp Gradients	Air Temp	Phytoplankton Density	Ocean Currents	Ocean Bottom	Wind Stress	Wind Velocity	Horizontal Circulation	Fronts & Eddies	River Influx	Sea Level
Jim Brennan Glenn Flittner	X					X		X	X					X		
Andy Kemmerer Tom Lemming		X	X					X 1/dy ; RT				X 1/dy ; RT	X 1/dy ; RT	X	X 1/dy ; RT	
Mike Laurs Ron Lynn	Large <1 month			X		Large <1 month					X		X	X	X	X
Steve Reilly	X HF; <1 yr	X HF; <1 yr	X HF; <1 yr		X HF; <1 yr	X HF; <1 yr		X HF; <1 yr	X HF; <1 yr				X HF; <1 yr			
Tim Barnett	X 1/wk;					X	X 2/dy;				X 2/dy;					
Paul Smith	US W. Coast 1/mn;					US W. Coast 1/mn;		US W. Coast 1/mn;	US W. Coast 1/mn;		US W. Coast 1/mn;			US W. Coast 1/mn;		
Roger Hewitt								X	X				X	X		
Chuck Fowler	St.Paul AK 1/dy;	St.Paul AK 1/dy;	St.Paul AK 1/dy;				St.Paul AK 1/dy;	St.Paul AK 1/dy;				St.Paul AK 1/dy;	St.Paul AK 1/dy;			
Art Kendall								X RT								
Nick Bax	X dy/wk/mn;	X dy/wk/mn;		X dy/wk/mn;		X dy/wk/mn;			X dy/wk/mn;				X dy/wk/mn;	X dy/wk/mn;		X dy/wk/mn;
Rich Marasco	X					X										
Andy Bakun Dick Parrish				X		X	X				X	X				X
Gary Stauffer Tom Dark	X	X	X			X		X	X	X			X	X HF;		
Bud Cross	X HF ; RT	X		X	X	X		X				X	X	X HF;	X	

ABBREVIATIONS

HF = high frequency RT = real time

- Phytoplankton density (ocean color very important)
- Horizontal circulation
- Fronts and eddies

Other variables mentioned include water depth, dissolved oxygen, wind stress, water depth, ocean bottom characteristics, air temperature (for marine mammals), and surface pressure. Most NMFS scientists did not specify the grid size necessary for their research needs but indicated that it should be small enough to be able to be integrated with their survey results.

Regarding frequency of data observations, requests ranged from yearly to monthly to daily, depending upon the purpose of the project. There was a consensus on spatial requirements; since the small scale, micro-orientation of the cruise surveys does not give the researchers the broad-based context they need in which to understand better the peculiarities of their limited geographic samples, they would like to have the data indicated on the chart available in synoptic form. Accessibility is a key issue. Most respondents indicated they wanted on-line computer access through conventional software packages as well as hard copy availability. Depending upon the respondent, the data had to be current or up to one year lagged. Generally speaking, operationally-oriented scientists desired near real-time data, whereas researchers focused on longer time scales. Most scientists wanted data available within the quarter or the month. Some of the albacore researchers regularly used Japanese data on satellite imagery because it was available four to six months ahead of comparable NOAA data reports. The above requirements are compatible with a Center activity of integrating data sets over time, i.e., combining data into weekly, monthly, etc., summaries.

There was also some discussion about the need for pollution information, which only a few scientists now use. There was interest expressed in being able to explore the extent to which heavy metals and other toxic substances are found in the sediments, in the food chain, and in the discharges into the ocean. Although some information on these factors is obtained in NMFS cruises, its value is limited since not enough information exists to test hypotheses adequately. Thus, there was some tentative suggestions that COAP might want to initiate data collection efforts in this direction.

Most respondents indicated that if the Center were to be truly helpful, it should have a capable support staff who were professionally trained in the disciplines represented by the data to be made available, so that they could assist users in understanding and interpreting the data properly. One respondent suggested that the Center establish a Data Network and Product Division comprised of both computer systems individuals and substantive staff who could design and implement the data service function of the Center.

Other suggestions which were made for this role of the Center are summarized below:

- o COAP could be the liaison with other nations which make satellite information available (specifically the French and the Soviets) to ensure that those data are available to American researchers;

- o COAP could be a clearinghouse for relevant data which are collected on a primary basis elsewhere within NOAA (i.e., NODC or NMC data sets);

- o Althouth COAP is presently involved in primary data collection activities through its connection with FNOC, it should synthesize and integrate primary and even secondary data collected elsewhere into specialized data sets;

- o COAP should establish the standards for data relating to the ocean in terms of spatial, temporal and other data characteristics.

COAP as a Training and Educational Center

As a companion to the recommendation that COAP perform an important role in organizing and making available multidisciplinary data sets about the oceans was the suggestion that COAP establish a training function to teach NOAA scientists the following types of skills:

- o use of these data in their own research activities;
- o setup of data bases which can readily use these data sets;
- o building of advanced multidisciplinary models that account for the dominant physical, chemical and biological interactions in the ecosystem; and
- o use of advanced computer techniques, such as artificial intelligence and expert systems.

The basis for this recommendation was that many of the NOAA scientists who would like to incorporate the data in their research are either unfamiliar about their advantages and disadvantages, or not computer literate enough to be able to take advantage of their availability. Thus, COAP could run resident courses of several days or one to two weeks to educate researchers about the data bases that exist, what their shortcomings are, and how the information can be used in their respective research efforts. Specialized seminars could be held on advanced computing techniques, the design of expert systems, etc. Those individuals in NOAA who already know these techniques could become part of the faculty at COAP on a visiting basis.

COAP as a Multidisciplinary Research Organization

The original concept for COAP envisions its research activities as being directed toward meeting operational requirements. It is in this context that the word "research" is introduced for the Center.

The concept of COAP as a basic research organization in its own right was not embraced by the majority of individuals interviewed for this project. There was somewhat broader support for the idea that COAP establish a quantitative modeling center which could predict changes and fluctuations in ecosystems, and which could serve as an information resource for other scientists engaged in less ambitious modeling efforts. One respondent

suggested that the advantage of a multidisciplinary research group could be obtained by co-locating at COAP research entities from NOAA's Line Organization components (as is currently the case) and encouraging them to interact on specific projects. This situation would be somewhat like a graduate school of marine affairs where researchers representing different disciplines are housed in the same organization and work together for certain common goals and interests, but maintain their disciplinary loyalty to their main department in the university.

The reluctance of some of the respondents to embrace the idea of COAP as a research organization stems from the concern that COAP could become a competitor to existing work and, if funded more generously, could overshadow the Line Organizations' roles. Most of those interviewed, however, felt that if appropriate safeguards were instituted, and if the very specialized, multidisciplinary focus of the Center were predominant, then it could undoubtedly play a useful role.

COAP as an Institute for Short Term Visits

A final set of suggestions for COAP's role was that it could serve as a place where a NOAA (or other) scientist could go for a three to six month sabbatical, either to obtain new skills or to engage in a cooperative, multidisciplinary effort which would be difficult to undertake at his or her home facility. This idea was embraced by most interviewees who described it as a positive aspect of COAP, in that COAP would then be potentially available for all scientists, since any one of them could eventually obtain a position there for a sabbatical leave. Also, this idea was seen as a positive aspect in that it provides the opportunity for a scientist to "get away" to a place where he or she can leave everyday work for a short period and finally get to "that project" which he or she has always wanted to do. Placed in this context, there was a great deal of support for this COAP role.

6.0 RECOMMENDATIONS

A set of recommendations for the COAP is presented in this section. The recommendations are a reflection of the opinions of the respondents as interpreted by our project team. Some personal viewpoints are also represented.

The survival and vitality of the Center depend on several factors: the political and fiscal climate; the choice of a scientific agenda for the Center and its acceptance by the general scientific community; the effect of the transition between administrations within NOAA; the administrative and scientific lines of command, i.e., the structural components, of the Center; and the degree of support that the Center receives from the NOAA Line Organizations. This last factor is particularly important in the short-term.

Because the COAP is part of the NOAA family of organizations and will respond most directly to the programs and needs of the LOs, the support and cooperation of the LOs is crucial to the long-term health of the COAP. To garner that support requires that the COAP recognizes the traditional areas of responsibility of the various LOs and seeks ways to provide unique and complementary services. The Center should view the LOs as its immediate clientele. This arrangement was alluded to in the Introduction where the statement was made that the constituency for the Center should be the government decision-makers, operational modelers and the university scientific community rather than the private commercial sector. Once the needs of the scientific community are satisfied, then the needs of the private sector can be addressed with information flowing from COAP and its first tier constituency. Given the knowledge of regional and local business conditions/aspirations that the LOs and universities collectively possess, it is they who can most effectively respond to and interact with the private sector at the regional and local levels. LOs have forged alliances with universities and universities have forged alliances with business concerns. In order of priority, the COAP would respond to: 1) NOAA LOs, 2) other government agencies (Navy, EPA, DOE, MMS) and universities, and 3) the private sector. An example of 3) would be the subscription by a company to a continually updated dataset produced by the COAP. The distancing of the COAP from the private sector with a shift of this responsibility to other entities, should defuse some of the concern about the length of the shadow cast by the Center and foster a greater degree of cooperation within NOAA. Hopefully, this type of arrangement would also help to dispel the image that NOAA at times projects, of being internally fractured.

The COAP can establish its identity and satisfy its user constituency by pursuing activities in operational products, mission-oriented research and data management. Current activities at COAP provide a historical foundation for both of these undertakings. The building of models (analytic and numerical) to hindcast, nowcast and forecast and the compilation of data sets and combinations of data sets represent unique contributions. These activities are supportive of the long-term goal of multidisciplinary ecosystem studies. Additionally, complementary and cooperative efforts can be undertaken that take regional applications at other centers and carry them into a national program at the COAP.

There are other types of support that the Center requires to be wholly viable. Support from the local Monterey Bay scientific establishment, including the Navy, and support from the general scientific community. We recommend that linkages be established early between COAP and the Hopkins Marine Station and Monterey Bay Aquarium Research Institute as well as other research institutions in the Monterey Bay area (the Central California consortium), as appropriate. It has been suggested by some that the COAP physically re-locate to be in proximity to Hopkins and MBARI. Such a move has advantages but is not absolutely necessary for positive interaction among these groups. These institutions offer research programs and laboratory and field components that are complementary to present and projected COAP activities. This cooperative approach would provide an entry point for the COAP to research projects of common interest on the U.S. West Coast and, specifically, the Monterey Bay area. Other benefits that would accrue are a strong interdisciplinary program that could merit national and international attention and a higher profile for the COAP in the Monterey Bay community where it needs to establish itself. The designation of Monterey Bay as a marine sanctuary under NOAA management further encourages a cooperative relationship. One result should be very active participation by NOAA's Coastal Zone Management Program which can provide the proper interface with those states that are involved in this program. Finally, this association would lay a foundation for the long-term goal of ecosystem modeling which requires a blending of diverse talents.

It would be in the interests of the Center to build upon the relationship that already exists with FNOC, the Naval Postgraduate School (NPS) and other components of the Navy. The Navy is a major participant in near real-time modeling. The NPS performs global and regional oceanic modeling. In the recent past the Navy, through ONR and INO, has expressed interest in the dynamics of the coastal ocean. It is possible that this interest could serve as the basis of a cooperative effort to link basin-wide dynamics with shelf and nearshore dynamics through a hierarchy of models. COAP could specialize in models of the coastal ocean with boundary forcing coming from the FNOC/NPS models. Another area where a common cause might be identified is satellite data transmission and processing. A cooperative approach could justify the setup of a satellite downlink and processing center rather than simply receiving real-time images via a dedicated line. Such a setup has implications for numerical model input and operational products of the Center. We suggest that exploratory contacts be made with appropriate Navy personnel. If the discussion proves positive, then a mini-workshop could be convened involving NOAA and Navy elements.

Support from the scientific community in general will develop with time as the Center demonstrates the quality of its research and operational products and the expanded utility and accessibility of these products and information sets to more groups outside of COAP. Inherent in this statement is the need for the Center to educate outside users/scientists. For example, fisheries scientists at other institutions who may not presently see the utility or role of the Center should, with the passage of time, become more aware of the products/services portfolio of the Center and how it relates to their work. In other words, some fisheries scientists who can not presently articulate what the Center can do for them will be educated to its potential

impact on their operations and research as the Center evolves. Also, as fisheries scientists become more oriented toward environmental monitoring studies, this task should become easier.

Before presenting the summary of recommendations of the project team, there is a distinction to be made between the traditional activities that have occurred at the Center and the future program for the Center. Independent of the COAP concept, the programs, data management schemes and communication systems at PFEG and OAG would have naturally undergone modifications and upgrades. For example, it is expected that the building of the historical ocean data base would have continued irrespective of the creation of COAP. The data management schemes and communication systems of COAP have been discussed elsewhere and will not be described here. However, there are plans to make use of the Integrated Marine Analysis and Forecast System (IMAFS) in an advanced networking system. This fits in nicely with the idea of integrating and disseminating datasets.

The Mission Statement calls for a program that, in many ways, is a natural extension of the types of work that have been performed at the Monterey facility in the past. We believe that major elements of those programs should be retained with some selective consideration for streamlining or discarding of tasks/products, specifically atmospheric information, that are outdated or duplicative of efforts performed elsewhere within NOAA. It is also suggested that collaborative efforts be undertaken with other groups both within and outside NOAA, e.g., certain atmospheric data and products.

Based on interviews with physical and biological scientists, data managers, and environmental regulators principally within NOAA but also drawn from other research institution and government agencies, there results the following set of recommendations for the role and structure of COAP:

- COAP should institute a program in the Coastal Ocean. This would include hydrodynamic numerical modeling, satellite data acquisition and analysis, time series analysis, and data analysis. Interfacing with other organizations (Navy, EPA, Monterey Bay research institutes) is encouraged. Full ecosystem modeling is a long-term goal. Meteorological numerical modeling of the nearshore area is considered a necessary, specialized task in support of the Coastal Initiative and is justified on this basis.

- COAP should examine its current task responsibilities, e.g., meteorological products, to determine which of these functions should be streamlined, discarded, or performed collaboratively.

- PFEG/COAP should continue the types of analyses that it has performed historically and extend these analyses to longer time series, i.e., paleo-biological indicators, in support of the Global Change Program.

- COAP should be set up as a NOAA-wide and government resource, the purpose of which is to organize, assemble and make available to

NOAA Line Organizations integrated data sets of oceanographic, climatic, and where available, chemical variables.

- COAP should provide support to its users by placing service to its users as the highest priority in the organization and by hiring knowledgeable individuals to staff the data service function.

- COAP should carry out research in what might be called "niche" areas. These would include multidisciplinary research, quantitative modeling, artificial intelligence, etc. In performing these functions, COAP should serve as a resource to other parts of NOAA needing education and training in these areas.

- COAP should enhance its attractiveness to existing governmental offices by initiating a "fellowship" program which can sponsor visiting scientists for short periods from three to 12 months.

- The programs at COAP should be periodically reviewed for their relevance and effectiveness. An initial evaluation of the Work Plan for COAP by the National Research Council, Ocean Studies Board is appropriate.

- The initial work of COAP should be to lay out specific, written goals and a milestone schedule. When a Director of the Center is in place, the broad functional vision for the long-term and specific goals for the short-term should be set.

- Care should be taken to establish priorities for issues and activities that fall within available resources.