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Ocean Services User Needs Assessment

Volume I: Survey Results, Conclusions & Recommendations

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Abstract

This report is designed to aid decision makers and planners in finding affordable improvements to the National Oceanic and Atmospheric Administration (NOAA) system. The report consists of an accurate interpretation of environmental information needs of marine users, derived from a result of a direct-contact survey of eight important sectors of the marine user community. Judgments about the value of current or future systems designed to serve marine users should take into account the opinions of these eight user communities.

This report is part of a two volume set. Volume I presents the findings of the survey and results and recommendations. The findings consist of specific and quantized measurement and derived product needs for each sector as well as comparisons of these needs with current and planned NOAA data and services. Volume II consists of supportive and reference material collected during the study: the direct contact interviews with industry members, analyses of current NOAA data gathering and derived product capabilities, evaluations of new and emerging domestic and foreign satellite data gathering capabilities, and a special commercial fishing survey conducted by the Jet Propulsion Laboratory (JPL).

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GLOSSARY

ABBREVIATIONS AND ACRONYMS

AEIDC	ARCTIC ENVIRONMENTAL INFORMATION DATA CENTER
AFTN	FAA WEATHER DATA
AOGA	ALASKA OIL AND GAS ASSOCIATION
AOSC	AUXILIARY OCEAN SERVICE CENTERS
CCT	COMPUTER COMPATIBLE TAPE
DMSS	DEFENSE METEOROLOGICAL SATELLITE SYSTEM
EEZ	EXCLUSIVE ECONOMIC ZONE
FAA	FEDERAL AVIATION ASSOCIATION
FAX	COMMUNICATIONS SERVICES (ALSO TWX, TELEX, UNIFAX)
FNOC	FLEET NUMERICAL OCEANOGRAPHIC CENTER
GTS	GLOBAL TELECOMMUNICATIONS SYSTEM
GWSI	GLOBAL WEATHER SERVICE, INC.
HF	HIGH FREQUENCY
HN	HYDRODYNAMIC - NUMERICAL
INMARSAT	INTERNATIONAL MARINE COMMUNICATIONS SATELLITE
IR	INFRARED
JPL	JET PROPULSION LABORATORY
MAREP	MARITIME REPORTING PROJECT
MARISAT	MARINE COMMUNICATIONS SATELLITE
MLD	MIXED LAYER DEPTH
NMC	NATIONAL METEOROLOGICAL CENTER
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ASSOCIATION
NOBC	NATIONAL OCEAN BUOY CENTER
NODC	NATIONAL OCEAN DATA CENTER
NODDS	NAVY/NOAA OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM
NOS	NATIONAL OCEAN SERVICE
NROSC	NORTHWEST REGIONAL OCEAN SERVICE CENTER
NROSS	NAVY REMOTE OCEAN SENSING SYSTEM
NWR	NOAA WEATHER RADIO
NWS	NATIONAL WEATHER SERVICE
OCM	OCEAN MINING INDUSTRIES
OIP	OCEAN INDUSTRY PROGRAMS
OMC	OCEAN MINERALS COMPANY

OMS	OCEANOGRAPHY AND MARINE SERVICES
ORI	OCEANROUTES, INC.
OSC	OCEAN SERVICE CENTERS
OTEC	OCEAN THERMAL ENERGY CONVERSION
PMEL	PACIFIC MARINE ENVIRONMENTAL LABORATORY
ROSC	REGIONAL OCEAN SERVICE CENTERS
SAR	SYNTHETIC APERTURE RADAR
SEASAT	OCEAN REMOTE SENSING SATELLITE (NASA)
SEAS	SHIPBOARD ENVIRONMENTAL ACQUISITION SYSTEM
SSB	SINGLE SIDE BAND
SSMI	SATELLITE SURFACE MICROWAVE IMAGER
SST	SEA SURFACE TEMPERATURE
TOPEX	OCEAN TOPOGRAPHIC EXPERIMENT SATELLITE SYSTEM (NASA)
USL	UNITED STATES LINES
UWS	UNIVERSAL WEATHER SERVICE
WMO	WORLD METEROLOGICAL ORGANIZATION

1.0 Introduction

Sections 1.0 and 2.0 of this document form an executive summary of the findings of the study, provide information about the basic structure of the report, contain an overview of the marine user sectors considered, and sets forth conclusions and recommendations. The remaining sections contain more detailed descriptions that support these concise summaries. The following paragraphs outline the entire report and indicate where particular information can be found.

1.1 Volume I Readers Guide

The observations and conclusions presented in this report are not the opinions of the Jet Propulsion Laboratory (JPL), but are the strongly held opinions of working marine users representing the following interests:

- OFF-SHORE OIL AND GAS
- MARINE TRANSPOPTATION
- DEEP OCEAN MINING
- COMMERCIAL FISHING
- OFF-SHORE SUPPORT AND CONSTRUCTION
- PRIVATE FORECASTING AND VALUE-ADDED INDUSTRIES
- SEA GRANT AND ACADEMIC INSTITUTIONS
- THE CLIMATE COMMUNITY

These users answered questions about the value and timeliness of data products, identified products that are not very useful and, most importantly, provided insight about the benefit of the Ocean Service Center concept based on the early implementation of the Seattle center. The context of these results are lists of marine measurements and derivative products graded and prioritized by each user community. This information, useful in its own right, provides a foundation for modifying existing or creating new data sources, information processing systems, and dissemination paths.

Since the foundation of the document rests on comprehensive interviews with a large number of companies and individuals representing the important sectors of the user community, the document is organized in line with the assessment process and each of the marine user sectors.

The purpose of Section 1.0 is to describe the logical structure of the report, how the report was commissioned, the marine user community interviewed during the assessment, and the Ocean Service Center concept being evaluated.

Section 2.0 follows these introductory remarks with conclusions and recommendations. This summary presents the distilled findings of the report and provides suggestions as to how the NOAA can improve the value and usefulness of the information collected and distributed to the marine user.

Section 3.0 describes the assessment process. Individuals and companies interviewed are identified, the questionnaire and techniques used during the survey are discussed, and the scope and validity of the collected information is evaluated. The results presented in the succeeding sections are based on the foundation provided by these assessments.

Section 4.0 presents the data needs for each of the marine user sectors. The intent of this section is to be as quantitative as possible in terms of measurements, derived products, data formats and delivery schedules.

Section 5.0 matches the user needs described in Section 4.0 with existing or planned near-term National Oceanic and Atmospheric Administration (NOAA) products. The result is a listing of high value products, products not used or of limited utility, products of low value in their present form that could be improved, and deficiencies in the current system in the areas of data input, processing, and delivery.

Section 6.0 continues this development of data utility by paying special attention to the Value-Added industry and considers the question of encroachment by the Ocean Service Center in this area. Interviews with Value-Added industry leaders forms the basis for the content and conclusions presented.

The most effective test of whether an idea works or not is to try it out. Pilot experiments performed by and with marine industry users usually cost less than many studies and draw firmer conclusions. The danger that exists with pilot experiments is that they will become institutionalized and become a drain on funds. Section 7.0 weighs the pilot experiment approach by looking at past efforts. This section also evaluates the currently unsatisfied needs expressed by users in Section 4.0 and draws some conclusions about how pilot experiments could be used to evaluate benefit and worth on a cost effective trial basis.

The structure outlined above provides a readable and useful handbook of marine user needs, how they can best be satisfied, and whether it is worth the effort in terms of economic or social gain.

1.2 Study Background

In recognition of a gap in understanding the needs for NOAA's ocean services and products, and in support of the emerging Ocean Service Center concept, NOAA authorized and funded this user needs assessment in August 1983. The JPL was selected to conduct the assessment and as an operating element of the California Institute of Technology, brings an independent, non-Government character to the study and evaluation process through its development efforts in satellite oceanography and the conduct of operational demonstrations using satellite observations in commercial ocean applications. JPL has developed a unique relationship with the private sector. This relationship has evolved over a ten-year period and has permitted the Laboratory staff an opportunity to establish a broad set of working relationships with industry and gain a thorough understanding of the ocean industry needs and requirements for ocean observations, products, and services.

The user needs assessment was initially established as a ten month study, to be concluded in early June 1984. Late in 1984, an evaluation committee was formed for the prototype Regional Ocean Service Center in Seattle and it then became desirable to complete the user needs assessment earlier to make it available to the Committee for their review and consideration. Accordingly, NOAA-National Ocean Services (NOS) authorized an accelerated effort in order to complete the assessment report in early April 1984.

A preliminary assessment report, based on the knowledge of user needs by the study staff, was completed and forwarded to NOAA-NOS in October 1983. Although this report did not reflect an update of user needs and requirements through the interview/questionnaire process, it did serve as one resource in guiding the formulation policies of the prototype Regional Ocean Service Center in Seattle.

The staff of JPL was ably supported in the performance of this assessment by Dynamics Technology, Inc., of Torrance, California, and User Systems, Inc., of Annandale, Virginia. The staff of the External Affairs Office at the Seattle Regional Ocean Service Center, as a part of their outreach program, visited a selected set of users on the U.S. West Coast during the assessment period. In the interest of time and efficiency, the reports from these visits were used to both augment and update the needs defined by these users as established during additional contacts by JPL.

The National Weather Service office in Anchorage, Alaska, and the integral Ocean Service Unit have taken a lead role in developing a unique and strong marine weather capability in the Alaska region. The personnel in the Ocean Service Unit office have done pioneering work in determining the needs of the Alaska users and have implemented an ocean and ice program responsive to these needs. This needs assessment has taken advantage of the work performed by the NWS staff and the user needs determined by the Alaska office have been factored into this report.

1.3 The Assessment

The assessment was conducted by means of comprehensive interviews conducted with companies representing major sectors of the user community. Interviews were facilitated with a questionnaire which guided the interview process. The results of these interviews form the substance of this report.

The objectives of this user needs assessment were:

1. To identify the needs and requirements of private sector users for NOAA's marine weather and oceanographic products and services.
2. To identify the needs and requirements of academic users and the climate community for NOAA's marine weather and oceanographic data and services.
3. To compare all user needs to existing NOAA products and services to identify voids, unnecessary products, good match-ups, etc.
4. To emphasize the user community serviced by the Seattle-Regional Ocean Service Center.
5. To present the views of the private sector concerning NOAA and its role in serving the needs of the marine community versus the role of Value-Added industry in serving this same community.

The material in this report can serve as a guide to NOAA-NOS in the formulation of its policies toward the private sector users, and should influence the selection and generation of products for, and the delivery of services to, the marine community.

1.4 The Ocean Service Center Program

In an effort to focus and improve its marine and oceanographic services, NOAA has recently reorganized to form the National Ocean Service (NOS). This reorganization consolidates the marine weather and oceanographic product services.

To improve the NOAA/user relationship, and to further provide a focal point for NOAA's marine services, NOS established the concept of Ocean Service Centers. The Ocean Service Centers are a major division in the office of Oceanography and Marine Services (OMS). A prototype center is operational in Seattle, Washington.

The Concept

NOAA has initiated Regional Ocean Service Centers in an effort to realign, focus, and improve NOAA's service to the ocean community. The "one stop" concept was developed to enhance the quality, coordination, and deliverability of NOAA products and services to the marine community. The present plan calls for each center to improve the existing service base within a region, and to integrate and unify products for an area of responsibility covering the U.S. Exclusive Economic Zone (EEZ). An additional emphasis in the design of the Centers is to provide guidance products for the Value-Added industries. The centers are designed to work closely with Government and private industry groups to ensure that these relationships are cooperative and non-competitive.

This new emphasis to supply data products and services to the ocean user community has been greeted by the community with mixed feelings. The user community, having been disappointed in the past, is somewhat wary of the new initiative and views the longevity of the Center concept with some skepticism.

Services

As currently structured by NOAA, an Ocean Science Center will provide the following services:

- Marine atmospheric and oceanographic analyses, predictions and warnings.
- Nautical charting, tide and current predictions.
- Archived data (meteorological, oceanographic, and seismic).
- Marine advisory services, education, training, and technology transfer.
- Satellite imagery.
- Oil and hazardous materials spill information.
- Sea Surface Temperature (SST) analyses.
- Wave/wind forecasts.
- Surf/beach erosion data.
- Water quality data.
- Living resources data.

Special services will include:

- Storm surge information.
- Fog information.
- Ocean mixed layer depths.
- Bottom temperatures on the continental shelf.
- Ice and ice movement information.
- Harbor bar forecasts.

The program will provide basic ocean information on living resources (including marine fisheries) and environmental quality, scientific research, environmental analyses, forecasts and warnings. The centers will concentrate on the collection, analysis and dissemination of basic marine environmental data essential to the protection or safety of life and property. The private sector will be encouraged by the centers to respond to specific users needs and to prepare "tailored" products from the basic NOAA information.

The present NOAA Ocean Service Center Program is designed to function through a three-tiered framework. The Ocean Service Headquarters will have oversight responsibility of the structure consisting of: (1) National Centers, (2) Regional Ocean Service Centers (ROSC), and (3) Auxiliary Ocean Service Centers (AOSC). The National Centers will supply data and products on a large scale. The ROSCs will prepare relevant regional data such as regional forecasts, advisories and warnings of marine environmental conditions, and carry out a liaison function with industry and other Government agencies. The AOSCs will be located in major maritime port communities where they can draw upon the information supplied by the ROSCs and distribute the NOAA products and services locally.

A unique aspect of the centers is that, in addition to supplying standard regional marine forecast products, they will also provide operational information covering NOAA's entire marine product spectrum. The centers are intended to become primary points of contact for all ocean data users.

The Northwest Regional Ocean Service Center (NROSC) located in Seattle, Washington, has been established as a prototype for the OSC program and began operations on October 27, 1983. The Northwest Center will serve the marine community along the U.S. west coast from the Canadian/U.S. border on the north to the Oregon/California border on the south. Both existing and future NOAA products and services will be coordinated by the center to structure them to meet the needs of the general ocean users in the region.

The Seattle prototype center will serve as a pathfinder for future centers. Additional regional centers will depend upon the success of the Seattle Center, the success as perceived by both the user community and a Department of Commerce evaluation committee. The future of the Ocean Service Center concept will depend upon the ability of the prototype center(s) to build a user constituency and a strong user awareness of the marine products and services available from NOAA through the centers.

2.0 Conclusions and Recommendations

The most important conclusion is that NOAA regional centers must act as an ombudsman for the regional marine users. This means that they will act for user interests as opposed to Government interests. This is an important distinction in any outreach activity because it sets the tone for all of the actions that follow and will certainly determine the success of user oriented programs. To accomplish marine user data and data use improvements will involve a major NOAA outreach effort geared to identifying users, developing a user awareness about NOAA's capabilities and services, and constructing a product suite and service proficiency which is responsive to the needs of the user community. Sections 4.0 and 5.0 are specific and quantitative about what these services should be. The users must shape the Ocean Service Centers (OSC) concept for it to be successful and must directly participate in the evolution of the prototype center(s) and develop an advocacy for the NOAA ocean program.

Special attention should be given to the Value-Added industry, many elements of which view the OSC concept with serious concern. Section 6.0 is specially devoted to the concerns of the Value-Added industries. NOAA policies regarding the role of NOAA versus the private sector in terms of marine products and services need to be formulated in concert with industry leaders and, once established, be honored by the centers on a long-term basis. Consistent policies and data continuity are key to establishing a successful working relationship with the marine industries.

Study of many listings of NOAA products and services revealed that some important and very valuable functions performed by NOAA were not listed at all. An outreach program, led by the service center concept, should make sure that all users are made aware of products and services and how to acquire them.

Section 4.0, Ocean Data Users - Needs and Applications, and Section 5.0, Correlation of User Needs with Current NOAA Products and Services contain the quantitative assessments to be used in order to make specific changes in current or projected systems. These two sections define needs and cross-compare capabilities. Tables 26, 27, and 28 summarize needs and capabilities by marine user sectors and rank capabilities in terms of a "total value" score based on the utility of the product or service. This estimate was based on the response to a direct contact survey and should be used by NOAA planners to revise and improve current and future capabilities.

The Ocean Service Center's hopes are composed of their representation of the interest of the marine users, not a provider of current NOAA proceedures and policies. Acting in this capacity, the center should:

1. Establish a working level clearinghouse type of communication, with the user groups endemic to the region, where problems get solved.
2. Improve data accessability to Value-Added and end-item users alike.
3. Advise NOAA policy and program planners about new data collection, processing, and distribution needs.

2.1 Conclusions and Recommendations by User Sector

Each of the marine user sectors have unique operating personalities and have specific needs and opinions about how those needs can best be served by Government/industry cooperative actions.

Oil and Gas

General - Oil and gas commerce in the marine environment is characterized by a general dependence on Value-Added and support industries for information and services. Operators use the most modern techniques and equipment to develop systems which are as insensitive as possible to weather. This trend is associated with the fact that the community operates in many hostile environmental regions, including the Arctic, where the threat of ice is added to bad weather and sea conditions. Operations costs have increased recently and exploration plans are being scaled back and placed on a longer time base.

As a group, this industry is self-reliant and is wary of Government control, intervention, and cooperative efforts.

Today's Improvements - Since this industry depends on Value-Added companies for assistance, NOAA must improve and strengthen their relationship with the Value-Added sector. Better and faster data base access is the key to this improvement with adherence to clear and consistent data policies. Methods of obtaining environmental observations from off-shore platfoms with a cooperative data pilot program is a method of improving the dialog between NOAA and the oil and gas industries.

Tomorrow's Changes - The most important additions to the NOAA data base would be global synoptic ocean wind measurements made at least twice daily and large area high resolution ice maps also updated on a daily basis. Both of these measurements require satellite observations using radar sensors. The technology for doing this was established in the 1970s, but NOAA operational systems or plans do not include these capabilities to date.

Marine Transportation

General - The marine transportation industries readily seek and use Government assistance and services. These users are beginning to use better communication services and technologies on board ships and are in position to take advantage of improvements in data products and Value-Added services. Coastal operators find NOAA products quite helpful and many operators use NOAA data directly during transit. A large number of ocean transit users and some coastal users rely on Value-Added services to optimize routing and improve storm avoidance.

Today's Improvements - Since Value-Added companies provide weather routing services to a large part of the marine transportation industry, better data base access will also help. Data base improvements for the Southern Hemisphere and Arctic regions would also greatly aid these users.

Tomorrow's Changes - Fundamental improvements in data sources include twice daily measurements of global wind speed and direction, and daily ice maps with sufficient resolution to aid navigation. These measurements are feasible using satellite borne remote sensors, but are not presently planned in the NOAA system. Marine transportation users could also be used to implement an automatic observation marine data collection system using satellite relay capabilities.

Deep Ocean Mining

General - Deep ocean mining companies are appreciative of both Government help in providing research data and development support for their fledgling industry and are, at the same time, leary of Government decisions in essential policy areas such as "Law of the Sea." At the present time, this industry is at a "wait and see" point in their bus'ness plan. "All out" mining operations remain a future dream, but "on-station" pilot mining operations have convinced the venturers that this future is worth protecting.

The areas of highest potential for deep ocean mining are remote and the surrounding and influencing adjacent environments in these vast reaches of the Pacific are difficult to monitor. Sparce quantities of critical weather data also make forecasting a nearly random art in these areas. All this confronts an operation that is perhaps the most weather sensitive off-shore commercial enterprize now being conducted. When the flexible surface to ocean floor collection system is in place, the miners are vulnerable to weather-related damage and major economic loss.

<u>Today's Improvements</u> - Better data collection and forecasting services aligned to the specific mining area would aid the ocean mining industries. This would require improvements in data collection systems in the mid-Pacific basin and would mean that forecast information with improved grid densities be made available. It is also vitally important that information turn-around times be compressed.

<u>Tomorrow's Changes</u> - The ocean mining industries could benefit from improved satellite data collection. An evaluation of the detailed needs presented in Section 4.0 indicate that wind, wave, and swell information is critical to mining operations and this type of information is sparce and, in some cases, nearly nonexistent in the region of interest. Microwave scatterometers, altimeters, and synthetic aperture radars are needed on U.S. polar-orbiting data collection platforms.

<u>The U.S. Commercial Fishing Industries</u>

<u>General</u> - Foreign fishing competition will continue to impact U.S. industry, shrinking profit margins and creating policy issues. Foreign fisheries use the most modern equipment and techniques and also have Government support. By contrast, our fishing industries are fragmented, do not have the kind of Government support provided by their foreign competitors and, although they have gained benefit and advantage by using experimental satellite temperature and ocean color information, face a future where these experimental data sources are about to disappear.

Today's Improvements - The support provided to the west coast and Alaskan fisheries should be extended to the Gulf and East coast fisheries. Continued use of the Navy/NOAA Oceanographic Data Distribution System (NODDS) to provide weather information, formatted specifically for the fisheries, is important combined with sea surface temperature and ocean color information from any available source. NOAA should improve the quality of general weather forecasts out to 24 hours by involving fishermen in an efficient observation collection and reporting system. NOAA should provide satellite-derived temperature and ocean color data products on an experimental basis until operational systems become available. NOAA should encourage a dialogue between fishermen and Value-Added firms and provide marine weather and fisheries oceanography educational programs for fishermen by an extension outreach program.

Tomorrow's Changes - NOAA should establish a national marine weather radio (voice and FAX) reporting and collecting system and structure this system so that station time can be sold to Value-Added firms. The Government should implement operational polar-orbiting satellites with ocean color and temperature measuring capability, the latter on an all-weather basis. A subsidy program should be devised to encourage fishermen to access the capabilities of the Value-Added industry for tailored environmental products.

Off-Shore Support and Construction Industries

General - The off-shore support and construction industries are primarily associated with off-shore oil and gas interests, although a variety of new energy conversion and controlled fishery businesses use services from these industries. Operations are often sited in hostile environmental regions that are in remote areas with respect to resupply and maintenance. Operators rely on NOAA/marine information to schedule and conduct activities at the site and also provide support to off-shore locations. Recent activities in the Arctic have added the difficulties of ice encroachment to the problems confronting rig deployment, installation, and daily operation.

Today's Improvements - Improving the accessibility of the Value-Added industries to NOAA data would aid the marine support and construction industries due to their reliance on Value-Added services. More businesses are turning to the Arctic regions for resource extraction and current data collection systems in these areas are poor. NOAA could improve service in these areas by expanding both collection and data product capabilities.

Tomorrow's Changes - Although conventional systems can aid the support industries in the Arctic and in hostile weather regions, the real improvements will be made possible by adding airborne and satellite microwave sensors to the NOAA data collection system. Microwave radiometers and synthetic aperture radars, already proven in space, are needed to make critical wave, wind, temperature, and high-resolution surface imagery available in areas where poor lighting conditions or cloud cover prevail.

Private Forecasting and Value-Added Industry

General - This industry will continue to depend on NOAA and other Federal agencies to collect and distribute global environmental observations. This industry will combine NOAA data with other information and their own special knowledge of a particular end item user to create customized products for the off-shore oil and gas, marine construction, marine transportation, and other users. The industry will vigorously seek access to all national and international data including foreign satellite generated products. The industry will accept an equitable user charge arrangement for both observations and products but will maintain a vigilance about NOAA's intention to provide users with specialized products. The Ocean Service Centers are a source of concern to this industry. This sector of the user base is particularly interested in data continuity and consistent policies relative to the NOAA/Value-Added interface.

Today's Improvements - The most important improvement would be better access to the NOAA data base. In this instance, the data base are the bulk of environmental observations, analyses, and forecast-derived products. The Value-Added industries would like to access this data base with their computers and receive it in formats and on time scales consistent with their client interests which, in many cases, is a near-real-time requirement. This industry would like NOAA to concentrate on global environmental observations, forecasts, and severe storm warnings and withdraw from the generation of specialized products. This group of users would like NOAA to establish a referal system to direct users to Value-Added firms in response to requests.

Tomorrow's Changes - Because of the expansion of the off-shore oil and gas, mining and support industries (including marine transportation) in hostile regions (including the Arctic), the Value-Added industries would like NOAA to improve their data collection capabilities in these regions. This group considers that NOAA should protect their interests in gaining access to all future domestic civilian and defense satellite systems and act as an interface to foreign satellite systems as well. The industry expects that NOAA will improve the marine radio communication and data networks on which the industry can buy time.

Sea Grant and Academic Institutions

General - The sea grant activities in ocean research are diminishing at the present time. Marine user extension programs, based in academia, are continuing but with reduced budgets. This trend is regretable because many of the data collection and process product innovations were developed by these programs. Academic users require access to well planned and maintained archives. It is important to involve these users in all areas of civil programs, including direct interfaces with commercial marine user sectors.

Today's Improvements - NOAA can improve their service to the marine industries by improving their support of academic investigators. An outreach program at any level should introduce the academic researchers and the commercial marine users by jointly involving them in regions of common interest by Pilot programs dedicated to establishing a new or better data application. Both of these groups would benefit by the association and NOAA would gain considerable leverage on future programs from the support of these groups.

Tomorrow's Changes - Universities should be encouraged to improve their direct access to global data bases. The satellite data collection facility at the Scripps Institute of Oceanography is an example of the kind of interface that should be established in several other locations (Woods Hole, Rhode Island, Florida, New Orleans, Houston, San Francisco, and Seattle, etc.). More than anything else, this would help to accelerate the process of spinning new ideas developed by the universities into the private sector.

The Climate Community

General - Members of this sector are engaged in global or large regional data applications and research. Most of their daily needs can be satisfied with easily accessed and well managed data archives similar to the academic community.

Today's Improvements - The Federal Government has been collecting and will continue to collect very large and valuable environmental data bases. This data needs to be more accessible to users. In many cases, the data is scattered in several locations and is poorly identified and exposed, which makes it difficult to acquire and use. Better data management on a national scale is the key to supporting the climate community. Specific listings of data deficiencies in this area are provided in Section 5.0.

Tomorrow's Changes - The only way environmental data sets would be useful in the future is if a rapid expansion of the mini and personal computer businesses and similar improvements in general communications access would occur. These two trends make it possible to address a rapidly expanding data base. It is possible for NOAA to take advantage of this rapidly changing and improving capability to significantly improve data base accessibility.

2.2 Updating and Utilization of User Needs Assessments in the NOAA System

The community of private sector ocean users is comprised of broadly-based and diverse groups with both general and site-specific or tailored data/product requirements. Academic users and members of the climate community also have similar data needs. The commercial user relies on NOAA products in order to operate in the coastal waters surrounding the Continental U.S., the ocean regions of Alaska, and the ocean areas encompassing Hawaii. In order to establish environmental observation capabilities, product generation and dissemination requirements, and service policies and procedures which support these diverse activities, NOAA requires an accurate compilation of both user needs and available data sets determined by both the ocean users and NOAA, working in close cooperation. Rather than being just an archive of unorganized material, this type of information should be readily accessible and reflect changing requirements in the user community. Such a handbook can facilitate a conciliation of user needs with available NOAA products and services, and can aid in identifying new product/service requirements and eliminating those which appear underutilized. Also, the handbook can serve as a compendium of new technologies which are emerging as candidates for operational applications, as well as a medium in which to report the results of pilot demonstrations (see Section 7.0). A handbook which can fulfill this function can, and should be, a natural product of this type of user needs study. It should be designed as a reference document for the OSCS to be updated annually.

User needs are usually defined with reference to specific types of data products, or services which pertain directly to a users activity, whether it be a commercial operation or research activity. For example, drilling platforms on the North Slope need timely sea ice movement forecasts. However, another aspect of user needs, particularly in a highly technical and competitive environment, is the development and implementation of innovative and specialized data services, including Value-Added data, which can increase productivity. Improving the state of the art in a wide spectrum of ocean-related technology requires integrating knowledge of data processing capabilities with a thorough understanding of the users' operating or research requirements. The handbook concept will fill this need by collecting into one document, an assessment of user needs, a description of data and data processing services available from both NOAA and the Value-Added industry, and evaluations of experimental techniques and studies. Such a handbook can provide the architecture for, and become a reference resource of, a NOAA catalog of ocean products and services.

It should be stressed that the handbook is intended to be a catalyst for effective communication between NOAA and the ocean users, including the various sectors of ocean industry.

The exchange of information and views inherent in the formulation of an effective reference document can be as important to advancing the application of technology and maintaining dialogue as are the final results.

3.0 The Assessment Process

3.1 Design

The assessment was constructed along three essential lines, consistent with the objectives introduced in Section 1.0.

- Product and Service Assessment
- Value-Added Industry Issues
- Pilot Demonstration Concepts

Using these guidelines, the assessment process was designed to improve communication between NOAA and the users, and was tailored to examine the proper role for NOAA in the marketplace. This meant that the assessment addressed the relationship of NOAA and the Value-Added industry comprised of private meteorological services, including ship routing firms. The assessment was also designed to address the concept of pilot demonstrations as vehicles by which new technologies and applications ideas can be tested and evaluated. This part of the assessment explored the pilot demonstration concept with the private sector users and solicited their reaction and willingness to participate in such demonstrations.

3.2 Direct Contact Approach

The process used to conduct this user needs assessment draws upon the experience of the JPL in conducting similar studies involving private sector users. Structured but informal direct interviewing formed the basis for the assessment. A questionnaire was developed to aid and guide each interview and to serve as a supplementary record of each interview.

Emphasis was placed on understanding the unique character of each user. In this fashion, the needs for ocean products and services could be placed within the context of the individual user.

Users selected for interviews were drawn from a broad set of firms and institutions from the ocean community. While the emphasis was placed on users in the Western United States, including Alaska, east and gulf coast users were also included. Table 1 provides a listing of the user contacts that support this report.

The direct contact interview process is illustrated in Figure 1. The informal atmosphere, coupled with the fact that an independent organization was conducting the assessment, provided a forum in which attitudes and perceptions regarding NOAA's current products and services could be discussed.

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Off-Shore Oil and Gas

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
Mobil Oil Corp. (Dallas, TX)	Dr. Max Sheppard Dr. Walt Spring	February 13, 1984
Sun Oil Co. Offshore Explorations (Dallas, TX)	Walter Carraway	February 13, 1984
Arco Alaska (Anchorage, AK)	Paul Norgaard	January 1984
Sohio	Dr. Henry Chen	January 26, 1984
Alaska Oil and Gas Association	O.K. Gilbert	November 1984

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Marine Transportation

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
Chevron Shipping Co. (San Francisco, CA)	Dick Daunt	January 26, 1984
Chevron Shipping Co. (Los Angeles, CA)	Capt. Burton Les Busch (2nd Mate)	February 15, 1984
American Institute of Merchant Shipping (Washington, DC)	RDM. Benkert	March 6, 1984
Puget Sound Tug & Barge (Crowley Maritime) (Anchorage, AK)	Alex Sweeny	February 2, 1984
U.S. Lines (Cranford, N J)	Capt. William McManus	February 23, 1984
Maritim Association of the Port of New York (New York, N Y)	Len Butler	February 23, 1984

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Deep Ocean Mining

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
Lockheed Ocean Minerals (Sunnyvale, CA)	Connie Welling	January 26, 1984
Ocean Mining Associates (Gloucester Point, VA)	William Siapno	February 17, 1984

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Commercial Fishing

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
*Western Fishboat Owners Association	Art Haworth Frank Mason	March 2, 1984
*American Tunaboat Association	Jose Munos Vic Bernardini	March 2, 1984
American Fishermans Research Foundation	Frank Martins	January 1983
*Pacific Coast Federation of Fishermens Associations	Zeke Grader	March 2, 1984
Oregon Marine Advisory Program	Robert Jacobson Paul Heikkila	January 1983

*Contacted by Seattle - ROSC External Affairs Staff

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Off-Shore Support & Construction

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
E G & G (Anchorage, AK)	Frank Rose	February 3, 1984
Sohio Construction Co. (San Francisco, CA)	Dr. Henry Chen	January 26, 1984
*Vetco Offshore, Inc, (Ventura, CA)	Tim Downey Kathy Carlson	March 3, 1984

* Contacted by Seatlle-ROSC External Affairs Staff.

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Off-Shore Support & Construction

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
Digicon, Inc. (Houston, TX)	Charles Holt	February 9, 1984
Western Geophysical Co. (Houston, TX)	Paul Jubinski Leonard Snowman	February 10,1984
Talon Technology Systems (Richardson, TX)	Lynn Heitman	February 8, 1984
Rowan Companies, Inc. (Houston, TX)	Paul Kelly	February 9, 1984
Brown & Root (Houston, TX)	Bill Stallworth	February 13, 1984
Geophysical Service, Inc. (Dallas, TX)	Larry Bowles	February 8, 1984

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Private Forecasting (Value-Added)

ORGANIZATION (LOCATION)	CONTACT	VISIT DATE
Global Weather Dynamics, Inc. (Monterey, CA)	Kenneth Ruggles	January 24, 1984
Oceanroutes (Palo Alto, CA)	Fritz Snideman	January 24, 1984
Nortec (Anchorage, AK)	Joe Ostrom	February 3, 1984
Oceanweather, Inc. (Cos. Cob, CT)	Vince Cardone	February 21, 1984
Weather Services, Inc (Bedford, MA)	William Saulnier Peter Leavitt	January 1984
Universal Weather Service (Houston, TX)	Jack Garman Donald Taft	February 10, 1984
Telesystems Master Weather Ctr. (Fairfax, VA)	Gordon McMillian	March 12, 1984

Table 1. NOAA-NOS User Needs Assessment User Contacts

Industry: Academic & Climate

ORGANIZATION (LOCATION).	CONTACT	VISIT DATE
Woods Hole Oceanographic Institute (Woods Hole, MA)	Hartley Hodgkis George Heimerdinger Arthur Gaines	February 21, 1984
Univ. Of Rhode Island (Kingston, RI)	Randy Watts Peter Cornillo	February 22, 1984

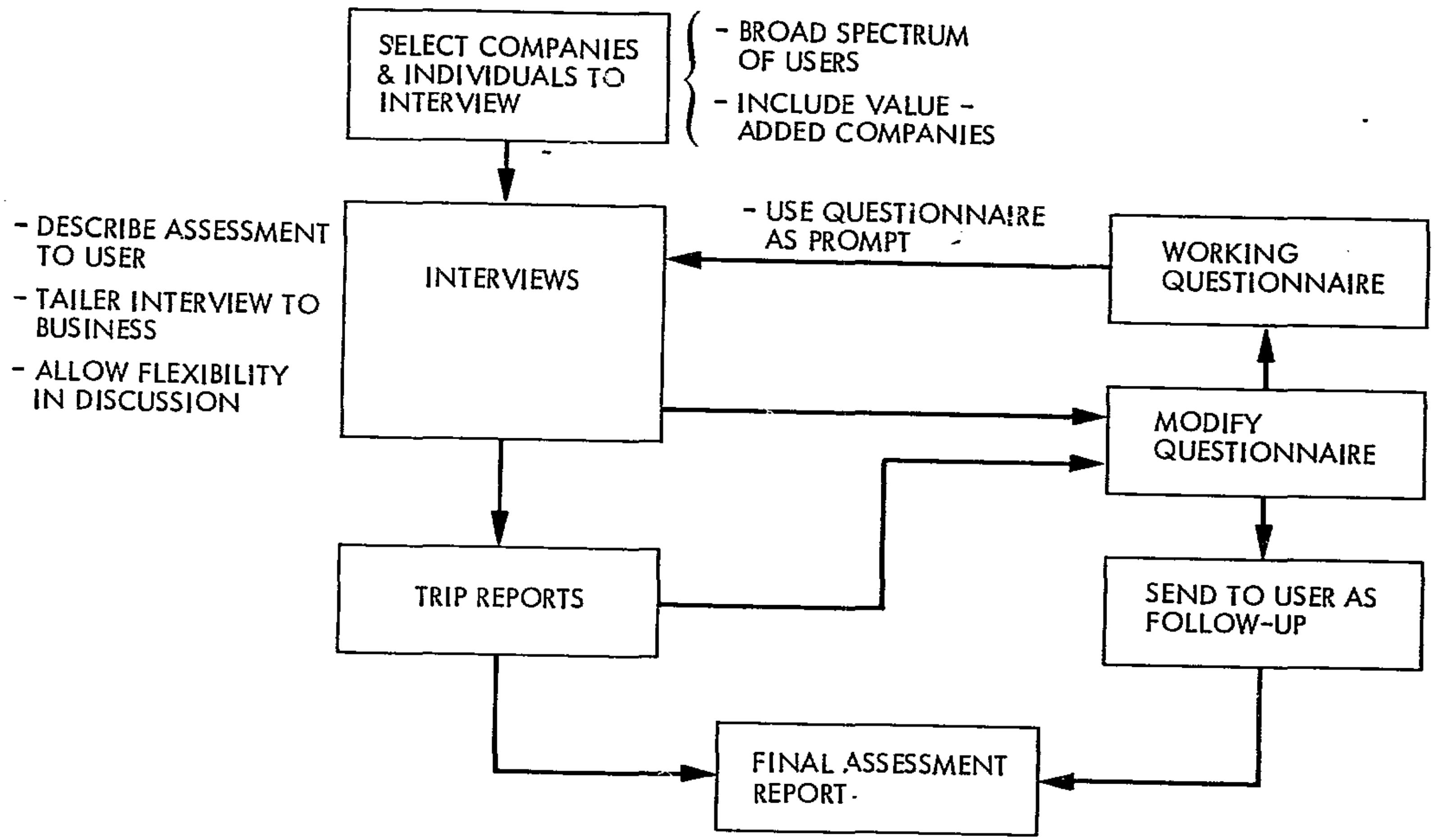

Figure 1. Assessment Process

4.0 Ocean Data Users - Needs and Applications

As a result of direct contact interviews, specific needs and requirements were identified and categorized in terms of importance and timeliness for each of the user sectors.

The coastal, oceanic, and polar region measurements of major interest to the combined set of users were organized and quantified as a result of the direct contact survey. Table 2 presents the coastal, oceanic and polar measurements of primary interest to marine users. Marine users also require derived products such as weather and wave model forecasts as well as less time sensitive charts and climate histories. These derived products are included in the detailed discussions that follow.

4.1 The Off-Shore Oil and Gas Industries

4.1.1 Survey Results

Table 3 contains the survey results listing the needs of this industry group. The off-shore oil industry is a $100 billion per year business. Today's off-shore operations use expensive equipment with high lease rates that make it more imperative than ever to perform at peak efficiency. The costs of off-shore drilling activities have grown from $55/ft in 1974 to over $305/ft in 1981. Drilling vessel daily costs may easily exceed $50,000. A major factor for these high costs is the need for equipment of special design to carry out deep water exploration and development drilling in the world's most severe environmental areas. The present trend is toward deeper and more hostile environments, with programs planned in such places as Alaska, the Beaufort Sea and off the U.S. east coast. To design and build vessels and rigs to operate in these waters, oil companies need basic data about the wind/wave environment where vessels, and eventually the production platforms (with vessel resupply), will operate. Off-shore operations are also highly weather dependent,

Table 2. Composite Data Requirements

Parameter	Units	Accuracy*	Precision*	Range	Resolution (kilometers)	Frequency (hours)	Delay (hours)	Coverage	Grid (kilometer)	Priority
Sea Sfc. Temp.	°C	0.1, 0.5, 1	0.1, 0.25	−2, − 35	2, 10, 50, 100	3, 12, 24	12, 24	Coastal/ global	25,100	H
Currents	cm/sec degrees	1, 5 10°	2, 5 1°, 10°	0 − 250 0 − 360	1, 10, 100	3, 6, 24	12, 24	Coastal/ global	100	H
Tides	cm	2, 5, 20	1, 5	0 − 1500	0.5, 100	3, 6	3, 24	Regional coastal/ global	−	H
Waves Ht. Dir.	m degrees	0.3/10% 10°	0.2, 0.3 5°, 10°	0 − 25 0 − 360	5, 50	3, 6, 24	3, 12	Coastal/ global	10, 100	H
Bathymetry	m	0.3	−	0 − 30	0.04	−	1, 30	Coastal	Contours	M+
Chlorophyll	μg/ℓ	30%	10%	0.01 − 100	0.1, 0.4, 10	24, 48	6, 24, 48	Coastal/ global	10, 25, 50	M+
Turbidity	g/m³	40%	10%	0.01 − 100	0.4	12, 48	24, 48	Coastal	1	M
Salinity	ppt	0.1, 0.2, 1	0.05, 0.1	30 − 40 0 − 40	2, 10, 50, 200	3, 24	3, 12	Coastal/ global	10	M
Sfc Winds Speed Dir.	S = m/s D = degrees	0.2, 1, 2 10°	0.5 50	0 − 75 0 − 360°	5, 50, 100	6, 12	3, 6	Coastal/ global	100	H
Sea Ice Cover Thick.	OKTAS cm	0.3, 1 0.5, 30	0.1, 1 0.25, 5	0 − 8 0 − 500	20, 100	12, 24	12, 24	Regional	−	H
Precip. Rate	cm/hr	1	10%	0 − 10	1, 10, 50, 100	12, 18, 36	3	Coastal/ global	100	M
Precip. Water	cm/cm²	0.3	0.3	0.5 − 10	10, 50, 100	12, 18, 36	3	Coastal/ global	100	H
Sfc Air Temp.	°C	0.5, 1	0.1, 0.2	−40 − 35	25, 50, 100	3, 12, 24	−3	Coastal/ global	100	H

(a) Derived from NOAA Workshop on Oceanic Remote Sensing, Volume II, March 1980.
(b) Delay for climate is 10 days or more.

*Commercial users can readily accept and use larger values, often by factors of two or more.

which points to their need for improved weather predictions. The column listings in Table 3 reflect the types of operations and operations planning information that this community requires.

Synoptic or near-real-time information is required for operations and logistics support with special attention given to dynamic station keeping. The Arctic environment poses a special challenge to the oil and gas industries.

Ice cover and ice movements vary greatly with the time of year and surface wind conditions. The percentage of ice cover in polar regions governs much of the weather there, owing to the large exchange of heat between air and water occurring through open water areas, especially in narrow leads and polnyas. Operations support shipping depends upon an accurate assessment of ice conditions throughout the navigable waters.

Off-shore drilling needs to know ice edge location for deploying its support vessels during the course of drilling operations. Presently, the east coast drilling is on a seasonal basis, so the location of the ice edge and its projected movement is needed to decide when the drillship can be sent to the site. In the Beaufort Sea, the position of the multiyear ice edge and its relation to the drilling sites is always of concern. The edge location affects the conduct of drilling operations in that differing distances of the edge from the site call for differing levels of alert. Alert levels for Dome Petroleum operations in the Beaufort Sea are based on the "T" time, or time to disconnect plus a number of hours determined by the estimated arrival time of significant ice. At each alert level, certain procedures, such as close tactical reconnaissance or deployment of a supply vessel, are initiated while activities at the drill site are altered or changed in accordance with the ice status. The declaration of an alert level is dependent upon the concentration of ice, its speed, and the nature of the ice in terms of type and structure (mainly ridging).

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Table 3. User Needs - Offshore Oil and Gas

Measurement Requirements	Long Range Planning	Engineering Design	Environmental Impact	Operations	Dynamic Station Keeping	Logistics Support
OCEANIC						
Temperature						
Horizontal	□	□	□			○
Vertical	◧	◧				
Currents, Fronts & Eddies	■	◧	◧	○	●	
Tides	◧	◧				
Surface, Directional Spectra	■	■	□	●	●	●
Internal	■	■		●	●	●
Bathymetry	□	◧				
Entrained or Dissolved Organics						
Sediment	□	◧				
Salinity	□	□	□			
Surface Wind Vector Field	◧	■			●	●
POLAR						
Sea Ice Classification						
Grease	□	□		◑	◑	◑
First Year	◧	■		◑	◑	◑
Multi Year	◧	■		◑	◑	◑
Sea Ice Extent						
Individual Floes	■	■		●	●	●
Pack	■	■		●	●	●
Deformation & Leads				●	●	●
Sea Ice Thickness						
Floes	◧	■		●		●
Ridges	◧	■				
ATMOSPHERE						
Boundary Layer Winds			◧	●		●
Surface Pressure						
Sensible Weather	■	■		●		●

Data Category: ○ Real Time □ Archival

● Critical ◑ Important ○ Useful

Arctic ice structures vary considerably. For instance, ice islands are limited to the Beaufort Sea, although fragments have been observed in the past in some of the channels in the Arctic islands. Icebergs are a feature in the eastern Arctic and adjacent southern latitudes. Incursion of ice islands on a drilling platform or an artificial drilling island can have disasterous consequences economically and also pose life threatening situations.

Icebergs affect a wider range of activities because of their geographic origin and distribution. Present off-shore drilling operations off Canada's east coast, notably off the Labrador Coast and at Hibernia, must always know of the location of icebergs. The size, movement, and proximity of the icebergs relative to the site will decide the action to be taken. If the iceberg is small enough and projected to come dangerously close to the site, efforts will be initiated early to tow the iceberg away. If the threatening iceberg is sufficiently large enough to discourage towing efforts, the only option may be to move the drillship off the site.

While any one parameter in itself may be of concern to a ship or boat operator or drillship master, more often it will be a combination of factors that ultimately will dictate the course of action to be taken. For example, our survey revealed that alert level procedures for Dome Petroleum's off-shore drilling operations require knowledge of ice concentration and velocity along with a general description of the condition of the ice.

The declaration of an alert level is not only based on the available ice information, but also on the considered judgment of the master. It is in this context that the role of ice information must be assessed. Consider the decision-making process of the master and the information sources he has at his disposal. Ice information provided by aircraft and satellite sensors is one source. They provide data that is remotely measured, giving some inferred information on the composition and cross-sectional properties of the ice. While such information may be sufficient a large portion of the time, a closer look may be required in some instances. A supply vessel or ship-based helicopter may be needed as a probe. The information provided by such a probe, combined with remotely sensed data and the considered judgment and experience of the master, will all be given various weightings in deciding the appropriate course of action.

Conventional ice observation suffers from a sparcity of data and observation of ice from existing weather satellites is complicated by the persistent cloud cover and poor lighting conditions found in polar and subpolar regions. Thus, active or passive microwave sensor data is required for imaging ice cover and very large icebergs on an all-weather basis. With the Navy Remote Ocean Sensing System (NROSS) or Defense Meteorological Satellite System (DMSS) Satellite Surface Microwave Imager (SSMI), at an 85 GHz frequency, it is possible to image ice cover with good resolution (4 km) over the entire polar caps with swaths of 1,000 km on an all-weather basis. A Synthetic Aperture Radar (SAR) is required for measurements of a few meters and this sensor, although part of the SEASAT Program in 1978, will not reappear on a long duration space platform until later in the decade when European, Canadian and Japanese systems will include SAR sensors.

It is expected that in the future the Arctic Ocean will be used more for navigational purposes, particularly as oil and mineral sources are located there. Operations in the Arctic depend on up-to-date information on the extent, position, thickness, and breakup characteristics of sea ice, which requires mapping large areas. The all-weather, day-night operational capability of radar systems is particularly useful in this regard, since light and weather conditions are uncertain most of the time.

One indication about how the oil and gas community feels about satellite radar sensing of the Arctic is expressed by the Alaska Oil and Gas Association (AOGA) which is a trade association whose member companies account for the bulk of oil and gas exploration, production, and transportation activities in Alaska. AOGA is a division of the Western Oil and Gas Association.

AOGA discovered that NASA is planning to establish a receiving station in Fairbanks, Alaska, to obtain SAR data from the European Space Agency remote sensing satellite, ERS-1. Such data would be processed to create images of sea ice conditions of the off-shore Alaskan area.

The ERS-1 satellite is currently scheduled for launch in late 1987 or early 1988. Oil industry operations on the Alaska off-shore continental shelf in the late 1980s and early 1990s will need timely, accurate information on sea ice conditions in the Beaufort, Bering, and Chukchi Seas, especially in lease areas contained in the Interior Department's current five year lease/sale schedule.

AOGA expressed support to NASA for the planned receiving station and strongly recommended that a data processing capability be provided to produce near-real-time images of sea ice. Such data should be acquired and routinely archived for later analysis. AOGA stated that it was important that data processing should be rapid enough for forecasting use; that is, processed images should be available to forecasters or to industrial users within hours of data acquisition. Although NASA will site the station, they will only produce delayed images for scientific users. Marine users have been sent to NOAA for near-real-time images.

Until now, the off-shore industry has relied primarily on the Value-Added industry for support when issues of environmental concern have arisen. Taking an example of this reliance from our survey, SOHIO is a large off-shore oil company whose various drilling operations require site specific forecasts. (SOHIO built the expensive MUKLUK Island drilling platform, with funding help from other companies, in the Beaufort Sea which appears to have failed to produce any oil.) They receive almost all of their forecast information through Value-Added companies and do not depend directly on NOAA. The attitude of our contact at SOHIO is that the very specialized and accurate weather reports and forecast information that they require could be best provided by the private sector. SOHIO does not need or expect NOAA to provide these highly tailored services. They were aware of the weather FAX medium and NODDS, but were not sure exactly what NOAA offered in terms of data products and services.

All of the companies interviewed felt that NOAA should concentrate on expanding its observational data base and improve the management of it, which would include developing a larger communications network. A universal opinion was that easier access to relatively inexpensive but high quality data by Value-Added companies would allow smaller, regional forecast services to compete with the larger Value-Added companies on a regional basis.

Most U.S. oil and gas companies are very interested in accurate and timely ice information. If the information is not available from the National Weather Service (NWS) (e.g., because of cloud cover), then they must fly their own reconnaissance, which is expensive. For this reason, they would be willing to help fund a pilot program to disseminate timely SAR data, but only if there was a foreseeable payoff. They would have to carefully study the profitability of the investment first. The demand for environmental support services, whether from NOAA or Value-Added companies, has grown as off-shore oil moves to harsher environments.

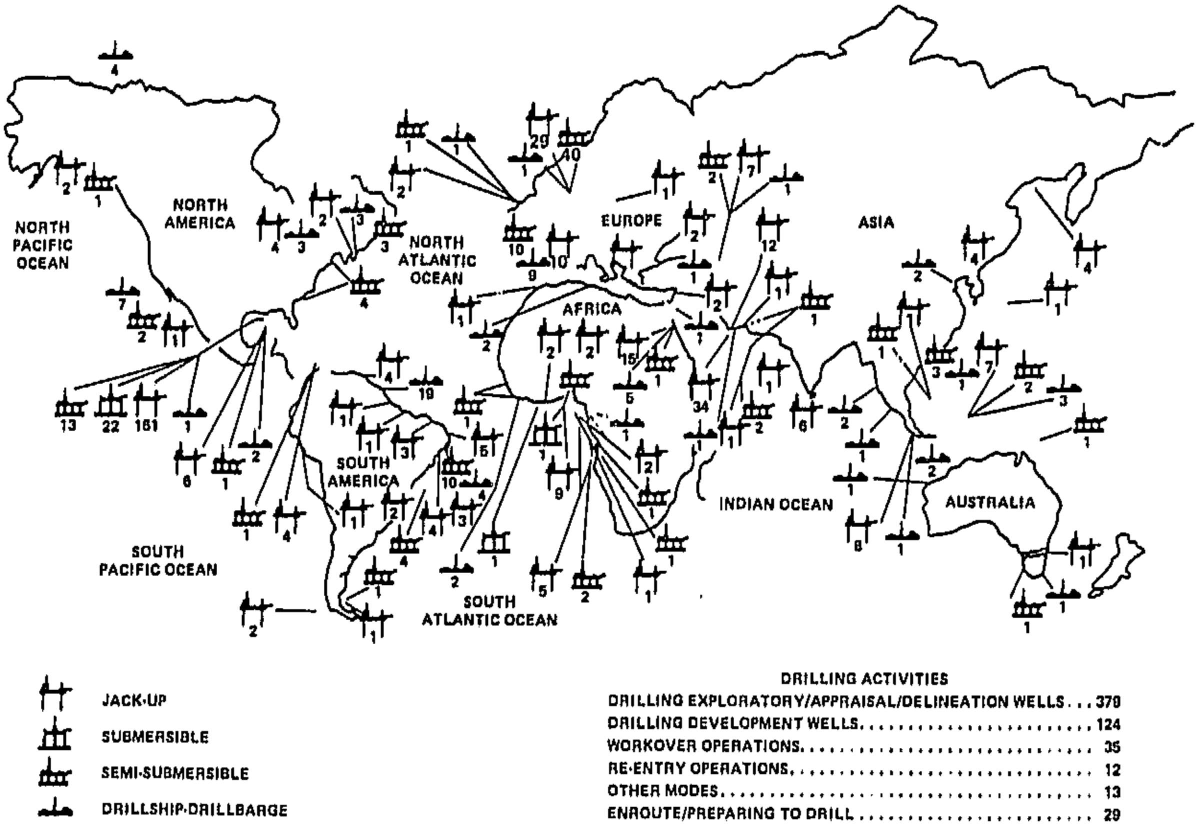
4.1.2 Issues

Some of the key issues of concern are:

- Real-time communications
- Ocean monitoring
- Detailed wave information, (i.e., directional wave spectra - height, period, direction)
- Weather-dependent decision assistance for off-shore oil activities (e.g., drilling schedule, supply vessels, helicopter shuttles for crews and supplies, oil surveillance, etc.)
- Data analysis for input to oil spill models
- Wind and wave hindcast studies for production design
- Ocean current analysis
- Mixed layer modeling
- Ice forecast and ice movement information

Despite the worldwide recession, off-shore daily activity in 1982 was at a record high. The decade of the 80s began with a rash of activity in the contract drilling market, and the industry was involved in several large-scale development programs around the world. Figure 2 illustrates the worldwide active fleet and provides a table of the off-shore wells drilled over the last 12 years. Mobile and platform rigs drilled almost 3,000 wells in 1981 off the coasts of more than 50 countries around the world. At each drilling location, the need for weather forecasting and environmental data gathering has become as standard as expenses for drilling equipment. The Ocean Industry Magazine's 1982 forecast of 3,095 wells indicates a significant upturn in this market.

The activity in deep-water lease acreage and equipment and the record pace of geophysical activity (which is a precursor to drilling) are further reinforcements of the increasing demand for support services that can be met by high technology Value-Added industries and NOAA data products, services, and observations.



OFFSHORE WELLS DRILLED
1970-1982

YEAR	U.S.	OUTSIDE U.S.	TOTAL
1970	1,058	312	1,370
1971	884	280	1,164
1972	993	601	1,594
1973	888	856	1,744
1974	830	986	1,816
1975	1,028	1,067	2,095
1976	1,028	1,070	2,098
1977	1,211	1,310	2,521
1978	1,236	1,520	2,756
1979	1,241	1,444	2,685
1980	1,266	1,570	2,832
1981	1,075	1,770	2,845
*1982	1,220	1,875	3,095

FIGURES ARE FROM SHORELINE OUT AND DO NOT INCLUDE LAKE DRILLING

*1982 FIGURES ARE ESTIMATES

Figure 2. Offshore Oil and Gas Industry Activity

4.2 Marine Transportation

4.2.1 Survey Results

The results of the survey of marine transportation industry users is displayed in Table 4. Marine transportation consists primarily of cargo and tanker fleets, vessel charters, and Government carriers such as portions of the U.S. Military Sealift Command. There are approximately 25,000 deep-water vessels worldwide in this category. Due to a combination of economic factors (notably the rising cost of fuel, the cost of replacing and refurbishing vessels, and the insurance and damage claims associated with groundings, collisions, and oil spills), there is a growing demand for environmental management information and optimization services, both at sea and in port. Furthermore, there is a large service market targeted at the maritime industries that maintain, service, and supply these vessels in the world's harbors.

Maritime transportation is obviously highly dependent on at-sea information concerning weather and wave conditions that will be encountered along the intended route. This is an important distinction of marine transportation user needs as reflected in the table. Nearly all information is needed synoptically in near-real time. As storm conditions develop and sea conditions change, ship masters need an update of their route planning quickly. Studies performed by EXXON and other oil companies have estimated that substantial cost savings are realized when vessels are weather routed with periodic updates enroute. Satellite data is important to this user group because it is the only source of large area synoptic data. Weather routing of ships to improve transit time, avoid damage, and improve insurance rates is an established business today. The weather routing business is largely performed by Value-Added companies, which rely heavily upon NOAA and U.S. Navy data products.

Table 4. User Needs – Marine Transportation

Measurement Requirements	Optimum Track Ship Routing	Route Surveillance	Fort/Harbor Operations & Scheduling	Pollution Monitoring & Control	Ship Design	
OCEANIC						
Temperature						
Horizontal	○	○		○		
Vertical						
Currents, Fronts & Eddies	●	●	◐	●		
Tides			◧			
Surface, Directional Spectra	●	●		●	■	
Internal						
Bathymetry						
Entrained or Dissolved Organics						
Sediment						
Salinity				○		
Surface Wind Vector Field	◐	◐	◐	●	■	
POLAR						
Sea Ice Classification						
Grease	●	●	◐			
First Year	●	●	◐			
Multi Year	●	●	◐			
Sea Ice Extent						
Individual Floes	●	●	◐			
Pack	●	●	◐			
Deformation & Leads	●	●	◐			
Sea Ice Thickness						
Floes	●	●	◐		■	
Ridges	●	●	◐		■	
ATMOSPHERE						
Boundary Layer Winds	●	◐				
Surface Pressure	◐	◐	◐			
Sensible Weather	●	●	◐	○		

Data Category

○ Real Time □ Archival

● Critical ◐ Important ○ Useful

The survey considered several marine transportation users and asked about their current and future needs. This cross section provided much variance in method but consistent use of up-to-date information.

The San Francisco office of Chevron Shipping is mainly concerned with the shipping of fuel and supplies back and forth from the Gulf of Alaska to Seattle, the San Francisco Bay Area and, El Segundo in California. Coastal weather data is generally more reliable than deep ocean data due to improved sampling and observations. Chevron finds that a weather routing service, providing detailed route specific weather and sea-state forecasting, is not crucial for their operations. The large size of their ships and their master's familiarity with the coastal route also influences this decision. Chevron has used private forecasting firms in the past, but now find the weather FAX and voice broadcasts adequate for their needs. The ships' masters make their own decisions based on this weather information and are more inclined to ride out bad conditions or duck into a harbor (a choice unavailable to deep ocean transit shippers) rather than significantly change their route. Chevron pointed out that optimal routing makes more sense for trans-Pacific runs because of the great distance and area that can be used to avoid problems, whereas the shipping along the coast is more restricted.

Given their reliance on NOAA marine weather products, Chevron would like to see more communication with NOAA so that the quality of the products could be improved and made even more useful to the general coastal mariner. As an example, Chevron mentioned that more frequent visits to the ships' officers from the Port Meteorological Officer (a NOAA official) would help iron out problems and keep the company in better touch with what NOAA is doing.

A similar interview with a subsidiary of Crowley Maritime revealed a similar opinion for the coastal region but quite a different opinion about Arctic shipping. The company supplies the entire Alaskan coast with fuel, prefab buildings, food, and just about everything else. They have about 11 barges and 8 tugs and are also involved in the annual summer sea-lift which supplies the north slope drilling operations. Operators are particularly pleased with the support from the local NWS office in Anchorage. They will occasionally call to get direct information about weather conditions, and the tide and bathymetric charts they use are specially compiled by the local NWS office. All operators would like to see more ice information (like everyone else who operates along the western and northern Alaskan coasts).

Commercial shipping operations in Arctic regions require knowledge of the location of ice edges. For shipping activities, the importance of ice edge is dependent upon the capabilities of the vessel, geographic location, and time of year. The large tankers which will be plying U.S. and Canadian waters within the next decade have little to fear for the safety of their vessel through contact with the ice edge. This contrasts with smaller cargo ships and fishing vessels that have little or no ice capability; they may wish to know the location of the ice edge to avoid ice entirely.

Ice edge data becomes important to a large tanker in the process of optimizing its route for economic reasons. The influence of the ice edge will be to change its mode of operation from open water to ice, depending upon ice concentration. It is probable that operating horsepower will be increased to break the ice cover with resulting increases in fuel consumption. The forward speed of the ship will likely be reduced. Therefore, it may be desirable to steer a course such that the tanker maintains its route in open water for as long as it is practical to do so.

Ridges and leads (navigable waters free of hard ice) are of particular interest to shipping or barge transit in the Arctic. When transiting a consolidated ice cover, the ship crew wishes to find the path of least resistance to speed up transit time, to expend less fuel, and to reduce wear and tear.

Ridges are the single, greatest ice impediment to a ship's forward progress and ridge determination requires high resolution surveys of the ice. During the dark winter months, this can only be accomplished by radar imaging. Why is knowledge of ridging so important? Successful penetration of ridges is a function of the ship's horsepower and mass as well as the ridge geometry, type, degree of consolidation, surrounding ice thickness, and the proximity of other ridges. Multiyear ridges are the worst case because of the stronger ice and full consolidation of the ice ridge keel requiring a larger mass of ice to be broken. Should a ship become stuck in the ridge, it must back up in its own track and ram the ridge at nearly full power. This "ramming" cycle may have to be repeated several times before the ridge is penetrated. Significant fuel is spent during the ramming and there is greater potential for damage. The ship's net forward progress is slowed in penetrating ridges. When the ship backs up in its track to enable it to build up proper speed before hitting the ridge, ice can be ingested into the propellers and/or hit the rudder. Therefore, it is desirable to minimize the ship/ridge interactions as much as possible. Ice islands are to be avoided entirely by all ships.

Icebergs affect a wider range of activities because of their geographic origin and distribution. The iceberg size will determine what course of action is to be taken in relation to the operation and its capability. For example, a large tanker can withstand collisions with icebergs that would severely damage a smaller vessel. The known presence of icebergs in an area will undoubtedly cause a tanker master to slow down his vessel substantially. The above-water profile of an iceberg is not necessarily sufficient to establish whether it is of concern. In addition, the master is trained to minimize damage even though collision may not disable or stop the ship.

In summary, like the drilling operations discussed previously, Arctic shipping is a risk venture at present that could be greatly improved with better environmental data about the location, structure, and composition of the ice. This information must be provided in a consistent routine manner with frequent updates owing to the rapid changes in location (10s of km in a day) and condition.

Ocean transit shipping relies more heavily on weather routing services and also must skirt the ice edge in the northern latitudes. United States Lines (USL) is a company with a fairly large fleet of cargo and container vessels (around 40 ships worldwide). As with the other shipping companies, USL uses the NWS FAX broadcast information and they also receive the Notice to Mariners as well as any updates on various charts (tides, currents, etc.). Although USL receives NOAA data that they are aware of, they also use private weather forecasting services to augment the NOAA data. Their fleet operations also use satellite communications by Marine Communications Satellite (MARISAT).

For their more northerly routes, USL relies on timely ice information to avoid not only the ice edge, but also icebergs. They rely heavily on Canadian reports which are based at least partly on remote sensing aircraft reconnaissance. USL is also involved with the global network of ship weather observations which are supplied to the NWS. Various ships from their fleet maintain a log of weather observations taken at 0, 6, 12 and 18Z, which they hand over to NOAA. They also report any navigation problems which are incorporated into the Notice to Mariners.

As is evident, USL is willing to use private companies for their specific forecast needs and are more interested in the quality of the information than its cost.

As with other shipping users, USL did not feel they were aware of all that NOAA has to offer and would like to see this information compiled into a catalog. If a regional OSC were established in the northeast, USL would certainly use it.

4.2.2 Issues

Many modern vessels today are equipped with sophisticated communication systems such as International Marine Communications Satellite (INMARSAT) terminals and satellite navigation equipment. Many shipping companies use the services of a weather routing company. However, much of the independent vessel transportation relies solely upon NOAA marine advisories and high seas warnings. A major problem for these shipping companies is timely communication. Many ships using NOAA information are only equipped with Single Side Band (SSB) radios which takes several hours or days before a vessel on the high seas can receive a storm warning. Therefore, this industry would greatly benefit from a coordinated effort between industry groups, the Value-Added industry, and NOAA to improve the general marine forecasts.

Nearly all of the shipping companies stressed that better communication between Government and industry was necessary but, at the same time, seemed very wary of any Governmental influence, especially NOAA. They feel that their industry knows best what is good for itself and that NOAA is not independently competent to decide how to improve the operational capabilities of marine industry, whether through delivering advanced products (e.g., electronic communications) or in promoting more cooperation between industry components. They feel that NOAA's role as a provider of the important and useful weather and marine products used daily by the marine industry is very important but data types, formats, and priorities should be established by the industry working in concert with NOAA.

There is a critical need for improved data collection in two regions. First, timely data about ice conditions in the Arctic would help open up this region commercially. All users agree that the expense of working in or designing for this region could be significantly reduced if they had better information. Good data would also extend operating periods. The required information can be collected from satellites (region) or aircraft (local) using high resolution microwave radiometers or imaging radars.

4.3 Ocean Mining Industries

4.3.1 Survey Results

Table 5 presents the results of the Ocean Mining Industry survey.

Ocean mining equipment, similar to that for off-shore oil exploration, is costly and subject to damage or loss if an unexpected change in weather conditions catches a mining operation off-guard. Thus, the need for environmental forecasts within the exclusive economic zone and in the deep ocean is a high priority of ocean mining operations. This need is clearly indicated in the table. There is a need for real time data keyed to the deep ocean mining region in the mid-basin ocean floor in the South Pacific. Currents, wave directional spectra, surface wind vector field, and the reliable prediction of tropical storms are all essential data that must be delivered in a timely manner to permit successful dredging or collection operations.

The Ocean Mining Industry is a new industry still in its development stage. The search for minerals in the ocean floor has been spurred on by finds of manganese nodules and now polymetallic sulfides. At present, only two U.S. companies and a few international consortiums have developed techniques for mining the ocean bottom. The U.S. companies are:

Ocean Mining Associates
Route 17
Glouster Point, VA 23062

and

Lockheed Ocean Minerals
P.O. Box 504
Sunnyvale, CA 94088

The technology needed to harvest these metals promises to expand during the coming decades.

Table 5. User Needs – Ocean Mining

Measurement Requirements	Long Range Planning	Engineering Design	Operations Design	Dynamic Station Keeping	Logistics	Forecast Support
OCEANIC						
Temperature						
Horizontal	□	□	□			
Vertical						
Currents, Fronts & Eddies	◨	■	◨	○	○	○
Tides	◨	◨	◨			
Surface, Directional Spectra	■	■	◨	●	◑	●
Internal						
Bathymetry						
Entrained or Dissolved Organics						
Sediment						
Salinity	□					
Surface Wind Vector Field	◨	◨	■	●	◑	●
POLAR						
Sea Ice Classification						
Grease						
First Year						
Multi Year						
Sea Ice Extent						
Individual Floes						
Pack						
Deformation & Leads						
Sea Ice Thickness						
Floes						
Ridges						
ATMOSPHERE						
Boundary Layer Winds			□	◑	◑	●
Surface Pressure						○
Sensible Weather			□		◑	●

Data Category: ○ Real Time □ Archival

● Critical ◑ Important ○ Useful

Lockheed is a major partner in the Ocean Minerals Company (OMC) which is a consortium of U.S. and Dutch companies interested in mining the sea floor and, in particular, the recovery of manganese nodules. Lockheed has been involved over the last 17 years in developing techniques and machinery for deep ocean mining. Retrieving the manganese nodules from the ocean bottom under three miles of water is a very expensive undertaking. A $100M 1/10 scale system has already been developed and tested to access the availability of mineral resources and to determine the effect on the environment that a large scale mining operation would have.

Because the nodule beds lie outside the coastal jurisdiction of the maritime nations, there is a question as to who has the right to exploit the resourses of the mid-basin ocean floor. This controversy is being addressed in the international Law of the Sea Treaty. The outcome of this legal and political document will, of course, directly impact the profitability of ocean mining.

NOAA ships have been used for basic biological research in the nodule areas and will continue to work closely with NOAA scientists as new areas and resources, such as the poly-metallic sulfides found near the newly discovered deep sea vents, are explored.

4.3.2 Issues

The current operational side of deep ocean mining consists mainly of data collection for research and the at-sea testing of mining equipment and systems. For these purposes, the importance of good forecasts and near-real-time data is crucial to the extension of mining equipments to the ocean floor from the mining ship. This extension requires nearly a day to recover and can be easily lost if a sudden storm occurs. Mining operators have found the weather data provided by NOAA (voice and FAX) to be helpful, but they require smaller geographic grid forecasts and better data relay to the site. In the future, when the profitability of deep-ocean mining is more clear-cut and large scale efforts can become operational, Ocean Mining Industries (OCM) would be willing to pay for private forecasting services, realizing that a quality product is worth its price in a competitive market. NOAA could help private industry by contracting out research and development tasks in this area which would put U.S. private industry in position to exploit the new technology on an operational basis when the time is right.

4.4 Commercial Fishing Industries

4.4.1 Survey Results

During the course of this User Needs Assessment, the Seattle Regional Ocean Service Center (ROSC) commissioned an in-depth needs survey focused on the U.S. west coast fishing industry, including fishermen operating in the Alaska region. Because of its focused nature, this fisheries survey will provide detailed results regarding the needs of the commercial fishing industry. By design, this section of the User Needs Assessment report is brief, incorporating results not found in the fisheries survey. This section is intended to augment the more detailed survey. The reader is encouraged to review the results from both studies in order to gain a comprehensive view of the marine weather and oceanographic data needs of the commercial fishing industry.

Table 6 represents the user needs survey results for the marine fishing industries. Commercial fishermen, when asked to identify the most important weather elements that can affect their operations, will generally specify wind and sea state conditions. In Arctic regions, freezing spray, air temperatures below 32°F., and fog are "also critical" weather factors. Fishermen desire ocean color and temperature information to help locate the best fishing areas. Various species are known to have a preference for specific temperature and color regions.

In the polar regions, the ice edge is important to fishing boats for several reasons. Most have little or no breaking or resisting capability, and will want to avoid the ice as much as possible. At the same time, it has been shown that some fish stocks follow the ice, so knowledge of the ice edge may determine the probable best fishing areas.

Commercial fishing operations are always affected by marine weather and ocean conditions. In recent years, however,

Table 6. User Needs – Fisheries

Measurement Requirements	Fish Behavior Studies	Selection of Optimal Fishing Areas	Fishing Tactics	Forecasts for Operations Safety	Logistics Scheduling	
OCEANIC						
Temperature						
Horizontal	■	●	◑			
Vertical	■	●	◑			
Currents, Fronts & Eddies	■	●	●	◑	◑	
Tides						
Surface, Directional Spectra	◨	◑	◑	◑	◑	
Internal						
Bathymetry						
Entrained or Dissolved Organics	■	●	◑			
Sediment	◨	◑	◑			
Salinity	■	●	◑			
Surface Wind Vector Field	■	◑	◑	●	●	
POLAR						
Sea Ice Classification						
Grease						
First Year						
Multi Year						
Sea Ice Extent						
Individual Floes						
Pack				●		
Deformation & Leads				●		
Sea Ice Thickness						
Floes						
Ridges						
ATMOSPHERE						
Boundary Layer Winds			◑	●	●	
Surface Pressure					◑	
Sensible Weather			●	●	●	

Data Category

○ Real Time ☐ Archival

● Critical ◑ Important ○ Useful

fishermen are being forced to take additional weather-related risks as fishing seasons and stock quotas are decreased. The fishermen are under increased pressure to catch more fish in less time. As a consequence, marine weather information will become more important in terms of short term, tactical planning rather than in terms of aiding in the decision of when or where to go fishing. Fishermen may use marine weather information to decide when to leave the grounds to unload, but adverse weather advisories may not force fishermen to stay in port or leave the grounds. An increasing number of weather-related accidents may result from this situation in the future, although vessels are increasingly being built to withstand, and operate in, severe weather conditions.

It has been shown by a "Fisheries Demonstration" pilot program conducted on the U.S. west coast, using Nimbus-7 data that fishermen appreciate and would like to receive more fisheries-oriented data products. However, their independence and frugality (a result of the general state of U.S. fisheries) makes theirs a hard market to profitably exploit with this type of service. Many Value-Added industries feel private industry should have a chance to compete to produce these data products (e.g., ocean color and specific weather information). NOAA could satisfy everyone's needs by subsidizing the differential between the cost of development of these products and the level which the fishing industry can pay.

A Marine Assessment Conference was held by the NOAA-NWS Weather Service Forecast Office (WSFO) in Redwood City, California during March 1983. This conference addressed the needs of the marine users with respect to the operational demands placed on the San Francisco Marine Unit. The requirements of the west coast commercial fishing industry were compiled during this conference. These requirements are set forth in the charts shown in Table 7. These needs were developed in close association with both individual fishermen and industry associations, including the

Table 7. Marine Weather & Environmental Needs of the U.S. West Coast Commercial Fishing Industry

Product	Depictions	Geographic Coverage	Distribution/Transmission Type	Distribution/Transmission Time	Seasonal Emphasis
Surface Prog. (24 hr.)	Major highs and lows Direction of Movement of Highs and Lows (Storm Track) Isobars (4 mB Spacing) Fronts Wind Speed and Direction Precipitation Severe Storm Warnings Jet Stream Trajectory	1. 60° N to 30° N, Coast to 160° E 2. 35° N to 10° S, Coast to 150° W	Facsimile	12:00 PM 8:00 PM	No
Ocean Temperature Analysis	Sea Surface Temperature (2°F Isotherms) Key Fisheries Isotherms Mixed Layer Depth (50 ft. Iso-Depth Lines) Updwelling Index Analysis and Forecast Significant Wave Height and Direction (?)	1. 54° N to 40° N, Coast to 135° W 2. 42° to 28° N, Coast to 135° W	Facsimile	12:00 PM 8:00 PM	April thru October

Note: Mercator Projections Preferred.

These needs can be met through the combined services of NOAA and the value-added industry.

Table 7. Marine Weather & Environmental Needs of the U.S. West Coast Commercial Fishing Industry (Cont)

Product	Depictions	Geographic Coverage	Distribution/Transmission Type	Distribution/Transmission Time	Seasonal Emphasis
Weather Outlook – 5 Day	Summary of Fisheries – Related Environmental Conditions (Sensible Weather), Departures from Normal, Severe Storm Warnings, Include Key Fisheries SST	Eastern Pacific Basin Facsimile	Voice (NWR) Facsimile	NWR: 4:30 AM : 9:30 PM Facsimile: 12:00 PM 8:00 PM	April thru October
Surface Prog. (24 hr.) (Marine-Only Package)	Sensible Weather Summary Severe Storm Warnings Sea Surface Temperature Buoy Reports (Applicable to Region)		Voice (NWR)	4:30 AM 9:30 PM	No
Surface Analysis	Major Highs and Lows Past 12-24 hr. Position of Highs and Lows Fronts Isobars (4 mB Spacing) Wind Speed and Direction Waves	1. 54° N to 40° N, Coast to 135° W 2. 42° to 28° N, Coast to 135° W 3. 35° to 10° S, Coast to 150° W	Facsimile	12:00 PM 8:00 PM	No
Ocean Color Boundary	Major Ocean Color Boundaries Based on Nimbus-7 CZCS Observations	1. U.S. West Coast – San Diego to Vancouver Is. 2. Midway Is.	Facsimile	12:00 PM 8:00 PM	April thru October

Note: Mercator Projections Preferred.

Western Fishboat Owners Association.

4.4.2 Issues

Key needs of the west coast fishing community can be summarized below:

1. The NOAA Weather Radio (NWR) will serve a large number of the fishermen operating in the coastal region. These fishermen need a marine-only package which is broadcast around 4:30 a.m. and again around 9:30 p.m. (local time).

2. The NWR marine package should include a sensible weather summary, severe storm warnings, sea surface temperatures, and any buoy reports applicable to the area.

3. Fishermen with radio-facsimile capability need good surface prognosis and analysis charts, along with a five day outlook summarizing sensible weather, key fisheries SST, and storm tracks.

4. Facsimile broadcasts should be made around 12:00 a.m. and again around 8:00 p.m. (local time).

5. Fishery-aids charts, including satellite-derived SST depictions and ocean color boundary charts, are of great value to fishermen. Some of these charts can be included as a part of the NWS operational charts and others (i.e., color boundary) can be included as experimental products.

6. A good 24-hour surface prognosis is an essential ingredient of any suite of marine weather products for all commercial fishermen.

4.5 Marine Construction/Off-Shore Support Industry

4.5.1 Survey Results

The backbone of the off-shore industry is the group of support companies that perform seismic surveys and move the supplies, crews, and drilling equipment from the land-based facilities to the off-shore rig, and the construction and installation companies that build the equipment and rigs. To realize the importance of environmental concerns to this industry group, all one has to do is talk to them and let them describe the storms in Alaska, the hurricanes in the Gulf of Mexico, or the time they launched a rig in 1000 ft of water and needed a "weather window" of three days with wave heights less than 4 ft. Off-shore rigs are not autonomous entities. A rig, either a semi-submersible, jack-up or drillship, depends on contact with a supply base in order to rotate crews and to get essential drilling equipment, pipe, and food supplies. Time is of the essence when working off shore. The daily operations of a rig, including all support personnel, supply vessels, and helicopters, can reach $600,000 per day while drilling in Arctic waters. The pressures of cold, wind, ice, fog, and barren environmental conditions are a burden to these operations and their efficient management.

Table 8 presents the results of the survey of this user sector. There is a strong reliance on archival data of nearly all types to assist in site selection and engineering design of a proposed installation. Companies also use archival information to support required assessments of environmental impact.

Real-time temperature, current, wind, and ice data is required to schedule and conduct operations. Since many installations are sited in hostile environments, environmental information is critical to the economics of a project.

The basic work in seismic exploration, conducted prior to

Table 8. User Needs – Marine Construction/Offshore Support

Measurement Requirements	Site Selection	Engineering Design	Environmental Impact	Construction Scheduling	Operational Forecast Support	
OCEANIC						
Temperature						
Horizontal	□	◧	◧	○	◐	
Vertical	□	◧	■			
Currents, Fronts & Eddies	■	■	◧	◐	●	
Tides						
Surface, Directional Spectra	■	■	◧	■	●	
Internal	■	■	◧	■		
Bathymetry	◧	◧	□			
Entrained or Dissolved Organics						
Sediment	◧	◧	◧			
Salinity	□	◧	□			
Surface Wind Vector Field	◧	◧	□	●	◐	
POLAR						
Sea Ice Classification						
Grease						
First Year						
Multi Year						
Sea Ice Extent						
Individual Floes						
Pack	■	■		●	●	
Deformation & Leads						
Sea Ice Thickness						
Floes	■	■		●	●	
Ridges	■	■		●	●	
ATMOSPHERE						
Boundary Layer Winds		◧	◧	●	●	
Surface Pressure						
Sensible Weather	■	■	◧	●	●	

Data Category: ○ Real Time □ Archival

● Critical ◐ Important ○ Useful

off-shore oil lease bidding or any drilling activity, is accomplished by the geophysical contractors. These services consist principally of the collection, processing, and interpretation of geophysical data. The companies have fleets of ocean-going seismic survey vessels capable of operating at sea for extended periods. These vessels are equipped with satellite navigation systems and a sophisticated array of geophysical instrumentation including seismic, gravitational, and magnetic instruments using digital recording systems.

When operating the fleet for prolonged periods of time, and in remote and environmentally hostile waters, the cost of operation depends on the sea-state conditions.

Like the oil and gas industries, this industry sector has, in the past, gone to the Value-Added industry for help. The Value-Added industry now supplies the data, forecasts, and studies needed to solve the ever-increasing problems facing off-shore exploration and development. However, the basic products, data, and forecasts used by the Value-Added group is generated in NOAA and Navy data collection and computer facilities.

Rowan was one of the many construction companies interviewed and is engaged as an off-shore drilling contractor building, deploying, and maintaining oil rigs on a worldwide basis for various oil companies. About 10% of their business is in Alaska where they also have a subsidiary helicopter company, ERA Helicopters.

Rowan uses the NWS weather FAX broadcasts in their operations as well as several private forecasting services (Universal Weather Services, Willkins Weather in Houston, and Glenn's Weather Services in New Orleans, to name a few). Rowan indicated that since weather patterns generally move west to east in the upper latitudes, more weather information from Siberia would be useful.

4.5.2 Issues

Oil rigs also serve as weather stations for NOAA and private industry can, in this way, make an important contribution to the weather data base in remote regions. Since the weather window for their off-shore operations is short (48 hours), accurate and timely weather data is more critical than it would be for, as an example, a shipping company. Improved weather gathering technology is essential. As an example, most companies suggested the development of weather buoys and their deployment in the Bering Sea.

Construction companies engaged in Alaskan operations would benefit from improved ice information. Most companies expressed a willingness to contribute to a NOAA-sponsored pilot program to develop real-time SAR data dissemination if such a decision were based on the results of an industry/NOAA implementation and marketing study. As with other off-shore companies, the bottom line is "return on investment," and if SAR data is too expensive an investment compared to what they are paying now for ice information, it would not be a good buy.

These companies felt that they were not totally aware of all that NOAA has to offer and could benefit from a better catalog of services.

4.6 Private Forecasting and Value-Added Industries

4.6.1 Survey Results

This group of users is so important to the commercial assimilation of marine environmental data that Section 6.0 of this report has been devoted to issues identified with this group.

The term "Value-Added Industries" in this study refers to companies which enhance the basic NOAA products, data, and services for specific clients and specific uses. The companies take the basic environmental data provided by Government, add some meteorology and oceanography, and produce a technical product to support a broad-based but highly specialized user group. Several companies in this core of industrial users have been active participants in previous Government user conferences and demonstration programs such as the SEASAT Commercial Demonstration Program.

Table 9 presents the results of the survey performed with this user sector. Nearly every category is filled in this diagram because many of the commercial user sectors, discussed previously, use Value-Added support services.

The Value-Added industry needs a responsive Government in terms of data, products, and delivery. In return, the existence of the Value-Added industry can enhance NOAA's efforts by offering services beyond the scope intended by Government.

A large number of Value-Added companies were interviewed. Opinions of a representative cross-section of these companies are included in this section.

Universal Weather Service, (UWS) based in Houston, is a private forecast service using NWS data to produce worldwide tailored

Table 9. User Needs – Private Forecasting and Value Added Industries

Measurement Requirements	Data Services	Design Studies	Planning Studies	In-House Analysis and Special Purpose Prediction	Exstactiions Customization of NOAA Products	Special Weather Advisories
OCEANIC						
Temperature						
Horizontal	◐	□	□	◐	◐	
Vertical	○	□	□	◐	◐	
Currents, Fronts & Eddies	◐	◧	◧	◐	◐	
Tides	○	◧	◧	◐	○	
Surface, Directional Spectra	●	■	■	●	●	●
Internal	○	□	□	○	○	
Bathymetry		◧	◧			
Entrained or Dissolved Organics			◧			
Sediment			◧			
Salinity			◧			
Surface Wind Vector Field	●	■	■	●	●	●
POLAR						
Sea Ice Classification						
Grease		□	□	◐	◐	◐
First Year		□	◧	◐	◐	◐
Multi Year		□	◧	◐	◐	◐
Sea Ice Extent						
Individual Floes		□	◧	○	○	◐
Pack		□	◧	◐	◐	◐
Deformation & Leads		□	□	◐	◐	◐
Sea Ice Thickness						
Floes		□	◧	◐	○	◐
Ridges		□	◧	◐	○	◐
ATMOSPHERE						
Boundary Layer Winds	●	■	■	●	●	●
Surface Pressure	●	□	□	●	●	○
Sensible Weather	●	◧	■	●	●	●

Data Category: ○ Real Time □ Archival

● Critical ◐ Important ○ Useful

forecasts for off-shore oil companies, airlines, radio, and television stations, etc. (UWS has about 200 clients). They receive the whole suite of NOAA FAX products as well as the visible and infrared (IR) satellite data and radar images from various stations from San Diego to San Juan. They distribute their products to their clients by an extensive communications system, including telecopies by TELEX and TWX. They also have their own High Frequency (HF) transmitter to enhance their global communications.

UWS is generally content with the amount and quality of data that they receive from NOAA. The most specific improvement mentioned was an increase in weather coverage for the mid-East and the Indian Ocean and that it would be useful to have a better catalog of NOAA's products and services. For example, they had heard of and were interested in NODDS, but were not sure what sort of data is distributed or how to get on the system.

NORTEC is a Value-Added and consulting company whose main emphasis is on collecting and analyzing data for pre-drilling environmental impact studies. One-sixth of their business involving forecasting is focused mainly on Alaskan users; they are also under contract to the NWS to put together flight folders for international flights that contain copies of the standard FAX charts. NORTEC does not subscribe to the National Meterological Center (NMC) data circuit, but they do have high-speed land lines to receive their FAX data from the FAA data base in Kansas City. Besides using the resources of the Anchorage NWS office, with which they are quite pleased, NORTEC also gets information from the Arctic Environmental Information Data Center (AEIDC) which is part of the University of Alaska. Along with other Value-Added companies, NORTEC believes NOAA should provide an expanded observational data base. A specific example mentioned was a desire for more buoy data, both in the various straits and inlets around Alaska as well as on the open sea, at 5^{o} resolution. NORTEC would be willing to cooperate with NOAA in providing observations from the drill platforms which they monitor (they have done this in the past). As usual, for companies operating around Alaska, they would also like to see ice-information from SAR images, but do not seem eager to invest their own money into a pilot project.

Global Weather Service, Inc. (GWSI) is a Value-Added company that provides detailed site and operation specific weather and ocean condition information to various marine users. GWSI obtains much of its data from NOAA by NODDS and the NMC data circuits. They also obtain a significant amount of observational data from international sources as well, and have the computer resources to tailor large data bases to specific user needs and to run sophisticated forecast models.

GWSI perceives the role of NOAA to be a provider of observational data to whoever wants it (and, in particular, Value-Added companies) and to provide general and safety related processed information for the public at large. GWSI feels that more Government-generated data is available and would be useful in their business. In particular, the U.S. Air Force has a very large data base (at Carswell AFB) which is only partially being tapped by NOAA and made available to the private sector through the NMC. More satellite data is also desired, both in the form of images and as digital data which can be directly accessed by GWSI's own computers. This would enable the Value-Added industry to greatly improve the quality of their products. NOAA is perceived as dragging its feet in deploying marine-oriented satellite borne instruments.

Oceanroutes, Inc. (ORI) is a Value-Added company providing, as a major component of their business, optimal ship routing on a global scale. ORI is also involved in site and operation specific forecasting for oil and mining companies. They use virtually 100% of the data available through the NMC circuits and have a NODDS FAX graphic hook-up. Along with the usual FAX marine weather data (e.g., surface analysis and progs, wave height, ice boundaries, etc.), they also receive satellite images on their own UNIFAX machine. The observational data they receive through NOAA sources is also supplemented by data collected from foreign sources. As an example, the Global Telecommunications System (GTS) worldwide weather network, which subscribers can access through NMC, does not contain all the Japenese weather information, so ORI has set up their own data circuits to pick up this additional Japanese information. Hindcasting and climatological studies are also a major component of their business and ORI has built up their own archived data base. They update this with microfilmed climatoloical data from NMC.

4.6.2 Issues

Value-Added companies feel that private industry, in general, is quite capable of fulfilling the needs of the marine user, aside from safety and general information applications. They will require a clear and consistent idea of what type of data bases NOAA will provide and no competition from NOAA in providing services to the marine user market. All Value-Added groups are wary of the new Ocean Services Centers. In terms of fulfilling user needs, a paraphrase of the views of the industry might be, "if it is really needed, the user will be willing to pay for it." They perceive NOAA's main role as that of a provider of observational data and large numerical model outputs. The Ocean Services Centers are not seen as being necessary except perhaps in providing an "information booth" which can give an inquiring marine user a list of private companies whose services can fulfill the user's needs. This view maintains that private (Value-Added) companies are capable of fulfilling all the specific needs of the marine community and should be allowed to do so within a competitive market environment.

Besides maintaining a non-competitive stance, NOAA should also make its policies clear on the types and availability of data bases it provides to the private sector. The types of services that Value-Added companies would like to see NOAA expand and improve include: a broadcast network on which private companies could buy time, and more observational data from existing sources (e.g., U.S. Air Force and U.S. Navy), as well as new data gathering efforts such as more satellite data. They also feel that NOAA is not following through on its goal of increased communication between it and private industry. The communication that exists is seen as more of an intermittent effort (e.g., yearly user conferences) rather than the open and regular dialogue needed to get views across effectively.

4.7 Sea Grant and Academic Institutions

The backbone of ocean research lies in the resources of our universities and the Government-supported research at Sea Grant institutions. Although the universities are not directly involved in the commercial sector, their research feeds back into the growing technology base used in industry. Several universities are working with industry and Government to transfer technology for practical application. This interdependence creates a healthy environment for bringing together groups with similar needs and interests in basic data and products. Since universities use the data supplied by NOAA and gathered through ocean cruises and ocean satellite programs sponsored by the Government, they have a vested interest in the exchange of NOAA products.

4.7.1 Survey Results

Table 10 provides an overview of the data needs of Sea Grant and academic institutions. The salient feature of the table is the absense of real-time data requirements. This user sector relies on archival data sets to fuel studies of the marine environment and climatology. Model design and development efforts are also a mainstay of this community.

A review of the opinions and needs resulted from the survey conducted interviews with a number of institutions including Woods Hole Oceanographic Institute, Scripps Institute of Oceanography, and the University of Rhode Island.

A generally held opinion is that the establishment of the Ocean Service Centers is a needed mechanism for improving NOAA's communication capabilities. However, the institutions did bring up the issue of the scope of the OSCs, i.e., how large and selfcontained should they be; and whether data, such as that contained in the National Ocean Data Center, should be duplicated

Table 10. User Needs - Sea Grant and Academic Instructions

Measurement Requirements	Hydro-Climatological Studies	Net Model Design	Oceanographic Model Design	Climate Model Design	Ocean Resource Management Studies	
OCEANIC						
Temperature						
Horizontal	■	■	■	■	■	
Vertical	■	■	■	■	■	
Currents, Fronts & Eddies	■		◧	◧	◧	
Tides	◧		□	◧		
Surface, Directional Spectra	◧		■		□	
Internal						
Bathymetry			■	◧	□	
Entrained or Dissolved Organics					■	
Sediment						
Salinity	◧		□	□	◧	
Surface Wind Vector Field	■	◧	◧	◧	□	
POLAR						
Sea Ice Classification						
Grease						
First Year	◧		◧	◧		
Multi Year	◧		◧	◧		
Sea Ice Extent						
Individual Floes	◧		◧	◧		
Pack	◧	◧	◧	◧		
Deformation & Leads	□		□			
Sea Ice Thickness						
Floes						
Ridges						
ATMOSPHERE						
Boundary Layer Winds		■	■	■	□	
Surface Pressure		■	■	■		
Sensible Weather		◧		◧	□	

Data Category: ○ Real Time □ Archival

● Critical ◐ Important ○ Useful

and stored at the regional centers. The consensus seemed to be that the optimal configuration would have the OSCs be an extension of the national office, with regional data bases in-house.

Various academic centers have Ocean Industry Programs (OIPs). This program, which was initiated and has been entirely funded by private business, organizes various geophysical data bases (mainly seismic) so that industry can access them easily. There are programs at Woods Hole, Scripps, and Lamont-Dougherty. Though this type of program appears to represent a service very similar to what NOAA should be providing, the institutions feel that it is complementry to NOAA's data collection efforts. The forte of OIP is synthesizing and packaging the data into a self-contained medium. Thus, the OIP program adds value to collected data by correlating and collating it into an easily accessible and describable form. The OIP has even provided NOAA with data for its National Ocean Data Center (NODC).

In the past, the OIP mostly obtained survey data. However, because most areas have already been surveyed, a shift in data collection is being made (by researchers) to more specific and deterministic experimental results. Though industry is interested in this type of data, there is less of an impetus for private business to fund specific experiments. For this reason, the OIP is trying to diversify its services to the business community so that they are based not just on data base organization, but also the scientific consulting resources of the institutes. The OIP thus appears to be operating much like a Value-Added company.

All groups feel that an area where NOAA could help is in the cataloging of various small bases which, though perhaps somewhat obscure and seemingly insignificant, nevertheless may be usefull to someone if they knew it existed. NOAA would not necessarily obtain the data and reformat it to make it comply with internal standards, but should concentrate on publicizing its existence and whereabouts and leave the data base in the hands of its creator who would probably take better care of it.

The aim of the Sea Grant program is to improve the ability of industry to operate in and exploit the marine environment, particularly in the coastal areas.

4.7.2 Issues

Sea Grant tries to formulate user problems into well-posed research questions and also tries to convince typically independent researchers to become interested in industry-related problems. Sea Grant thus represents a mechanism for technology transfer to the private sector. Members of this sector feel that private programs tend to work better when an entrepreneurial element of the private sector sees a chance to profitably develop a new technology, in which case the organizational work is not left entirely to Sea Grant.

An atmosphere of cooperation and goodwill between universities and industry should be effective in increasing the awareness of university personnel of the practical problems of working in the ocean commercial sector. Industry, Government, and universities have developed common working interests in ocean resources by interacting together. More interaction needs to occur and NOAA could gain by encouraging and sponsoring this dialog.

4.8 The Climate Community

In general, it is more difficult and expensive to achieve adequate observational coverage over marine areas than over land. For this reason alone, special care must be taken in the design and maintenance of climatological data bases for support of the marine user community. Marine climatological files are defined here to include both raw observations and selected products in processed form. To be useful, the right kinds of climatological information need to be archived and the information should be in the proper formats.

Ocean-related industries need and use information derived from the results of climate research. Much of the climate research focuses on time scales and geographical areas of interest to operational marine users, and is important for planning and daily operations of a wide range of ocean industry activities.

4.8.1 Survey Results

The requirements for good marine climatological information are specified in terms of several broad functional areas as shown in Table 11. Both real time and archival information is needed. The archival data supports data base construction and model design with the real-time data supporting model run evaluations and near-real-time climate monitoring. The functional areas shown in the table include most of the marine commercial applications which are major users of marine climatological data bases. The following paragraphs discuss each of these functions in some detail and give examples in each area.

Data base construction is critical for operations planning for many marine operations that are so environmentally sensitive that they cannot be carried out at all under certain conditions. Before the economic feasibility of certain operations can be

Table 11. User Needs – The Climate Community

Measurement Requirements	Data Base Construction	Special Case Studies	Modeling Support	Climate Monitoring and Model Run Evaluation		
OCEANIC						
Temperature						
Horizontal	■	◧	■	●		
Vertical	■	◧	◧	●		
Currents, Fronts & Eddies	□	◧		○		
Tides	□					
Surface, Directional Spectra	□	□	□	◐		
Internal						
Bathymetry	◧		■			
Entrained or Dissolved Organics	□	◧				
Sediment	□	◧				
Salinity	□	◧				
Surface Wind Vector Field	■	■	■	●		
POLAR						
Sea Ice Classification						
Grease	□	□		○		
First Year	□	□		○		
Multi Year	□	□		○		
Sea Ice Extent						
Individual Floes	□	□	◧	○		
Pack	□	□	◧	○		
Deformation & Leads						
Sea Ice Thickness						
Floes	□					
Ridges	□					
ATMOSPHERE						
Boundary Layer Winds	■	◧	■	◐		
Surface Pressure	■	◧	■	●		
Sensible Weather	■	◧	□	◐		

Data Category: ○ Real Time □ Archival

● Critical ◐ Important ○ Useful

determined, the operation must be tested under the climatological conditions which can be expected in the area of interest.

In some cases, a particular operation can be scheduled during the season (month) when conditions are favorable from a long-term (climatological) viewpoint. However, in many cases it is not adequate to know only the monthly mean values for the most critical parameters. It is necessary to know how often a sub-critical "window" can be expected to occur and how long it will last. For example: deploying the "mining string" from a deep-ocean mining vessel requires a certain number of hours with wind and sea state below specific threshold values; and anchoring a drilling rig requires a different number of hours with different threshold limits.

It is obvious that some operations planning can be accomplished with monthly statistics of key parameters in field form at grid points; however, "window analysis" requires archives containing the same key parameters in field form at grid points on a daily or twice-daily basis for a number of years (at least five years and, preferably, 50 to 100 years). Discussions with various components of the marine user community reveal that the key parameters for operations planning, in approximate order of priority, are as follows:

- Sea State (Significant Wave Height, Predominant Direction/Period)
- Surface Wind (Direction/Speed)
- Sea Surface Temperature
- Surface Current (Direction/Speed)
- Ice Statistics
- Sensible Weather Statistics
- Restrictions to Visibility Statistics
- Air Temperature

Data base construction is also important for nearly all types of marine design: ships, drilling rigs, platforms, piers, breakwaters, habitats, etc. The object in economical marine construction is to design structures (vessels) which will withstand expected environmental conditions but not be over-designed, thereby increasing costs beyond what is reasonably required. It is customary to use what is commonly called the 100-year design climatology. That is, curves showing the probability of specific values for key parameters occuring in a period of 100 years. Since 100 years of observations (or analyses of observations in field form) are seldom available, statistical procedures are used to arrive at the required 100-year design climatologies.

The climatological parameters needed to support structural design are somewhat the same as those needed for operations planning except that many marine structures are frequency sensitive. This means that design work depends upon a knowledge of the entire wave energy spectrum (the distribution of spectral densities as functions of frequency and direction). In addition, it is usually necessary to know the distribution of ocean currents with depth. Key parameters, in approximate order or priority, for structural design are:

- Spectral Wave Energy Distribution (with Frequency and Direction)
- Current Structure (Direction and Speed) with Depth
- Boundary Layer Wind Structure (Direction and Speed with Height)
- Ice Statistics

Structural design work can be based either upon observational files from specific observation stations or analysis files of key parameters in field format at grid points. Again, the length of the second should be at least five years (preferably 50 to 100 years).

Special case studies can cover many diverse subjects. Three representative subjects of interest to academic and commercial users are basic climate analysis, pollution or environmental studies, and biological investigations. Climate studies of the oceans consider basic source functions such as the ocean serving as a primary heat, moisture, and momentum source for the atmosphere and, therefore, an influence on much of the world's weather (El Nino this year is a prime example). It is essential for climate researchers to have good (global) long-term means for key parameters and the fields necessary to study shorter-term anomalies from these means.

Of primary concern are the factors which control air/sea exchange of heat, moisture, and momentum:

- Sea Surface Temperature
- Air/Sea Temperature
- Wind Structure in the Boundary Layer
- Low-Level Stability Structure
- Wave Roughness

The storage of heat in the oceans:

- Mixed Layer Depth or
- Depth to Selected Isotherms

Future commercial activities such as Ocean Thermal Energy conversion will depend on climate studies of these phenomenon and the redistribution of heat, moisture, and momentum:

- Ocean Current Structure
- Atmospheric Wind/Temperature Structure

Some of the oceanographic parameters needed for climate studies are not now analyzed by NOAA and are available only from the Fleet Numerical Oceanographic Center (FNOC). Of particular importance are mixed layer depth, depths to selected isotherms, and surface currents. Action is required to add daily analyses of these parameters to NOAA marine climatology files.

Pollution studies gained importance with the increased interest in drilling for oil/gas in coastal waters and the rapidly increasing population in coastal zones (oceanic pollution is becoming more of a threat). Detailed pollution studies are virtually a "must" before new construction is permitted in these areas. The recent studies conducted in the Baltimore Canyon and Santa Barbara Channel areas are prime examples; environmental impact studies for Ocean Thermal Energy Conversion (OTEC) plants are another example for future consideration.

Most pollution studies are based on a combination of detailed field surveys and Hydrodynamic-Numerical (HN) model runs. The latter, especially, need marine climatological inputs to specify initial and boundary conditions. Of particular importance are local climatological data as follows:

- Surface Winds
- Ocean Thermal Structure (or Density Structure) with Depth
- Current Structure with Depth
- Chemical Compensation

In addition, it is necessary to have available the following "fixed" files:

- Detailed Land/Sea Boundaries
- Detailed Bathymetry
- Tidal Harmonic Functions

Fish population studies are a prime example of biological investigations. Academic studies of marine mammals and ecosystem balance, in general, are also included. Recent studies by the Pacific Marine Environmental Laboratory (PMEL) reveal that the drastic decline in the Alaskan king crab fisheries can only partially be attributed to over-fishing. Predation by protected mammals was a more serious factor, but most important of all was destruction of the young population through transport by anomalous currents into areas unfavorable for survival.

Biological investigations of this type are frequently supported by HN and Ecosystem Model runs. These runs, and associated general climatic investigations of anomalous conditions, require the following climatic information:

- Ocean Thermal Structure with Depth
- Current Structure with Depth
- Surface Winds
- Ice Statistics
- Chemical Composition

4.8.2 Issues

Because of the relative shortage of observations over many marine areas (especially "conventional" or "non-satellite" observations), numerical analysis models tend to drift from the probably "true" state of the atmosphere or ocean after a certain number of analysis sequences unless proper climatological control is exercised. If insufficient observations are available, the analyses drift because of an inadequate "first guess;" the "first guess" is usually: the previous analysis or a short range numerical forecast, or a mixture of both. It has been found that drift still occurs in sparse data areas unless a partial reversion to climatology is made to each analysis cycle.

This reversion is typically made before the new observations are introduced and is performed in: subsurface analyses (particularly for thermal structure, including mixed layer depth); surface analyses (particularly for pressure and temperature); and upper atmosphere analyses (particularly for pressure-height, temperature, and moisture). The marine climatological information for model support is most useful if maintained in field form at grid points at standard depth below the surface and at standard pressure levels in the atmosphere. This type of information is presently weakest in the Northern Hemisphere tropical latitudes and in all oceanic areas of the Southern Hemisphere.

4.9 Data Collection

Since 1960, we have had an unusual tool that permits us to collect global information in extremely short periods of time. This tool is a space platform either orbiting the Earth at regular intervals many times each day or seemingly fixed in space, always viewing a single large area. Using telescopes and radars to collect Earth environmental information, these new additions permit collection of the measurements indicated in the previous tables with great accuracy and on-time scales consistent with environmental charges that are important to marine users. Table 12 identifies generic sensors with each of the measurements. Remote sensing from space is the most important data collection tool available to the marine user and readers should evaluate the marine user needs that follow with this potential in mind.

The capability of current U.S. space systems to measure the marine user parameters are shown in Table 13. The satisfaction of user needs spans a range of important qualifiers such as format, time delay, area coverage, etc. Each measurement is compared to these qualifiers in the table. For example, sea surface temperature can be measured now using IR sensors, but measurements are cloud limited as shown. The table also reveals major voids in capability such as winds, waves, tides, and many ice conditions. Table 13 evaluates the U.S. satellites as a composite system. Table 14 identifies specific measurements with a particular satellite and adds planned systems such as NROSS and Ocean Topographic Experiment Satellite System - NASA (TOPEX) to the current capabilities.

NROSS is of particular interest to marine users because it offers new sensors (established during the SEASAT program) that will fill many of the voids in current capabilities. NROSS is a U.S. Navy initiative with NASA (but not NOAA) participation and the planned system will provide the capabilities shown in Table 15.

Still missing are major wave and ice measurements only made possible if a SAR is used. The U.S. does not have a SAR sensor planned for operational space application. Our Canadian, Japanese, and European neighbors are manufacturing SAR systems for the Radarsat and ERS-1 programs at the present time. The international satellite remote sensing line up is shown in Table 16.

Table 12. Ocean Sensors and Observables

Parameter	Measurement Unit(s)	Altimeter	Scatterometer	SAR	Microwave Radiometer	IR Radiometer	Visual Radiometer	LIDAR	
Sea Surface Temperature	°C				●	●			
Surface Currents	s = cm/sec. d = degrees	●		●		◑[e]			
Tides (Astronomical & Storm)	cm	●							
Waves Directional Energy Spectra	h = m λ = m d = degrees	● ○[b]		●					
Shallow Water Bathymetry	m	●[a]		○			○	○	
Chlorophyll Concentration	μg/ℓ						●		
Water Turbidity	mg/ℓ or g/m³			◑			●		
Salinity at the Surface	ppt				○				
Surface Winds	s = m/s d = degrees	◑	●	◑	●				
Sea Ice Conditions	c = 1/8(oktas) A = 1,2,M yrs. L = cm T = km	◑		●	●	◑	◑		
Precipitation Rate	cm/hr				●				
Precipitable Water	cm/cm²				●				
Surface Air Temperature	°C							○[c]	

● Primary usefulness.

◑ Secondary usefulness due to cloud observation, measurement accuracy, etc.

○ Developing sensor.

(a) Deep Water Sea Mounts only.
(b) Dual frequency, scanning.
(c) Developmental measurement of ocean vertical temperature profile.
(d) 5 GHz Navy NROSS sensor.
(e) Current boundaries.

Table 13. Current System Capabilities (GOES, NOAA, DMSP, LANDSAT)

Parameter	Measurement Unit(s)	Accuracy (±)	Precision (±)	Measurement Range	Spatial Resolution (Km)	Temporal Resolution (Frequency)	Acceptable Time Delay	Area Coverage	Data Grid Size Format
Precipitable Water	cm/cm^2	◐	◐	◐	◐	◐	●	◐	◐
Precipitation Rate	cm/hr	◐	◐	◐	●	●	●	◐	●
Surface Winds	s = m/s d = degrees								
Surface Air Temperature	°C								
Sea Surface Temperature	°C	●	●	●	●	●	●	◐ (a)	●
Wave Directional Energy Spectra	h = m = m d = degrees								
Sea Ice Conditions	c = 1/8(oktas) A = 1,2,M yrs. T = cm L = km	○	○	○	●	●	○	◐	●
Surface Currents	s = cm/sec. d = degrees	◐ (b)	◐	◐	●	●	●	●	●
Tides (Astronomical & Storm)	cm								
Salinity at the Surface	ppt								
Chlorophyll Concentration	μg/ℓ	◐	◐	◐	●	○	○	○	○
Water Turbidity	mg/l or g/m^3	◐	◐	◐	●	○	○	○	○
Shallow Water Bathymetry	E = km T = mm	◐	◐	◐	●	○	○	○	○
Oil Spills (Sheen Stage)		◐	◐	◐	●	○	○	○	○

● Meets Requirements (a) Cloud limited

◐ Partial Capability (b) Current boundaries and direction

○ Minimal Capability

Table 14. System Capabilities

Parameter	Measurement Unit(s)	System Capabilities — Current: DMSP	NOAA	GOES	LANDSAT	Planned: GEOSAT	DMSP(a) (SSM/I)	NROSS	TOPEX
Precipitable Water	cm/cm²						●	●	
Precipitation Rate	cm/hr			○			●	●	
Surface Winds	s = m/s d = degrees			◑		◑	◑	●	◑
Surface Air Temperature	°C								
Sea Surface Temperature	°C	●	● (b)	◑ (d)	○ (f)		●	● (j)	
Wave Directional Energy Spectra	h = m ℓ = m d = degrees					◑		◑ (h)	○
Sea Ice Conditions	C = 1/8(oktas) A = 1,2,M yrs. T = cm L = km				◑ (e)		◑	●	
Surface Currents	s = cm/sec. d = degrees	◑	◑		○	●	◑	●	◑
Tides (Astronomical & Storm)	cm					●		●	◑
Salinity at the Surface	ppt							○ (g)	
Chlorophyll Concentration	μg/ℓ		(c)		◑				
Water Turbidity	mg/ℓ or g/m³				◑				
Shallow Water Bathymetry	m				○			◑ (i)	◑ (i)
Oil Spills (Sheen Stage)	E = km T = mm	◑	◑		◑		◑	◑	◑

● Primary

◑ Secondary/Partial Capability

○ Developmental Sensor/Capability

☐ No Capability

(a) DMSP with microwave scanner.
(b) Superior to DMSP in accuracy
(c) CZCS addition proposed.
(d) Lacks mid and high latitude coverage.
(e) Data timeliness precludes use.
(f) TM infrared.
(g) Low frequency radiometer 5 to 10 GHz.
(h) H 1/3 only.
(i) Deep water only.
(j) All weather SST.

Table 15. NROSS Capabilities

Parameter	Measurement Unit(s)	Accuracy (±)	Precision (±)	Measurement Range	Spatial Resolution (km)	Temporal Resolution (Frequency)	Acceptable Time Delay	Area Coverage	Data Grid Size Format
Precipitable Water	cm/cm^2	◑	◑	●	◑	●	●	●	●
Precipitation Rate	cm/hr	◑	◑	●	◑	●	●	●	●
Surface Winds	s = m/s d = degrees	●	●	●	◑	◑	●	●	●
Surface Air Temperature	°C								
Sea Surface Temperature	°C	●	●	●	●	◑	●	◑	●
Wave Directional Energy Spectra	h = m m = degrees	●	●	●	◑	◑	●	◑	●
Sea Ice Conditions	c = 1/8(oktas) A = 1,2,M yrs. T = cm L = km	◑	◑	●	◑	●	●	●	●
Surface Currents	s = cm/sec. d = degrees	◑	◑	◑	◑	○	●	○	◑
Tides (Astro-nomical & Storm)	cm	◑	◑	●	◑	○	●	○	◑
Salinity at the Surface	ppt	○	○	○	◑	◑	●	◑	◑
Chlorophyll Concentration	μg/ℓ								
Water Turbidity	mg/ℓ or g/m^3								
Shallow Water Bathymetry	m	◑	◑	○	◑	●	●	○	○
Oil Spills (Sheen Stage)	E = km T = mm	○	○	○	◑	◑	●	◑	◑

● Complete (meets requirements) ◑ Partial ○ Minimal capability ▭ No capability (a) Sea mounts in deep water.

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Table 16. Satellite Systems of Interest to Oceanic and Polar Users -- Foreign

				MICROWAVE RADIOMETERS		RADARS			V&IR RADIOMETERS	
SATELLITE	SPONSOR	APPLICATION	STATUS	ATMOS	SUR	ALT	SCAT	SAR	ATMOS	SUR
SPOT-1	FRANCE	HIGH RESOLUTION STEREO IMAGING	85 LAUNCH							HRV
SPOT-2	FRANCE	TOPOGRAPHIC, GEOIDAL MAPPING	89 LAUNCH, POSS. TOPEX COOPER-ATIVE MISSION			ALT				
RADARSAT	CANADA	OPERATIONAL ARCTIC OBSERVATIONS	PRE-IMPLEMENTA-TION DESIGN & TEST 80/90 LAUNCH					SAR		V&IR
SHUTTLE	DFVLR	EXPERIMENTAL MICROWAVE MEASUREMENTS			MRSE		MRSE	MRSE		
ERS-1	ESA	OPERATIONAL OCEAN OBSERVATIONS	IN DESIGN & MANUFACTURE 88/89 LAUNCH			ALT	AMI	AMI		
METROSAT AND GMS	ESA JAPAN	GEOSYNCHRONOUS WEATHER	ON GOING PROGRAM						X	X
MOS-1	JAPAN	MARINE OBSERVATIONS	85 LAUNCH	MSR						VNIR VTIR
MOS-2	JAPAN	MARINE OBSERVATIONS	90 LAUNCH	MSR	SSR	ALT	SCAT			VNIR VTIR
ERS-1	JAPAN	GLOBAL IMAGING	90 LAUNCH					SAR		

5.0 Correlation of User Needs with Current NOAA Products and Services

Section 4.0 of this assessment summarized the major support service requirements (measurements and/or processed analysis and forecasts) for key functions within eight sectors of the overall marine user community. The purpose of this section is to correlate the user needs identified in Section 4.0 with current NOAA capabilities to provide the required products and services. Since certain user products and services have greater operational importance than others, an attempt has been made to quantify the value of each NOAA service capability. Although this process is subjective, it is based upon years of experience in this field and facilitates the assignment of priorities to specific support service areas which require more emphasis by NOAA.

The list of individual NOAA products and services which provide some degree of support to the marine user community is very long. The most complete compilations of the products and services currently available are contained in:

- "NOAA Products and Services of the National Weather Service, National Environmental Satellite Service, Environmental Data Service and the Environmental Research Laboratories." Volumes I, II, III and IV, November 1977.
- "National Ocean Survey Products and Services Handbook." NOAA-NOS Tech. Services Pub., May 1982.

Some of the products and services detailed in these two publications are specifically oriented toward marine users; others are more "general-purpose" in content and benefit several different user communities (e.g., aviation, agriculture, general public, and marine). Furthermore, study of these documents revealed that some important (and very valuable) functions performed by NOAA were not listed at all, especially observation programs such as the Volunteer Ship Observation Program, the

National Ocean Buoy Center (NOBC) Observation Program, etc. Finally, there were several new NOAA support service capabilities which are being developed (or are in a stage of advanced planning) which we felt were particularly important to marine users and should be evaluated here.

In order to avoid getting bogged down in the details of individual products (charts, messages, satellite images, etc.), NOAA service capabilities were assembled into 24 broad categories as shown in Table 17. These categories were then subjected to quantitative correlation with the user requirements discussed in Section 4.0. The results of these correlations (comparisons) are presented in Tables 18 through 25. A separate table has been prepared for each of the eight major components of the marine user community. The vertical axis shows the 24 existing (or developing) NOAA support service categories introduced in Table 17, the horizontal axes show the major functions to be supported for each component, and the interior symbols present our estimate of the relative user value in each matrix intersection.

An inspection of the full and half-shaded symbols gives an immediate indication of which functions are most environmentally sensitive and which NOAA service categories are potentially most valuable. As would be expected, the different marine user components have different requirements. To some degree these are function dependent, but the geographical area of operations (and the type/amount of observational and forecast coverage available) also plays a critical role in determining the products and services needed. It is interesting to note that requirements of commercial fishing industries are so comprehensive and sensitive that a NOAA capability to provide good support to this component would initially assure satisfactory services to other marine users.

NOAA capabilities to provide products and services are not

Table 17. NOAA Service Capability

NOAA Service Capability	Present NOAA Capability	Expansion Planned (Needed)
Ship Observation Programs	G	↑
Buoy Observation Programs	E	⇑
Weather Satellite Observation Programs	E	↑
Oceanographic Satellite Observation Program	N	(⤊)
Subsurface Observation Program	F	⇑
Manned/Automatic Coastal and Island Observation Programs	F	⇑
Tide Observation Program	G	↑
Marine Radar Observation Programs	G	↑
Basic SFC/UA Analysis and Forecast Programs	E	•
Sea State Analysis and Forecast Programs	F	⇑
Sea Surface Temp (SST) Analysis Programs	F	⇑
Subsurface Analysis and Forecast Programs	N	⤊
Emergency Warning Services	E	•
Coastal/Offshore/E. Lakes Forecast Services	G	↑
High Seas Weather Service	F	(↑)
Port Services for Mariners	G	↑
Marine Displays/Telephone/Radio Services	F	⇑
Satellite Image Distribution Programs	E	•
Satellite Winds/Soundings/Summaries Programs	G	•
Ice Information Programs	G	↑
Tide/Current/Water-Level Forecast Programs	F-G	↑
Marine Survey Operations	G	•
Marine Charting Services	E	•
Marine Climatological Summaries	F	(⇑)

Present Capability

E - Excellent
G - Good
F - Fair
N - None

Expansion Planned

⤊ Major
⇑ Moderate
↑ Some
• Existing Capability Deemed Adequate

Table 18. NOAA Product Matchup-Offshore Oil and Gas Industries

NOAA Service Capability	Long-Range Planning	Engineering Design	Environmental Impact	Operations	Dynamic Station Keeping	Logistic Support
Ship Observation Programs	⦶	⦶	⦶	◑		◑
Buoy Observation Programs	⦶	⦶	⦶	◑		◑
Weather Satellite Observation Programs	⦶		⦶	●		◑
Oceanographic Satellite Observation Program	⦶	⦶	⦶	●	◔	◑
Subsurface Observation Program		⦶	◑	⦶		
Manned/Automatic Coastal and Island Observation Programs	⦶		⦶	◑		◑
Tide Observation Program	⦶	◔	⦶	⦶		⦶
Marine Radar Observation Programs	⦶			◑		◑
Basic SFC/UA Analysis and Forecast Programs			⦶	●	⦶	●
Sea State Analysis and Forecast Programs	◔			●	◑	●
Sea Surface Temp (SST) Analysis Programs	⦶	⦶	⦶	⦶		
Subsurface Analysis and Forecast Programs				⦶	⦶	
Emergency Warning Services				●	◔	●
Coastal/Offshore/E. Lakes Forecast Services				◑		◑
High Seas Weather Service				●		●
Port Services for Mariners				◑		●
Marine Displays/Telephone/Radio Services						
Satellite Image Distribution Programs				◑		◑
Satellite Winds/Soundings/Summaries Programs				⦶		
Ice Information Programs	◑	◑	⦶	◑	◔	◑
Tide/Current/Water-Level Forecast Programs	⦶		⦶	◔	◔	⦶
Marine Survey Operations	⦶	⦶	⦶			
Marine Charting Services	⦶	⦶		⦶		
Marine Climatological Summaries	◑	◑	⦶			

USER VALUE CODE

● HIGH

◑ MODERATE

◔ LOW

⦶ SOME

OF POOR QUALITY

Table 19. NOAA Product Matchup-Marine Transportation Industries

NOAA Service Capability	Optimum Track Ship Routing	Route Surveillance	Port/Harbor Operations and Scheduling	Pollution Monitoring and Control	Ship Design	
Ship Observation Programs	Moderate	High		Some	Low	
Buoy Observation Programs	Low	Some	Some	Some		
Weather Satellite Observation Programs	Moderate	High	Some			
Oceanographic Satellite Observation Program	Moderate	High		Some		
Subsurface Observation Program						
Manned/Automatic Coastal and Island Observation Programs			Low			
Tide Observation Program			Moderate			
Marine Radar Observation Programs		Some	Some			
Basic SFC/UA Analysis and Forecast Programs	Moderate	High	Moderate	Low		
Sea State Analysis and Forecast Programs	High	Moderate		Low	Low	
Sea Surface Temp (SST) Analysis Programs	Some					
Subsurface Analysis and Forecast Programs						
Emergency Warning Services	Low	Some	Moderate			
Coastal/Offshore/E. Lakes Forecast Services	Some	Some	Some			
High Seas Weather Service	High	High		Some		
Port Services for Mariners	Some	Some	High			
Marine Displays/Telephone/Radio Services			Low			
Satellite Image Distribution Programs		Moderate	Some			
Satellite Winds/Soundings/Summaries Programs		Some				
Ice Information Programs	Moderate	High	Low		Some	
Tide/Current/Water-Level Forecast Programs	Moderate	Some		Moderate		
Marine Survey Operations						
Marine Charting Services	Some	Some	Low			
Marine Climatological Summaries	Moderate				Moderate	

USER VALUE CODE
- ● HIGH
- ◕ MODERATE
- ◔ LOW
- ⦶ SOME

Table 20. NOAA Product Matchup-Deep Ocean Mining Industries

NOAA Service Capability	Long Range Planning	Engineering Design	Operations Design	Dynamic Station Keeping	Logistics	Forecast Support
Ship Observation Programs	◔	◔	◑		◑	◑
Buoy Observation Programs	⦶	⦶	⦶		◔	◔
Weather Satellite Observation Programs	⦶		⦶		◑	◑
Oceanographic Satellite Observation Program	◑	◑	◑	◔	◑	◑
Subsurface Observation Program		◔	◔	⦶		
Manned/Automatic Coastal and Island Observation Programs					⦶	⦶
Tide Observation Program					⦶	
Marine Radar Observation Programs					◔	
Basic SFC/UA Analysis and Forecast Programs					◑	●
Sea State Analysis and Forecast Programs	◔	⦶	◔	◑	●	●
Sea Surface Temp (SST) Analysis Programs	⦶	⦶	⦶			⦶
Subsurface Analysis and Forecast Programs				⦶		
Emergency Warning Services				●	◑	◑
Coastal/Offshore/E. Lakes Forecast Services					◔	
High Seas Weather Service					◑	●
Port Services for Mariners					◔	⦶
Marine Displays/Telephone/Radio Services						
Satellite Image Distribution Programs					◑	●
Satellite Winds/Soundings/Summaries Programs						⦶
Ice Information Programs						
Tide/Current/Water-Level Forecast Programs	◔	◑	◔	◔	⦶	⦶
Marine Survey Operations	⦶	⦶	⦶			
Marine Charting Services	⦶		◑			
Marine Climatological Summaries	◑	◑	◑			

USER VALUE CODE

● HIGH
◑ MODERATE
◔ LOW
⦶ SOME

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Table 21. NOAA Product Matchup-Commercial Fishing Industries

NOAA Service Capability	Fish Behavior Studies	Selection of Optimum Fishing Areas	Fishing Tactics	Forecasts for Operations Safety	Logistics Scheduling	
Ship Observation Programs	SOME	MODERATE	MODERATE	MODERATE	LOW	
Buoy Observation Programs	SOME	MODERATE	MODERATE	MODERATE	LOW	
Weather Satellite Observation Programs	LOW	LOW	LOW	MODERATE	MODERATE	
Oceanographic Satellite Observation Program	MODERATE	MODERATE	MODERATE	MODERATE	LOW	
Subsurface Observation Program	HIGH	HIGH	HIGH			
Manned/Automatic Coastal and Island Observation Programs		SOME		MODERATE	MODERATE	
Tide Observation Program	SOME				MODERATE	
Marine Radar Observation Programs		SOME	SOME	MODERATE	MODERATE	
Basic SFC/UA Analysis and Forecast Programs		MODERATE	MODERATE	HIGH	MODERATE	
Sea State Analysis and Forecast Programs	MODERATE	MODERATE	HIGH	HIGH	MODERATE	
Sea Surface Temp (SST) Analysis Programs	HIGH	HIGH	HIGH			
Subsurface Analysis and Forecast Programs		HIGH	HIGH			
Emergency Warning Services				HIGH	MODERATE	
Coastal/Offshore/E. Lakes Forecast Services		HIGH	SOME	HIGH	HIGH	
High Seas Weather Service		HIGH	SOME	HIGH	SOME	
Port Services for Mariners				HIGH	HIGH	
Marine Displays/Telephone/Radio Services				MODERATE	MODERATE	
Satellite Image Distribution Programs		LOW		MODERATE	SOME	
Satellite Winds/Soundings/Summaries Programs				LOW		
Ice Information Programs		HIGH	MODERATE	HIGH	MODERATE	
Tide/Current/Water-Level Forecast Programs	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	
Marine Survey Operations		MODERATE				
Marine Charting Services		MODERATE				
Marine Climatological Summaries	MODERATE					

USER VALUE CODE
- ● HIGH
- ◑ MODERATE
- ◔ LOW
- ⦶ SOME

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Table 22. NOAA Product Matchup-Offshore Support and Construction Industries

NOAA Service Capability	Site Selection	Engineering Design	Environmental Impact	Construction Scheduling	Operational Forecast Support	
Ship Observation Programs	Some				Low	
Buoy Observation Programs	Some	Some		Moderate	Moderate	
Weather Satellite Observation Programs					Moderate	
Oceanographic Satellite Observation Program		Low				
Subsurface Observation Program	Some	Low	Low			
Manned/Automatic Coastal and Island Observation Programs	Moderate		Some	Low	Moderate	
Tide Observation Program	High	High	Moderate	Low		
Marine Radar Observation Programs				Moderate	High	
Basic SFC/UA Analysis and Forecast Programs				Moderate	Moderate	
Sea State Analysis and Forecast Programs	Moderate	High	Low	Moderate	Low	
Sea Surface Temp (SST) Analysis Programs			Some	Some		
Subsurface Analysis and Forecast Programs			Moderate			
Emergency Warning Services				High	High	
Coastal/Offshore/E. Lakes Forecast Services				High	High	
High Seas Weather Service				Low	Low	
Port Services for Mariners				Moderate	Low	
Marine Displays/Telephone/Radio Services				Low	Low	
Satellite Image Distribution Programs				Moderate	Moderate	
Satellite Winds/Soundings/Summaries Programs						
Ice Information Programs	Moderate	Moderate		Some	Some	
Tide/Current/Water-Level Forecast Programs			Moderate	Some	Some	
Marine Survey Operations	Moderate	Moderate	Moderate			
Marine Charting Services	Low	Some	Some			
Marine Climatological Summaries	Moderate	High	Low			

USER VALUE CODE

- ● HIGH
- ◑ MODERATE
- ◔ LOW
- ⦶ SOME

Table 23. NOAA Product Matchup-Private Forecasting and Value Added Industries

NOAA Service Capability	Data Services	Design Studies	Planning Studies	In-house Analysis and Special-Purpose Prediction	Extraction/ Customization of LOAA Products	Special Purpose Warnings/Advisories Briefing Services
Ship Observation Programs	Moderate	Some	Low	High	Some	Moderate
Buoy Observation Programs	Moderate	Some	Low	High	Some	Moderate
Weather Satellite Observation Programs	Some	Low	Moderate	Moderate		Moderate
Oceanographic Satellite Observation Program	Some	Moderate	Moderate	Moderate		Moderate
Subsurface Observation Program	Some	Moderate	Some	Some		Some
Manned/Automatic Coastal and Island Observation Programs	Moderate	Some	Some	Moderate		Moderate
Tide Observation Program		Moderate	Moderate			
Marine Radar Observation Programs						Moderate
Basic SFC/UA Analysis and Forecast Programs					High	High
Sea State Analysis and Forecast Programs		Moderate	Moderate		Moderate	Moderate
Sea Surface Temp (SST) Analysis Programs			Low	Low	Low	Some
Subsurface Analysis and Forecast Programs			Moderate		Low	
Emergency Warning Services	Moderate				Moderate	High
Coastal/Offshore/E. Lakes Forecast Services	Some					Moderate
High Seas Weather Service	Some					Moderate
Port Services for Mariners						Low
Marine Displays/Telephone/Radio Services						Some
Satellite Image Distribution Programs	Low					High
Satellite Winds/Soundings/Summaries Programs				Some		
Ice Information Programs		Moderate	Moderate			Moderate
Tide/Current/Water-Level Forecast Programs						Moderate
Marine Survey Operations		Low	Low			
Marine Charting Services		Some	Some			
Marine Climatological Summaries		High	High			

USER VALUE CODE
- ● HIGH
- ◑ MODERATE
- ◔ LOW
- ⦶ SOME

Table 24. NOAA Product Matchup-Sea Grant and Academic Institutions

NOAA Service Capability	Hydroclimatological Studies	Meterological Model Design	Oceanographic Model Design	Climate Model Design	Ocean Resource Mgmt. Studies	
Ship Observation Programs	MODERATE				SOME	
Buoy Observation Programs	MODERATE				LOW	
Weather Satellite Observation Programs		MODERATE			SOME	
Oceanographic Satellite Observation Program			MODERATE	LOW	LOW	
Subsurface Observation Program	MODERATE		HIGH	MODERATE	MODERATE	
Manned/Automatic Coastal and Island Observation Programs	SOME				SOME	
Tide Observation Program	LOW				LOW	
Marine Radar Observation Programs						
Basic SFC/UA Analysis and Forecast Programs						
Sea State Analysis and Forecast Programs	MODERATE				LOW	
Sea Surface Temp (SST) Analysis Programs	MODERATE	LOW	MODERATE	MODERATE	MODERATE	
Subsurface Analysis and Forecast Programs	LOW		LOW	LOW	MODERATE	
Emergency Warning Services						
Coastal/Offshore/E. Lakes Forecast Services	SOME				SOME	
High Seas Weather Service						
Port Services for Mariners						
Marine Displays/Telephone/Radio Services						
Satellite Image Distribution Programs	LOW	LOW			SOME	
Satellite Winds/Soundings/Summaries Programs		LOW				
Ice Information Programs	SOME	SOME	LOW	LOW	SOME	
Tide/Current/Water-Level Forecast Programs	LOW		MODERATE	MODERATE	MODERATE	
Marine Survey Operations	SOME		MODERATE	MODERATE	SOME	
Marine Charting Services						
Marine Climatological Summaries	SOME	MODERATE	MODERATE	MODERATE	SOME	

USER VALUE CODE
- ● HIGH
- ◑ MODERATE
- ◔ LOW
- ⦶ SOME

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Table 25. NOAA Product Matchup-The Climate Community

NOAA Service Capability	Data Base Construction	Near Real-Time Monitoring Programs	Special Base Studies	Modelling Support	Model Run Evaluation	
Ship Observation Programs	MODERATE	MODERATE	MODERATE	SOME	SOME	
Buoy Observation Programs	MODERATE	MODERATE	MODERATE	SOME	LOW	
Weather Satellite Observation Programs	MODERATE	LOW	MODERATE	SOME	LOW	
Oceanographic Satellite Observation Program	MODERATE	HIGH	MODERATE	LOW	MODERATE	
Subsurface Observation Program	MODERATE	SOME	MODERATE	SOME	MODERATE	
Manned/Automatic Coastal and Island Observation Programs	SOME	SOME	SOME		SOME	
Tide Observation Program	SOME		SOME	LOW	SOME	
Marine Radar Observation Programs						
Basic SFC/UA Analysis and Forecast Programs						
Sea State Analysis and Forecast Programs	LOW		SOME	SOME	LOW	
Sea Surface Temp (SST) Analysis Programs	HIGH	HIGH	MODERATE	MODERATE	HIGH	
Subsurface Analysis and Forecast Programs	MODERATE	LOW	LOW	SOME	LOW	
Emergency Warning Services						
Coastal/Offshore/E. Lakes Forecast Services						
High Seas Weather Service					SOME	
Port Services for Mariners						
Marine Displays/Telephone/Radio Services						
Satellite Image Distribution Programs		MODERATE	MODERATE		LOW	
Satellite Winds/Soundings/Summaries Programs	SOME		SOME			
Ice Information Programs	MODERATE		LOW	MODERATE		
Tide/Current/Water-Level Forecast Programs	LOW		LOW	SOME	LOW	
Marine Survey Operations	LOW		SOME	SOME		
Marine Charting Services						
Marine Climatological Summaries	HIGH		LOW	MODERATE		

USER VALUE CODE

- ● HIGH
- ◑ MODERATE
- ◔ LOW
- ⦶ SOME

equally well developed in each of the broad capability categories shown in Tables 18 through 25. NOAA has recognized the deficiencies in some categories and has taken action to improve the quality and/or expand the products and services offered. In order to assess NOAA's existing and planned capabilities to support all components of the marine user community, we have computed "total value scores" for each of the 24 NOAA service categories. Individual full-circle values were assigned a weight of 4, half circles 3, quarter circles 2, lined circles 1 and blanks 0. These values were then totaled for all eight user components for each NOAA category to obtain a quantitative estimate of total value. The results of this assessment, together with each evaluation of NOAA's capability and the expansion planned (or needed in each area of interest), are shown in Table 26.

Care should be used in interpreting the ranking of capabilities in Table 26. Categories near the end of the list still may have important overall value because they support other users. Port services for mariners, for example, are critical to the sport fisherman and small boat recreationist; marine radar observation programs benefit forecasting for the general public living along the coast, etc. It is essential to remember that some categories are most useful to only one or two components of the marine user community. SST analysis programs, for example, are of primary interest to the commercial fishing industry and the climate community. Categories near the top of the total value list generally have value spread through all components of the marine user community. This is illustrated by Table 27 which shows the most valuable NOAA service capabilities for each of the eight user sectors.

Sea state analysis and forecast programs are found to be of major value to seven out of eight user sectors, although a viable oceanographic satellite observation program is favored by five out of eight. Notice that present NOAA capabilities in these two key categories are noted as fair and none, respectively. Two other categories in the ten most valuable also have subjective rankings of fair (SST analysis programs and marine climatological summaries). The latter was ranked so low because NOAA documentation indicates the last significant update in marine climatologies was made in 1970.

NOAA has corrective action underway in a number of areas to correct deficiencies in marine support services; some of the most significant include:

- Inauguration of an Ocean Services Center (OSC) Program.
- Expansion of Ship Observation Programs (surface and subsurface) through programs such as Shipboard Environmental Acquisition System (SEAS), Maritime Reporting Program (MAREP), etc.
- Expansion of the Buoy Observation Program through activation of more moored stations and procurement of operationally oriented drifting buoys.
- Development of advanced software routines for: SST analysis, Mixed Layer Depth (MLD) analysis, Current/Tide/Water-Level Prediction.
- Installation of more manned and automatic weather stations on headlands, islands, and off-shore platforms of opportunity.

Table 28 presents a list of specific recommendations based upon this correlation of marine user needs with present NOAA products and services. If resources for these recommendations cannot be found without major reprogramming, it is suggested that NOAA consider commensurate reductions in:

- Marine Survey Operations
- Marine Charting Services
- Continental U.S. Observation Programs

Table 26. NOAA Sevice Capabilities Potential Value to All Marine User Components. (Assumes All User Functions and Each User Component of Equal Importance.)

Total[1] Value Score	NOAA Service Capability	Present[2] NOAA Capability	Expansion[3] Planned (Needed)
94	Sea State Analysis and Forecast Programs	Fair	⇑
89	Oceanographic Satellite Observation Program	None	(⤊)
76	Ship Observation Programs	Good	↑
72	Buoy Observation Programs	Excellent	⇑
71	ICE Information Programs	Good	↑
67	Weather Satellite Observation Programs	Excellent	↑
66	Tide/Current/Water-Level Forecast Programs	Fair-Good	↑
62	Sea Surface Temp (SST) Analysis Programs	Fair	⇑
62	Marine Climatological Summaries	Fair	(⇑)
58	Basic SFC/UA Analysis and Forecast Programs	Excellent	•
58	Subsurface Observation Program	Fair	⇑
51	Emergency Warning Services	Excellent	•
48	Satellite Image Distribution Programs	Excellent	•
46	Manned/Automatic Coastal and Island Observation Programs	Fair	⇑
43	High Seas Weather Service	Fair	(↑)
42	Tide Observation Program	Good	↑
38	Subsurface Analysis and Forecast Programs	None	⤊
38	Coastal/Offshore/G. Lakes Forecast Services	Good	↑
34	Marine Survey Operations	Good	•
31	Port Services for Mariners	Good	↑
29	Marine Radar Observation Programs	Good	↑
20	Marine Charting Services	Excellent	•
13	Marine Displays/Telephone/ Radio Services	Fair	⇑
8	Satellite Winds/Soundings/ Summaries Programs	Excellent	•

Expansion Planned

- ⤊ Major
- ⇑ Moderate
- ↑ Some
- • Existing Capability Deemed Adequate

(1) Weighted 4 - 0 for value symbols in Tables 18 through 25.

(2) Author's evaluation.

(3) Based on NOAA studies, discussions with senior NOAA staff and author's opinions.

Table 27. Most Valuable NOAA Service Capabilities for Marine User Community Components

OFFSHORE OIL AND GAS INDUSTRIES

1. Ice Information Programs
2. Sea State Analysis and Forecast Programs
3. Oceanographic Satellite Observation Program

MARINE TRANSPORATION INDUSTRIES

1. Basic Surface/Upper-Air Analysis and Forecast Programs
2. Sea State Analysis and Forecast Programs
3. Ship Observation Programs
3. Ice Information Programs

DEEP OCEAN MINING INDUSTRIES

1. Oceanographic Satellite Observation Program
2. Sea State Analysis and Forecast Programs
3. Ship Observation Program

COMMERCIAL FISHING INDUSTRIES

1. Sea State Analysis and Forecast Programs
2. Tide/Current/Water-Level Forecast Programs
3. Oceanographic Satellite Observation Program
3. Ice Information Programs

OFFSHORE SUPPORT AND CONSTRUCTION INDUSTRIES

1. Sea State Analysis and Forecast Programs
2. Tide Observation Program
3. Manned/Automatic Coastal and Island Observation Program

PRIVATE FORECASTING AND VALUE ADDED INDUSTRIES

1. Ship Observation Programs
1. Buoy Observation Programs
3. Oceanographic Satellite Observation Program
4. Weather Satellite Observation Programs
4. Sea State Analysis and Forecast Programs

SEA GRANT AND ACADEMIC INSTITUTIONS

1. Sea Surface Temperature Analysis Programs
2. Subsurface Observation Program
3. Tide/Current/Water-Level Forecast Programs
3. Marine Climatological Summaries

THE CLIMATE COMMUNITY

1. Sea Surface Temperature Analysis Programs
2. Oceanographic Satellite Observation Program
3. Buoy Observation Programs

TABLE 28. SPECIFIC RECOMMENDATIONS TO IMPROVE NOAA MARINE USER SERVICE CAPABILITIES

SEA STATE ANALYSIS AND FORECAST PROGRAMS

Obtain FNOC's Spectral Ocean Wave Model. Connect to the NMC computer stream. Drive with NMC analyzed and forecast marine wind fields. [Level of Effort - Moderate].

OCEANOGRAPHIC SATELLITE OBSERVATION PROGRAM

Push reinstatement of this program in the national budget. Emphasize sensors to measure sea state, surface winds, SST, ice coverage and atmospheric vertical temperature profiles. [Level of Effort - Major] [Side Benefit to Ice Information Program].

SHIP OBSERVATION PROGRAMS

Accelerate plans for automatic and semiautomatic surface and subsurface measurement systems. Focus on sparse data routes in (a) eastern North Pacific (b) western North Atlantic and (c) Gulf of Mexico.
[Level of Effort - Moderate] [Side Benfefit to Subsurface Observation Program].

BUOY OBSERVATION PROGRAMS

Double the number of deepwater moored systems. Initiate operational drifting buoy programs in (a) eastern North Pacific and (b) North Atlantic. Add thermistor chains to all buoys.
[Level of Effort - Moderate] [Side Benefit to Subsurface Observation Program].

TIDE/CURRENT/WATER-LEVEL FORECAST PROGRAMS

Assemble a family of general-purpose Hydrodynamic Numerical (HN) models with land/sea boundaries, tidal boundaries and bathymetry ready to drive with NMC winds on "as needed" or "routine" basis.
[Level of Effort - Modest].

SST ANALYSIS PROGRAMS

Develop Global, standard-mesh SST analysis program for support of The Climate Community and fine-mesh SST analysis programs for all U.S. Commercial Fisheries areas. Design models to blend satellite, ship and buoy data.
[Level of Effort - Modest].

Table 28 (Cont'd)

MARINE CLIMATOLOGICAL SUMMARIES

Prepare updated Marine Climatological Summaries for each ocean basin. [Level of Effort - Moderate].

SUBSURFACE ANALYSIS AND FORECAST PROGRAMS

Develop an operationally-oriented Ocean Circulation/Thermal Structure Analysis and Forecast Model for routine use at NMC [Level of Effort - Major].

6.0 Perspectives of Value-Added Industries on NOAA's Products and Marine Services

The resources of the Federal Government are finite and, because the services which the marine user requires are becoming more sophisticated and specific, the marine industry has turned to private companies to complement, extend, and customize the services and products they receive from NOAA. These private companies are referred to as Value-Added industries. Also, NOAA and the NWS have traditionally focused their attention and resources on areas with the largest population density; marine weather services have, therefore, had lower priority. As a consequence, the private sector has played an important and expanding role in satisfying the forecast requirements of the marine user community. These Value-Added companies enhance, or add value to, NOAA data to create a tailored, client-specific product of their own which they hope to sell at a profit.

Value-Added companies are also considered users by NOAA. However, the special position that Value-Added companies occupy requires special consideration as a user group. Since both NOAA and Value-Added companies seek to supply the end user with necessary information, there exists the possibility of competition between the private sector and the Government. Both sides would like to avoid such competition; Value-Added companies because they want to secure their niche in the marketplace and NOAA because it desires to promote the efforts of private industry in using the marine environment.

A general conclusion is that NOAA should provide more general information and take responsibility for generating large data bases and numerical code output while Value-Added companies should provide specific data to clients who require more specialized and higher resolution products. However, this still leaves a gray area where the responsibilities may either overlap or not be met. It is the purpose of this section to review the issues involved and to provide a clearer understanding of the relative roles of NOAA and the Value-Added industry in fulfilling the needs of commercial marine users.

6.1 The Issues

Examples of Value-Added services include site-specific ocean condition and weather forecasts which allow operations, such as resupplying an oil-rig, to be performed safely and efficiently. Optimum ship routing, statistical studies (hindcasts) for ocean platform design and general coastal forecasts for public broadcast media are other examples of Value-Added services.

In order to stay in business, a Value-Added company must sell its services to the marine user at a profit. A conflict arises when NOAA also tries to provide this necessary service, since a private company will have trouble competing with a tax supported service. The possibility of competition is a major concern of Value-Added companies.

The position of Value-Added industry is made even more precarious by its dependence on NOAA for its raw material (i.e., observations and numerical model outputs). If the content and availability of NOAA products are not consistent, it is extremely difficult for a cost-conscious Value-Added company to reconfigure its processing and marketing operations in order to keep up with NOAA and still make a profit.

A schematic description of the relationship of Value-Added industry to NOAA and to the end user, which attempts to depict the flow of information, is shown in Figure 3. Though the position of the Value-Added company appears to be squeezed between the data sources and public service functions of NOAA, this relation can also be seen as mutually beneficial. NOAA desires to disseminate the observational data that it collects and stores. The limited resources of NOAA restrict its ability

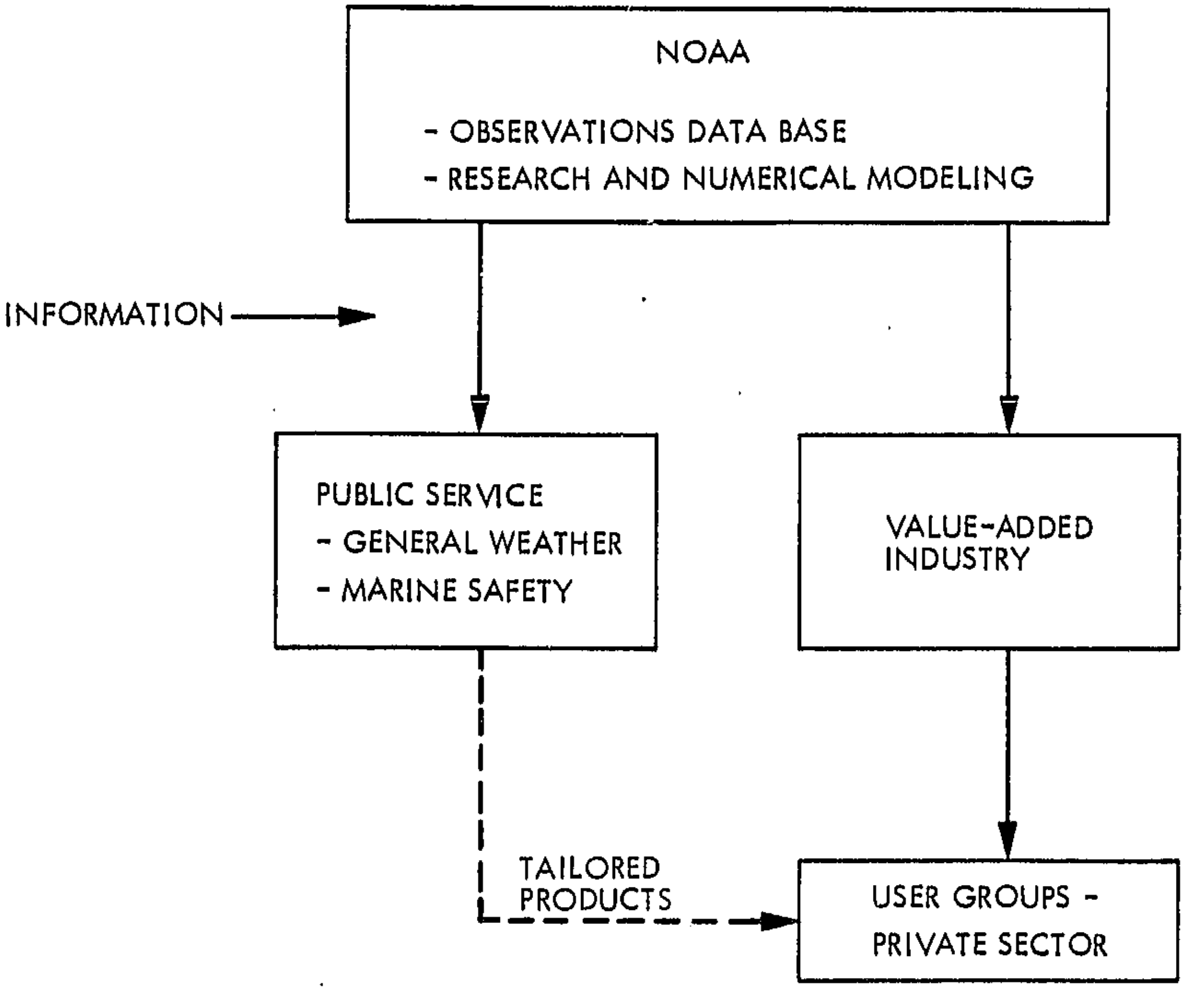

Figure 3. Value-Added Industry View of NOAA and its' Service to the Marine Community

to provide all of the high quality, specific data desired by the broad spectrum of marine users. Value-Added companies can perform a positive function for NOAA in both of these areas. To accomplish this sort of cooperative relationship, increased communication and a clear realization of the issues involved is necessary.

In summary, the predicament that Value-Added companies find themselves in is twofold:

1. Value-Added industries are largely dependent on the data NOAA provides and thus require a clear-cut policy from NOAA for their own planning needs.
2. The marketing efforts of Value-Added industry can be out-flanked if NOAA assumes a more aggressive policy of fulfilling user needs (the dashed line in Figure 3).

Data Sources

The first set of issues involves the data which Value-Added companies receive from NOAA. Value-Added industry sources of data include:

A) FAX marine weather charts, which depict surface winds, air pressure and sea-state, etc.
B) Data circuits originating from the National Meteorological Center (NMC) which provide digital data as well as graphics.
C) World Meteorological Organization (WMO) data circuits (e.g. GTS), which are supported by NOAA and provide global weather data.
D) Archived climatological data which can be obtained on Computer Compatible tape (CCT).

The need for observational data is supplemented by international data, Federal Aviation Association (FAA) weather data (AFTN), and output from large numerical models (obtained through the NMC and the NOAA Ocean Data Distribution System at the Fleet Numerical Oceanography Center).

The remarkable ability of satellite remote sensing to give high quality synoptic environmental data makes it an attractive data source for the Value-Added industry. This is particularly true in the mid ocean areas, the Arctic and the Southern Hemisphere. However, new active and passive microwave and color sensors are needed to supply good marine data products.

The high cost to the Value-Added industry in gearing up for satellite data processing and marketing points out the risks involved in trying to predict NOAA policies in this area. The key word is continuity. Consistency is the most important aspect of the Value-Added industries reliance on NOAA data. The desire by NOAA to improve its services to the general user community can impact the relation of Value-Added companies to its NOAA data in three ways:

1) Discontinuing an existing data source which is being used profitably by Value-Added companies.
2) Modifying the data path or format so as to create expensive hardware and software adjustments for Value-Added companies.
3) Providing data access mechanisms to the general user which were formerly the province of Value-Added companies.

The most important improvement of NOAA's data base policies, vis a vis Value-Added companies, would be improvements in data access. These improvements include establishing direct high speed data transmission lines to the Government's major data bases so that private companies can access them by their own computer.

By opening up its data banks, without further processing the data, NOAA could facilitate the dissemination of NOAA's environmental data to the general user by the Value-Added companies. This is a role that the Value-Added companies would very much like to expand. This would also fulfill NOAA's charter to disseminate its data as much as possible while encouraging the participation of private industry.

NOAA Competition

Considering specific NOAA services, there is no controversy regarding NOAA providing safety related information, collecting and maintaining large marine data bases, or developing and running large, numerical forecast models. The controversy of competition with Value-Added industries begins with the dissemination of these data sets to the general marine community. Thus, the universal concern of all Value-Added companies is the possibility of direct competition from NOAA in providing marine services and products to the general user community. This concern is based on the stated goal of NOAA to improve its user services over a broad spectrum. It is exemplified by the establishment of the Regional Ocean Service Centers, which is intended to provide a sort of "one stop shopping center" for marine users.

There is a wide range to the level of anxiety felt by the Value-Added industry. Some of the smaller companies, which have a regional clientele or serve as an established link between NOAA and other users (e.g., flight charts for airlines), show only mild concern, relying on the fact that NOAA does not want to compete in such a specific market. Larger Value-Added companies whose resources can rival NOAA's in narrow areas, show a great amount of anxiety about the future goals and capabilities of NOAA. Given the variety of services offered by companies within the Value-Added industry, it is not surprising that this range exists.

The Value-Added companies see anything that might be labeled a specific data product, whether it be operation, site or even industry specific, as a marketable commodity which they should be allowed to exploit. Site specific ice forecasting, the increased sophistication of FAX information and more detailed information for ports and harbors are examples of NOAA capabilities which fall into the Value-Added industry's definition of specific service.

The establishment of the Regional Ocean Service Centers, such as the one now operating in Seattle, is a main concern of the Value-Added industries. The biggest potential problem with the Ocean Service Centers is their emphasis on better communication. Although this can hardly be considered a bad thing in a general sense, there is a segment of the Value-Added industry which markets its ability to penetrate the data bases of NOAA for other private users. If the Centers make it very easy for the general public to conveniently access formatted data, then a service of the Value-Added industry will evaporate. One view of the Value-Added industry is that the OSC's should be little more than "information booths" where a marine user can go to get information about which private company can deliver the type of data product they want. Obviously, NOAA has more in mind than this.

The Value-Added companies interpret this as evidence that NOAA is trying to expand into their marketplace. In fairness, it should be realized that a main purpose of the centers is to improve communication between NOAA and private industry and, in particular, Value-Added companies. It is not clear at this time what specific services will be developed at the centers which will cause direct competition with Value-Added companies or stifle their participation in new and expanding markets. However, the enhanced general user orientation and consolidation of NOAA resources to better serve the general user is enough to cause significant anxiety in the Value-Added industy. The best way to deal with this is to establish a representative industry/NOAA working group that regularly convenes at the center to resolve issues.

6.2 Resolution of Issues

Value-Added Industry Views

The most important criteria for separating the roles of NOAA and Value-Added companies is the responsibility for general versus specific data products.

If we assume that the criteria above is accepted, major responsibilities of NOAA can be summarized as follows:

1) Collect, process, distribute (nationally and internationally) and archive all types of marine observations from all parts of the globe.
2) Prepare numerical meteorological oceanographic analyses and forecasts (especially global) which require advanced models and computers beyond those normally used by the private sector.
3) Distribute (by data links and in grid-point format) the results of regional and global numerical analyses/forecasts for use by the private sector.
4) Issue general-purpose marine warnings and forecasts in the interests of public safety.
5) Broadcast general-purpose large-area marine analysis and forecast charts for use by the general public and private-sector forecasters.
6) Distribute satellite imagery of marine areas for use by the private sector.

If we agree that specialized, customized, or tailored marine services can more effectively be provided by the private sector, how can we best delineate these services which should be the sole responsibility of the private forecasters? There are several criteria that can be used to define the role of private-sector companies:

1) Statistical studies which are used in the design of a particular marine vessel, structure, or installation.
2) Statistical studies which are used in the planning or licensing of a particular marine operation or venture.
3) Instrumentation of commercially owned off-shore and coastal platforms/installations and the taking of special observations when required.
4) Marine forecast services addressed to a particular commercial entity (e.g., Fisheries Co-op), company (e.g., shipping line), platform (e.g., off-shore drilling rig) or vessel (e.g., specific Tuna Clipper).
5) Marine forecast services which are definitely site specific (e.g., for the position of a moving vessel or for a certain point in the ocean).
6) Marine forecast services which are for a specific operation or series of operations (e.g., a salvage or towing operation, platform resupply, optimum track ship route selection, drill-ship positioning, selection of optimum fishing areas/tactics).

In summary, the private sector should be responsible for services which are specific, while NOAA should be responsible for those services which are general and involved with overall public safety. If customizing of NOAA data or products is required to satisfy a commercial customer, it should be done by a commercial company.

One of the best ways to illustrate the division of responsibility for effective provision of marine weather services is through a list of specific examples. Table 29 provides some typical examples broken down by broad functional areas..

The resolution of these various issues will only occur by effective communication. Along with making its intentions clear from a policy standpoint, NOAA should also increase its effort to contact individual Value-Added companies on a continuing basis.

Table 29. Private Sector Marine Forecast Services

NOAA	Private Sector
HURRICANE WARNING/FORECAST SERVICE	
1. Hurricane warnings of position, intensity, size and movement as functions of time.	1. Drill-stem secure and platform evacuation advice for offshore oil companies.
	2. Mining-string secure and ship movement recommendations for deep-ocean mining companies.
	3. Deck cargo tie-down and route diversion recommendations for shipping and barging companies.
	4. Wind-critical secure and tie-down forecasts for large marine cranes operated by drydock companies.
HIGH SEAS WARNING/FORECAST SERVICE	
1. Storm/gale warnings and high wave forecasts by area as functions of time.	1. Enroute survillance services and route diversion recommendations for shipping and barging companies.
2. High seas facsimile broadcasts showing fronts, winds, weather, waves, etc. for <u>general</u> use.	2. "Weather Watch" advisory services to fisheries, fishing companies, etc.
3. High seas synopses broadcast in plain language or synoptic code for <u>general</u> use.	3. Specific, evolution-sensitive forecasts for salvage operations, search and rescue, yacht races, ore transfer, liquid natural gas transport, etc.
OFFSHORE AND COASTAL WARNING/FORECAST SERVICES	
1. General warnings and forecasts for broad, pre-determined offshore and coastal areas.	1. Resupply scheduling forecasts for specific offshore platforms.
2. General small-craft advisories for coastal zones and harbor complexes.	2. Wind, wave and current forecasts for input to automatic position-keeping routines on drill ships.
3. General coastal flooding and beach erosion forecasts for pre-determined coastlines.	3. Wind, wave current and surf forecasts for a specific marine construction project.

Table 29. Private Sector Marine Forecast Services (Cont)

NOAA	Private Sector
SPECIAL SERVICES	
1. General marine data archival; provided to all users on reasonable response schedules.	1. Special design, planning and licensing studies (e.g., 100-year statistics for specific parameters related to specific projects).
2. Pollution forecasts which are in response to federal directive.	2. Actuarial studies to determine marine insurance rates.
	3. Hindcast studies of marine casualties for shipping, construction, insurance companies, etc.
	4. Fisheries forecasts of optimum areas/tactics for specific fish species.
	5. Ice forecasts for arctic oil/gas operations.
	6. Pollution studies and pollution forecasts for commercial applications.

User conferences have traditionally been the method NOAA used to reach out to the user community. These functions should, however, be augmented by more direct communication where candid and individualized discussion can occur. It is important that these discussions take place on a frequent basis so that ideas can be fully developed in parallel with changing market, political, and technical climates.

6.3 Conclusions and Recommendations

The most important actions that NOAA could take to improve their interface with the Value-Added industries are:

1) Improve access to data bases: this access should include high speed lines to national data centers.
2) Make clear statements of policy.
3) Improve communication: contacts should be more frequent: support a NOAA/User liaison group.
4) Expand satellite remote sensing capabilities: include satellite data in easily accessible data circuits.
5) Encourage private companies to develop pilot data applications programs: NOAA should act as a catalyst and a liaison.

The emphasis in these recommendations is on the increased commercialization of marine weather services. The success of NASA has been at least partly due to the use of private companies to develop the technology needed.

The increasing sophistication of data bases and data processing which can be used by the ocean industry has allowed a significant Value-Added industry to develop. Within the last decade, the size and spectrum of capabilities of Value-Added companies have increased to a point where they perform a useful and necessary service to the marine community which cannot be matched by NOAA. The finite resources of NOAA and the expanding needs of the marine community have created a situation where Value-Added companies are an essential component of the dissemination of ocean-related data. This balance satisfies NOAA's charter. Thus, a mutually beneficial relationship exists between NOAA and the Value-Added industry. However, it is a relationship that must be better defined and continually monitored.

7.0 Applications Demonstrations (Pilot Experiments)

7.1 Experimental Definition

Considerable ocean research and technology development is conducted by NOAA and related civilian agencies such as NASA and the National Science Foundation. Much of this applied research and development can lead to operational tools and techniques that can benefit the commercial user. Some technology developments may be adopted by private-sector enterprises to be translated into products and services of commercial value. Other developments may be assimilated into public-sector operations to enhance the production and delivery of services to benefit the public at large. Mechanisms to identify research activities and new technology prospects with commercial application potential are limited within NOAA. Government-conducted studies lack visibility to the private-sector user. Study results frequently remain dormant in agency files. Studies lack the ability to mechanize the transfer of research results and technology advancements into operational tools and techniques. As a consequence, much new work remains within the Government's laboratories, unavailable to either enhance the capabilities and well-being of the nation or to strengthen the commercial viability of U.S. industry.

One mechanism by which such technology transfer may be accomplished involves the concept of pilot demonstrations, which involve the testing of a research result or new technology or technique on a limited scale in an operational setting. The scope of demonstrations remain small; they proceed on a finite time scale and have a definite end point. Pilot activities involve representative users who have the responsibility for evaluating the utility of the candidate research, technology, or technique. Unique partnerships between the users and the sponsoring NOAA component exist to facilitate the transfer process, and the user must share in the overall demonstration process. Users can be selected from public agencies or commercial firms. A key element in this demonstration concept is the need to establish and adhere to viability criteria. For example, does the research or technology have operational or commercial viability; or based on the user-generated evaluation results, does the technology have operational utility?

The pilot demonstration concept has been successfully carried out by NASA and in a recent instance in a joint endeavor with NOAA. During the SEASAT Program, a series of such demonstrations were conducted with industry groups representing major elements of the ocean industry. While these active demonstrations were modified to accommodate the premature failure of the satellite, they were successful in most respects and served to establish firmly in the mind of ocean industry the commercial value and economic utility of satellite oceanography in private-sector applications. In 1980, NASA initiated, and NOAA augmented, a pilot demonstration to test the utility of the Coastal Zone Color Scanner (CZCS) on the Nimbus-7 satellite in commercial fishing operations. This three-year evaluation has been completed with results clearly indicating that Albacore Tuna fishermen can realize up to a twenty-five percent fuel savings by operationally using maps of ocean surface color structure derived from observations by the CZCS. These examples serve to illustrate that the pilot demonstration concept has merit and is one viable vehicle by which to implement the technology-transfer process.

As a part of this assessment, private-sector users were surveyed to solicit their views on the pilot demonstration concept. Insight was gained into their perceived value of such demonstrations, their willingness to participate by forming industry/government partnerships, and their inclination to invest resources in such pilot demonstrations. The results of this inquiry can be summarized as follows:

1) Private-sector users generally do not have visibility into the research and technology prospects being conducted within NOAA.

2) All sectors of the ocean industry represented in this assessment believe that the pilot demonstration concept is a useful means of testing new technologies and research results for operational viability. Paper studies were viewed as generally worthless.

3) All sectors of the ocean industry would willingly participate with NOAA in the conduct of appropriate (to their industry sector) demonstration prospects.

4) A few of the commercial users would be willing to invest some resources, on a shared basis with NOAA, to conduct a pilot demonstration. These users are primarily in the off-shore oil and gas industry and would be more inclined to share resources-in-kind than to invest finances.

5) Most commercial users were reluctant to invest dollars in such demonstrations because the return on that investment was viewed as being too long (greater than one to two years).

6) As a condition of participation, many commercial users and most users in the Value-Added sector would attempt to secure a period of exclusive use of the results, new technology, or unique technique to improve their competitive position within the marketplace. These users also recognize the barriers to such an agreement in those cases in which NOAA would contribute all the resources to the demonstration.

As a part of this assessment, selected commercial users were also invited to suggest pilot demonstrations that NOAA might sponsor today that could potentially serve private-sector needs and interests. Candidates that could be managed and conducted by the Seattle-Ocean Service Center are:

1) The use of satellite-passive microwave radiometry In operational sea ice reconnaissance.

2) The collection of environmental observations from off-shore platforms by satellite methods.

3) The use of radio station WWD as a pilot NOAA facility for the collection and distribution of environmental data for marine users.

4) The near-real-time processing and distribution of synthetic aperture radar sea ice observations from the European ERS-1 satellite.

5) Continuation of the processing and distribution of data from the Nimbus-7 coastal zone color scanner for commercial fishing applications.

Each of these candidates is discussed in detail in the following subsections.

7.2 <u>The Use of Satellite Passive Microwave Radiometry In Operational Sea Ice Reconnaissance</u>

Off-shore oil and gas operations and supporting marine transportation activities in Arctic regions requires daily, all-weather reconnaissance of sea ice conditions. Near-real time processing of data is required to support the drill platform or ship activities and to augment the navigational aids for routing transiting vessels. Passive microwave radiometry, as demonstrated from both aircraft and satellite platforms, can provide an all-weather surveillance capability to observe the distribution of sea ice and to differentiate between first-year and multi-year ice types.

The Canadian Ice Central-Ottawa, with support from PhD. associates in Toronto, Ontario, have refined the techniques and algorithms for converting radiometer brightness temperatures to sea ice parameters. This work has used observations from the Scanning Multichannel Microwave Radiometer (SMMR) on the Nimbus-7 satellite. Results of this work indicate that this technology is ready to test in a commercial setting. The off-shore oil industry is ready to participate in such a test, and private forecasters in the Value-Added industry have indicated a willingness to support such a demonstration.

The U.S. Air Force plans to place a new passive microwave sensor on board the DMSP satellite scheduled to be launched in 1985. The Special Sensor Microwave Imager (SSM/I) will permit ice-imaging spatial resolutions on the order of a few kilometers. The time is right to conduct a demonstration to test the use of this sensor in a commercial application.

It has been proposed that a demonstration be conducted in partnership with Canada and under the direction of the Seattle-Regional Ocean Service Center, in cooperation with the Joint Ice Center and selected firms of both the oil and gas industry and the private forecasting community. The proposed test area would be within the Bering or the Beaufort Seas, selected on the basis of the commercial participants interests and activities. The proposed demonstration would be designed to use the Nimbus-7 SMMR initially and in transition to use the SSM/I. Present operational networks and processing capabilities of the Navy Fleet Numerical Oceanography Center (FNOC) and Ice Central-Ottawa are sufficient to process and distribute near-real time ice products to support the proposed demonstration.

This proposed demonstration will promote the transfer of ice-oriented radiometer observational technology to the private sector; give the Seattle-ROSC visibility to, and contact with, U.S. industries conducting operations in the Arctic; and enhance the cooperative relationship between the U.S. and Canada in operational ice support services.

7.3 The Collection of Environmental Observations from Off-Shore Platforms by Satellite Methods

The ability to improve the skill of marine weather forecasts is directly tied to the increased capability to collect and assimilate environmental observations in ocean regions. Observations are critically lacking in frontier regions, including the Arctic. Improved forecast skill in the frontier areas will permit off-shore operations to increase operational efficiencies by reducing operating down-time, improve scheduling of platform operations, and make optimum use of workboat and helicopter capabilities.

An increasing number of off-shore platforms are being located in frontier regions where environmental observations are sparse or non-existent. The Department of Interior Notice 775 requires that oil and gas off-shore platforms contain instrumentation for obtaining environmental observations, particularly those related to ocean conditions. These instrumented platforms should be sources of weather observations for use in synoptic marine weather forecasts. In the Gulf of Mexico, some platforms provide regular observations, some of which are made available to the National Weather Service (NWS); others are being provided to private forecasters exclusively. A uniform, regular, and reliable means of collecting observations from off-shore platforms is needed to aid marine weather forecasting processes.

Many oil and gas industry firms are willing to participate with NOAA in conducting a demonstration to use the ARGOS data collection system on the NOAA-series satellites to collect and relay environmental observations to the NWS from Arctic regions. A satellite-oriented system provides for an automatic collection operation on each platform. All data are routed to single collection points for assimulation into the analysis process. A limited test, using the experimental SEAS system on at-sea vessels, has also been demonstrated by the NWS. A demonstration on platforms and islands located in the Alaska region would be a beneficial extension of the previous SEAS experiments. The oil industry is prepared to support such a demonstration - an Alaskan experiment could be conducted by the Seattle-ROSC, and benefit to Arctic marine weather forecasts would be real. This observation collection scheme is essential now, and will remain viable to augment satellite-derived observations from the Navy N-ROSS and the European ERS-1 systems.

7.4 The Use Of Radio-Station WWD as a Pilot NOAA Facility for the Collection and Distribution of Environmental Data for Marine Users

Radio station WWD, more formally known as the Chester W. Nimitz Marine Facility, is owned and operated by the Scripps Institute of Oceanography under an FCC license held by the NOAA-National Marine Fisheries Service. This radio broadcast facility has historically handled communications traffic for a broad range of marine activities, from commercial fishing operations, to research vessel cruises, to deep sea drilling programs. The facility continually handles voice, teletype, code and facsimile traffic. It is operated by highly skilled and versatile personnel who can accommodate user needs ranging from routine, operational activities to experimental programs requiring flexibility and non-standard procedures.

This marine facility is funded from several sources, including NOAA-NWS, NASA, and the National Science Foundation (NSF).

NOAA-NOS, in support of increasing the collection of environmental observations and broadening the dissemination of its marine products and services to vessels at sea, could benefit from the increased use of station WWD.

As an experimental demonstration, it has been proposed by the commercial fishing industry that station WWD undertake operations tailored to support the Seattle-ROSC. In this initial support role, the WWD facility could provide service to the Seattle-ROSC in four areas.

1) Routine collection of environmental observations from commercial fishing vessels operating in the Eastern Pacific from the equator to the Canadian border. Collected observations would be forwarded to the Seattle ROSC for incorporation into the NMC models.

2) Disseminate experimental marine weather and oceanographic products to vessels at sea. The ocean color structure chart derived from the CZCS on the Nimbus-7 satellite is an example of such an experimental product. Experimental products and services disseminated through WWD could be in support of a technology demonstration activity or serve as an evaluation of a new environmental product under test by NWS or NOS.

3) Distribution of marine weather and oceanographic products prepared by private weather forecasting and ship routing firms in the Value-Added industry. This use of the station facilities would be arranged on a cost-reimbursable basis, thus providing additional revenue for station operations. Such an arrangement would provide a flexible broadcast capability to the Value-Added industry to deliver products and services to clients at sea. This would be particularly useful for those clients whose resources preclude the acquisition of large marine radio equipment needed to communicate with commercial marine facilities. The use of station WWD in this fashion would be a mechanism to strengthen the ties of the Seattle-ROSC with elements of the Value-Added industry, which currently is viewing the ROSC concept with some concern..

4) Provide an operational message traffic center capability to NOAA for communications with NOAA vessels operating in Pacific regions. Current NOAA ship communications are routed from the originating NOAA shore facilities to NOAA ships by means of a complex collection of commercial and USCG radio installations. Handling this message traffic through a central facility will simplify message processing, which, in turn, will expedite message traffic.

These four uses of the radio facilities of station WWD will provide NOAA with an exclusive dissemination capability to at-sea users in the Pacific regions. The station, with this capability, can serve as a prototype facility to test the concept of a national NOAA radio network for the dissemination of government and private section marine products and services.

7.5 The Near-Real Time Processing and Distributions of Synthetic Aperture Radar Sea Ice Observations from the ERS-1 Satellite

Synthetic Aperture Radar (SAR) data collected by the SEASAT satellite has demonstrated conclusively that observations of sea ice can yield all-weather measurements of ice concentration, distribution, type, and ice dynamics on a spatial and temporal scale of immeasurable value to Arctic off-shore operations.

The European Space Agency (ESA) has an approved program to launch a SAR on the ERS-1 satellite in 1988, and both Canada and Japan have viable SAR programs late in this decade from which the U.S. can acquire sea ice observations by either cooperative or cost-reimbursable arrangements. The U.S. has no plans to launch a satellite-borne SAR at any future date. NASA has established a US/ESA agreement to implement a SAR data collection and processing capability in Alaska for producing SAR images of U.S. Arctic regions. The NASA plan is focused on the scientific community whose needs are for non-real time data. NOAA's users, primarily operational users in the private sector, have a need for SAR data on a near-real time basis.

Elements of both the off-shore oil and gas industry and the private weather forecasting community have proposed that NOAA, in concert with both NASA and private industry, implement a near-real time SAR processing capability in Alaska to process and distribute experimental sea ice observations from ERS-1 to operational users. Under the auspices of a government/industry demonstration program, SAR data would be delivered to participating Value-Added group(s) and end users for interpretation, refinement, and distribution to participating off-shore operators for their use and evaluation.

The technology exists now to process ERS-1 type SAR data in near-real time and the cost for such equipment is experiencing significant reduction in cost. The time is right to develop and execute a plan leading to the acquisition, installation, and operation of a U.S. near-real time SAR processing capability in Alaska.

As a "first-step", NOAA, with the Seattle-ROSC taking the lead role, should establish an ad-hoc government/industry SAR ice applications working group, whose principal objective would be to implement a near-real time, ERS-1 compatible, SAR processing capability in Alaska. A secondary objective of this group would be to define a series of applications demonstrations in ice operations which are complementary to the NASA, ERS-1 science program.

This proposed demonstration and preceding facility development program, will serve as the basis for creating a NOAA capability to collect and process SAR ice observations, and will revolutionize the ability of the Joint Ice Center to support U.S. Arctic and Antarctic operations, including civil, military and private sector.

7.6 Continuation of the Processing and Distribution of Data from the Nimbus-7 Coastal Zone Color Scanner for Commercial Fishing Applications

In 1980, NASA sponsored a three-year Fisheries Demonstration Program to assess the utility of the Nimbus-7 Coastal Zone Color Scanner (CZCS) in commercial fishing operations along the U.S. West Coast. During the three-year demonstration period, NOAA teamed with NASA to provide the funds necessary to successfully conclude the program. Commercial fishermen participating in the program have found the CZCS products highly useful in establishing fishing tactics, particularly in the Albacore Tuna and Salmon fisheries. Fuel savings of up to thirty percent, through reduced search times, have been realized by some participating fishermen. Interest in CZCS products remains high in the fishing industry, and West Coast fishermen desire continued access to the data.

As a "next-step" in this technology-oriented program, industry users recommend that NOAA continue to fund the collection, processing and distribution of CZCS ocean observations for the West Coast fishing industry. The facilities of the Scripps Institution of Oceanography would be responsible for the receipt and processing of the CZCS data, and improved arrangements for product distribution should be explored. Cognizance for the program should be transferred from the Jet Propulsion Laboratory to the Seattle-ROSC. No further formal "evaluation" should be undertaken, and the private sector should be encouraged to undertake the marketing of a "Value-Added" CZCS product.

The CZCS sensor, while operating beyond its design lifetime, remains a viable sensor capable of providing ocean color products to the commercial fishing industry. Continued availability of the CZCS products to the industry will strengthen its acceptance to the benefit of all fishing industry users. A lead role by the Seattle-ROSC will enhance its relationship with the commercial fishing industry and will provide a unique "experimental" product in its suite of marine products and services to the user community.