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# NOAA'S STRATEGIC PLAN 1991—2000

## AN AGENDA FOR AGENCY ADVANCEMENT

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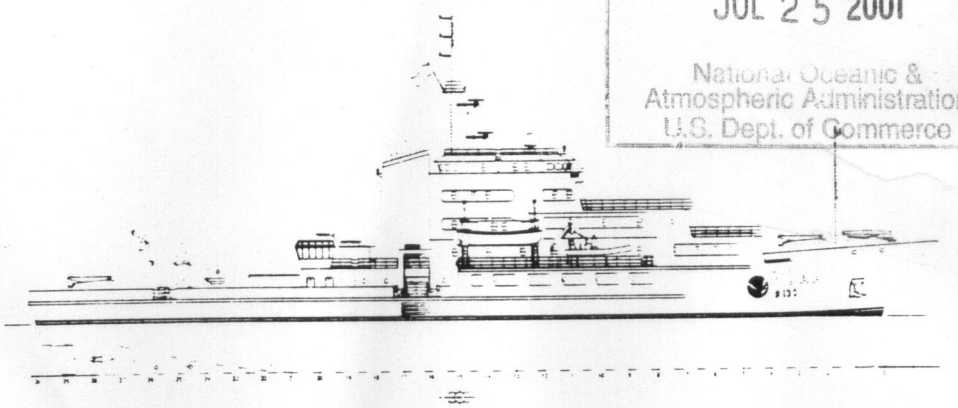

**U.S. DEPARTMENT OF COMMERCE**
**NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**
**JUNE, 1991**

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UNDER SECRETARY FOR OCEANS AND ATMOSPHERE
Dr. John A. Knauss

ASSISTANT SECRETARY FOR OCEANS AND ATMOSPHERE
Jennifer Joy Wilson

DEPUTY UNDER SECRETARY FOR OCEANS AND ATMOSPHERE
Gray Castle

CHIEF SCIENTIST
Dr. Sylvia A. Earle

**June 1991**

# *MESSAGE FROM THE ADMINISTRATOR*

When the Stratton Commission issued its report Our Nation and the Sea on January 9, 1969, Commission members all shared the conviction that a new oceanic and atmospheric agency could greatly serve our national interests in the ocean and the environmental sciences. To that end, NOAA was established on October 3, 1970. As I reflect on NOAA's first 20 years, I am pleased to see that the agency has both met the expectations contained in its charter and taken on responsibilities and challenges well beyond that original charter. I believe we are well positioned to meet the challenges of the 21st century.

The most encompassing challenge stems from the increasing recognition around the world that human well-being, the economy, and the natural environment are all closely linked. I believe realization of this interconnection will have a greater impact on NOAA than any other science or technical discovery in the last 20 years. The need to observe and to understand the Earth system, to unravel the natural and societal causes of change and to forecast those changes has become NOAA's fundamental mission.

Our next challenge is to move from the realization that the management of the natural environment is critically important to the insuring of environmentally responsible actions in public and private decision making about the economy. NOAA provides a basic understanding of the processes that govern environmental change, a description of human-caused changes apart from natural variation, and a developing capability to predict environmental change. Based on this solid scientific understanding, NOAA can make predictions and recommendations that will determine in part how we as a nation will use and manage our global environmental resources.

The inter-connectedness of the components of the global environment, which is inherent in the concept of "system," has become more and more apparent during the last decade. The links in the chain are often complex. For example, consider the following probable scenario:

- CFCs in the stratosphere can deplete ozone, which in turn can
- increase the intensity of ultraviolet radiation at the Earth's surface,
- which can decrease biological productivity in the ocean surface layer,
- which can reduce the production of dimethylsulfide (DMS) compounds by phytoplankton,
- which can reduce cloud droplet formation (DMS particles act as cloud condensation nuclei),
- which can warm the Earth due to reduced reflectivity of tropical clouds.

CFCs themselves can affect directly the physics of climate because they are also greenhouse gases. Many other interconnections of this type can be cited.

Great advances have been made during the last decade in the sophistication of our knowledge of the Earth system. NOAA has made significant contributions ranging from discoveries of increased greenhouse gas concentrations in the atmosphere and stratospheric ozone chemistry, to documenting the variability of

oceanic systems and oceanic/atmospheric interactions. Although NOAA has also made progress in marine ecosystem analysis in recent years, much work remains to achieve more fundamental scientific understanding to support NOAA's marine resource stewardship responsibilities from nearshore coastal to global oceanic scales.

Looking to the future, I envision five major attributes that will determine NOAA's success as the Earth system agency:

1. **Long-term** focus on **observing** the Earth to improve scientific understanding;

2. Commitment to **synthesis** of data and information leading to knowledge about the Earth as an integrated system;

3. Emphasis on understanding of **natural variability** as a basis for isolating human caused changes;

4. Pursuit of improved **prediction** through continued research and monitoring; and

5. Translation of observations and predictions into timely results that **inform** and **educate** citizens and policy makers in order that they may better manage and use the Earth system.

With this Earth system orientation, NOAA can meet challenges of the 21st century and ensure that the United States is a leader in the global effort to maintain the habitability and vitality of the Earth for all life.

NOAA's real strength has been and will continue to be the quality and dedication of its employees. I am grateful to each of you, for it is your work that made this agency what it is today, and your work that will take us into the next century. Together, we can play a leading role in the global management of the oceanic and atmospheric resources of the Earth. We should strive for no less.

# PREFACE

This strategic plan serves as the foundation for a long-term, coherent approach to policy development and management action to accomplish the goals set for NOAA by the Department of Commerce, the Executive Branch, and the Congress. Within the Department of Commerce NOAA is assigned the priority goal to:

***Support balanced management of the oceanic and atmospheric environment.***

NOAA also contributes directly to other Departmental goals to promote international trade in the global economy, increase economic competitiveness, to establish a Total Quality Management environment in the Department of Commerce, and to provide data and information products and services to support governmental policy and meet public needs.

As an agency committed to teamwork, NOAA's overarching management aim in the 1990's will be the following aspiration:

***NOAA will seek to be recognized as the best managed scientific agency in the nation, providing effective services to the public and responding to urgent national problems related to natural hazards, the environment and natural resources.***

The management principles, program priorities and agenda for action presented in the Strategic Plan will be the means to make this aim a reality.

NOAA's Strategic Plan is the impetus behind NOAA Annual Operating Plans, Monthly Operating Reviews, as well as program budgeting and employee performance plans. More specific strategic and action plans will also be keyed to NOAA's strategic plan to carry out NOAA's Agenda for the 1990's.

NOAA's Strategic Plan was prepared with extensive involvement of NOAA employees throughout the agency. As the Plan is revised and amended periodically, it will be a living document to which every NOAA employee will have an opportunity to contribute.

NOAA's Strategic Plan provides a challenge to everyone associated with the agency. In view of the diverse opportunities for NOAA to serve the nation as we approach the 21st Century, it will be a challenge worth the effort of every NOAA employee.

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# EXECUTIVE SUMMARY

Given NOAA's mission responsibilities for understanding the Earth system and promoting stewardship of the marine and air resources of the planet, NOAA's progress in the 1990's will be governed by ten management principles ranging from investments in human capital to virtually every facet of the way that NOAA does business. NOAA's business is to serve the American public in fulfillment of their needs associated with the ocean, the atmosphere and the natural environment. During the 1990's NOAA will attach special priority to:

- ***Modernization of weather warning and forecast programs to improve services to the public;***

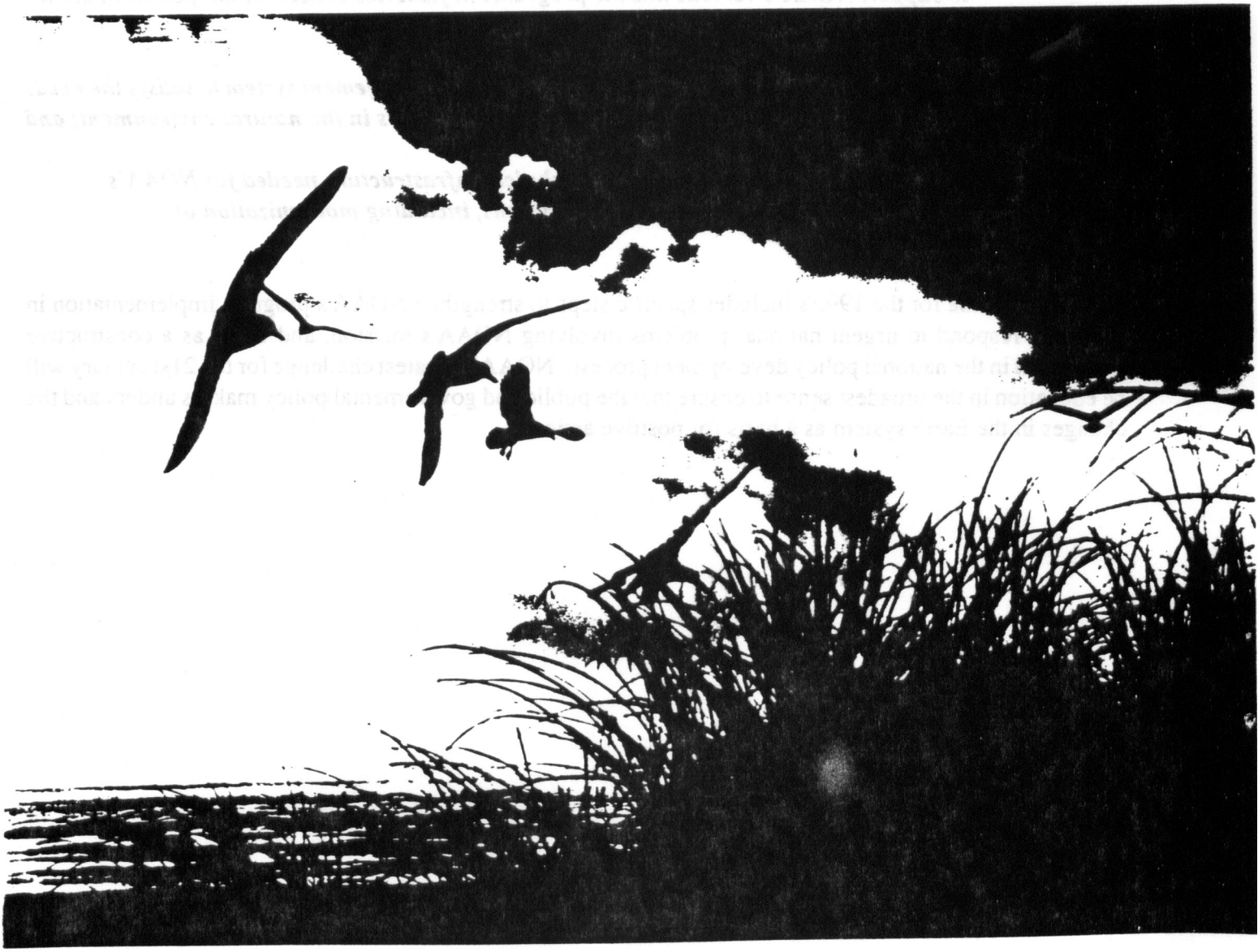
- ***Development of a climate prediction capability through the U.S. Global Change Research Program;***

- ***Implementation of a coordinated coastal ocean science program to provide new knowledge to support NOAA's various marine programs in fisheries conservation, pollution monitoring, habitat protection, and others;***

- ***Establishment of a long-term environmental data management system to satisfy the needs of NOAA and external users for data to assess changes in the natural environment; and***

- ***Modernization of the scientific and technical infrastructure needed for NOAA's marine resource and ocean service programs, including modernization of NOAA's fleet.***

NOAA's Agenda for the 1990's includes specific steps to strengthen NOAA's program implementation in all cases, respond to urgent national problems involving NOAA's mission, and serve as a constructive participant in the national policy development process. NOAA's greatest challenge for the 21st century will be education in the broadest sense to ensure that the public and governmental policy makers understand the changes in the Earth system as a basis for positive action.



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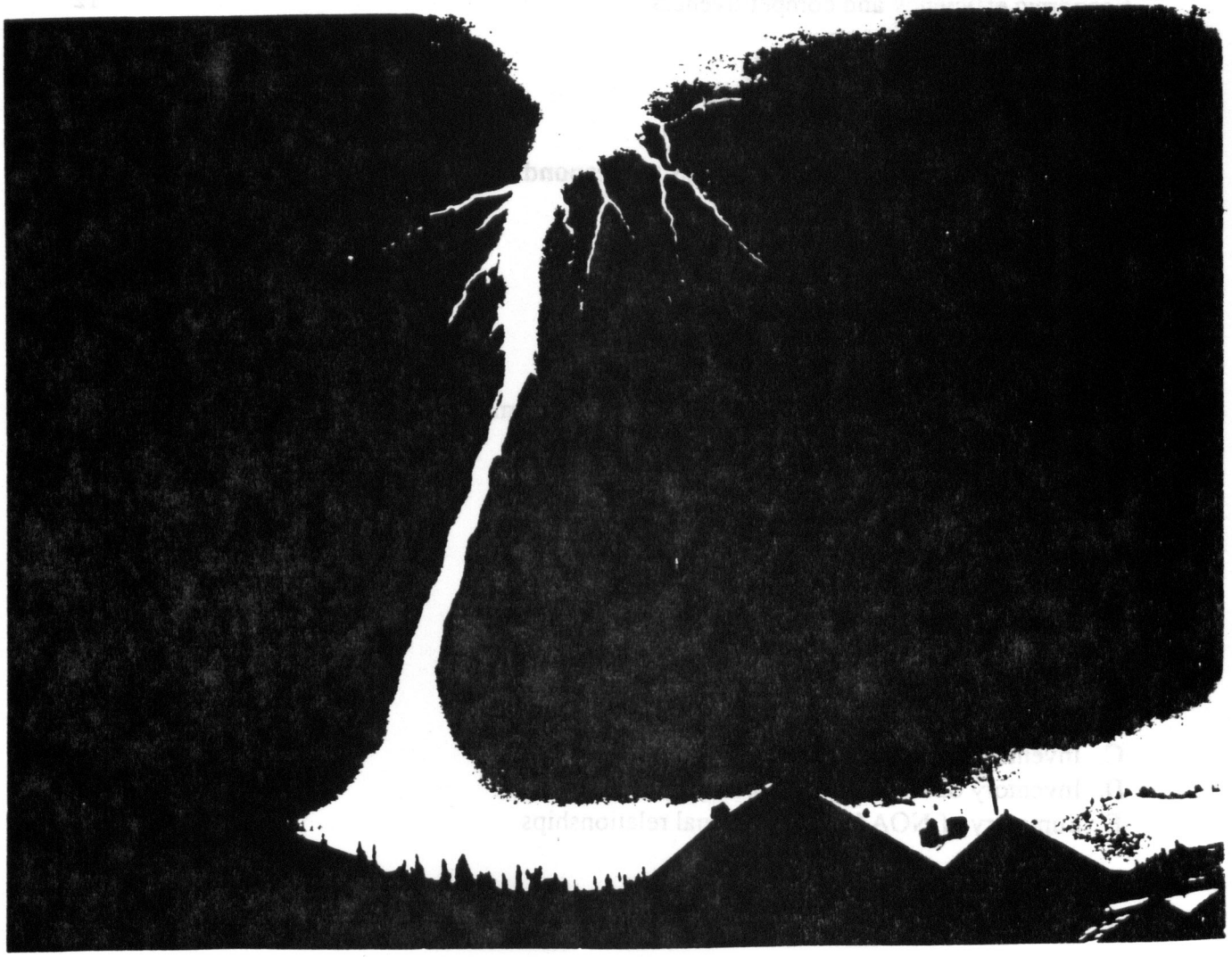


# I. INTRODUCTION: NOAA's MISSION IN PERSPECTIVE

## *Importance of the Ocean and Atmosphere*

Public recognition of the importance of the ocean and atmosphere will be vital for NOAA to fulfill its current and future missions. In fact, a sense of the magnitude and diversity of benefits that the public derives from the ocean and atmosphere provides a valuable perspective for understanding the significance of NOAA's mission.

Looking to the past, the ocean and atmosphere have always been major forces in history. Evidence suggests that natural climate change may have played a major role in the evolution of the human species itself. During the last 50,000 years, climate change was closely associated with the growth and migration of human populations around the globe; the rise of agriculture around 10,000 years ago, and its profound effect on human society, can be traced to the retreat of glaciation and the onset of a more moderate climate.

In historical times, the ocean served as the main highway for exploration, commerce and warfare as well as a source of vital fish and shellfish protein for coastal populations.

Until the last century, the basic characteristics of the ocean and the atmosphere remained largely a mystery enlivened by rich traditions of folklore and myth. The 20th century has witnessed an explosive growth of knowledge about the ocean and atmosphere as a result of systematic scientific study over many decades. Today, the ocean and atmosphere remain central to the welfare of the economy and nation at large.

Looking at Earth from space, the most dominant feature of the planet's surface is the ocean. The oceans continue to supply the United States with renewable natural resources and opportunity for significant employment and recreation. The nation benefits economically from offshore oil and gas, and may gain from thermal energy and hard minerals in the future; the nation depends upon maritime trade for bulk cargoes and highly valued containerized shipments, and depends on a secure line of naval defense, particularly by nuclear-armed submarines. These activities increase employment in ocean-related indutries, which, along with a surge in outdoor recreation, draw more and more of the population to the coast. We also use the ocean as a waste receptacle. In the past, areas of the ocean have been overutilized without regard for the consequences of pollution —a problem which careful management must now counter.

The atmosphere is the most essential component of the human environment, providing oxygen for life, a shield from cosmic radiation, the major link in the hydrological cycle, a medium for air transportation and for dispersal of airborne wastes. However, along with these benefits come the drawbacks of adverse weather, which disrupts essential services — food and fuel supplies, police protection, health services, transportation and communication — and endangers the public. Adverse weather can cause striking economic and human losses: thousands of lives and billions of dollars are lost annually as a result of weather and flood hazards. While weather causes short-term problems, climatic changes can affect society even more because such consequences are lasting and widespread. These changes may be caused in part by an increase in mankind's wastes, potentially altering the chemical balance of the atmosphere.

Scientific advances in the past century reveal the importance of the dynamic interface between the ocean and the atmosphere and the influence that interaction wields in the earth's physical, chemical, and biological processes. Further advances in scientific understanding of the ocean and atmosphere, and the continuing application of this knowledge for human benefit, will require a more integrated focus on this interacting Earth system — the ocean, the atmosphere, and the solid earth. The Earth system continues to make the planet Earth unique in the known universe: Earth is the habitat for life.

## *The Mission of NOAA is:*

- *to monitor, record and predict changes in the Earth Systems -- the ocean, the atmosphere, the Earth's surface and near space; and*
- *to promote long-term stewardship of marine and air resources of the Earth.*

## *In fulfillment of its mission, NOAA's responsibilities include:*

- *issuing severe storm warnings and weather forecasts;*
- *mapping and charting of U.S. waters;*
- *managing marine living resources and protected species;*
- *archiving world-wide environmental data bases;*
- *assessing, managing and restoring the marine environment;*
- *forecasting river flows and flooding;*
- *operating environmental satellites; and*
- *forecasting the space environment.*

## *NOAA's Proud Tradition of Service to the Nation*

NOAA employees can be proud of NOAA's past. Although NOAA was established in October 1970 to provide a unified focus for the nation's oceanic and atmospheric programs, some of NOAA's components are among the oldest scientific agencies in the Federal government. The National Ocean Service traces its origins to the Survey of the Coast established in 1807. The National Marine Fisheries Service was formed in 1871 as the Office of the Commissioner of Fish and Fisheries.

The National Weather Service was established in 1890 as a civil agency of the Federal government. NOAA's National Environmental Satellite, Data, and Information Service is a product of the space age a quarter of a century ago. NOAA's Office of Oceanic and Atmospheric Research undertook pioneering advances in the atmospheric and marine sciences as a result of momentum generated by the mobilization for World War II. Looking to the future, NOAA's mission will extend to new challenges such as routine space environment forecasting to protect astronauts and spacecraft from hazardous radiation from the sun.

## *A Growing Array of NOAA Products and Services*

NOAA is widely recognized for such familiar activities as weather forecasts, nautical charts, conservation measures to protect porpoises and environmental satellite images on the evening TV news. The actual magnitude of NOAA's products and services is staggering. The adjacent box describes the major categories of NOAA's products and services to provide perspective on the diversity of ways that NOAA serves the American public each day.

In many ways, this strategic plan provides a systematic framework for NOAA to improve its products and services to the public and to increase effectiveness with a continuing commitment to cost control and efficiency in all operations. In NOAA management, "growth" is both a qualitative and quantitative concept.

Looking to the future, NOAA's management process will continue to take account of changing public needs associated with natural hazards, the relationship of the environment to the economy, natural resources management and the expansion of knowledge about the Earth.

# NOAA Products and Services

*(In a typical year in NOAA)*

## *National Ocean Service*

- produces 10,000 aeronautical charts
- issues 1,500 nautical charts and bathymetric maps
- provides 40,000 ocean observations, 500 sea temperature analyses and 300 ice analyses
- maintains coastal zone management partnerships with 29 states and territories
- manages 8 marine sanctuaries and 265,000 acres in estuarine reserves
- monitors 250 sites in coastal areas to assess environmental quality change
- responds to 100 hazardous materials spills
- enhances its national inventories of human activities and natural resources in estuarine, coastal, and oceanic areas, such as national inventories of 7,000 coastal pollution sources
- expands its national data base on characteristics of 122 estuaries

## *National Weather Service*

- issues 12,000 severe weather and flood warnings and prepares 2.5 million routine public weather forecasts
- produces forecasts for:
  - aviation weather: 1 million
  - fire weather: 70,000
  - agricultural weather: 40,000
  - marine advisories: 40,000
  - river forecasts: 700,000
- operates the most powerful computer available to model the changing state of the atmosphere 4 times a day
- receives nearly 20 million surface weather observations, 1 million ship observations, 1 million aircraft observations, and 1 1/2 million weather balloon soundings
- maintains a sophisticated tsunami monitoring system in the Pacific Basin

## *Office of Oceanic and Atmospheric Research*

- supports 80 major oceanic and atmospheric field experiments
- supports 11 environmental research laboratories
- publishes 1,000 scientific articles
- makes 150 scientific presentations
- maintains the National Sea Grant College Program with 200 institutions and 3,000 scientists
- supports 20 postdoctoral fellowships
- forecasts changes in the space environment
- maintains 4 global baseline monitoring stations

## *National Marine Fisheries Service*

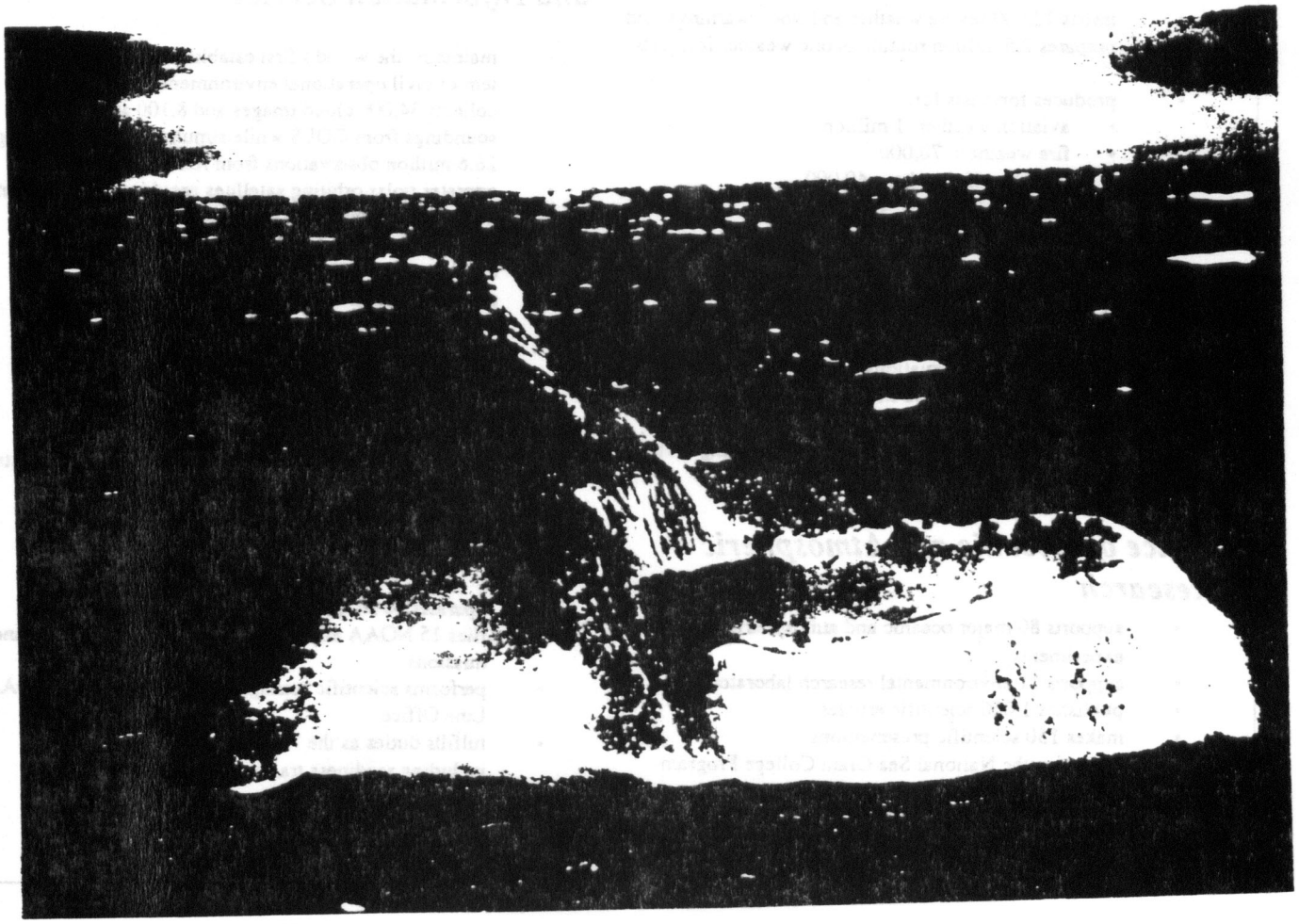
- maintains the largest and most complex marine fisheries management system in the world
- oversees 2 million square miles of ocean area where 300 species are harvested comprising nearly 20% of the world catch
- assesses 146 living marine resources stocks, including 28 marine mammal stocks
- administers 36 Fishery Management Plans
- undertakes 2,000 sampling days at sea
- monitors 400 protected species permits
- reviews 7,500 Federally licensed development projects and seeks habitat mitigation for 200,000 acres
- deploys over 500 observers for fisheries and marine mammal data collection
- undertakes 350 enforcement operations resulting in more than 2,000 convictions
- inspects 200 seafood processing establishments

## *National Environmental Satellite, Data, and Information Service*

- maintains the world's first established and largest system of civil operational environmental satellites
- collects 34,000 cloud images and 8,100 atmospheric soundings from GOES while simultaneously collecting 26.6 million observations from remote platforms
- operates polar orbiting satellites providing 16.8 million global temperature and water vapor profiles, and 400,000 global ozone measurements
- estimates over 1 million wind measurements
- maintains worldwide monitoring of tropical storms, flash floods, and volcanoes
- relays 8,200 emergency locator signals from stranded ships and aircraft
- maintains climate, oceanographic, and geophysical data bases with nearly 200,000 billion bytes serving 130,000 public requests and 35,000 researcher requests

## *NOAA Corps*

- operates 18 NOAA research and survey ships
- flies 15 NOAA aircraft for research and reconnaissance missions
- performs scientific management duties in every NOAA Line Office
- fulfills duties as the 7th U.S. uniformed service, including readiness training for national defense mobilization



# II. Basic Management Principles to Guide NOAA's Progress

Every successful organization has a corporate philosophy which explicitly or implicitly guides management at all levels. Within the context of NOAA's commitment to Total Quality Management, the following ten principles apply to every NOAA program:

## *NOAA will invest in its human capital*

The strength of an organization is directly related to the quality of its employees. NOAA's work force deserves credit for the many accomplishments achieved since the agency's establishment. Looking ahead, NOAA will need employees with unusual competence and vision to respond appropriately to the challenges that NOAA faces in the next century. In general, NOAA will seek to develop an organizational environment that will attract the most talented individuals in every field related to NOAA's mission. The highest caliber people will want to work for NOAA. Specific opportunities for NOAA investment include:

- more systematic and sophisticated recruiting, especially for women and minority candidates;
- more effective training and professional development approaches, particularly establishment of career ladders and the nurturing of high quality scientist/managers for the NOAA of tomorrow;
- creation of innovative compensation and reward packages in cooperation with the Office of Personnel Management to attract the most accomplished candidates, particularly at the entry and senior levels; and
- building of a work environment in which communication is fostered so that employee feedback to management ensures a very high level of morale and personal commitment by every employee.

## *NOAA will adopt a service-oriented posture that focuses on "customer" satisfaction*

Every NOAA employee works for specific customers, and the delivery of high quality products or services in a timely manner is a personal challenge for each employee. Internally, the customer can be other NOAA programs which depend upon some action or service. Externally, the ultimate customer is the American public or more specific user communities that rely on NOAA's activities. Inherent in the goal of customer satisfaction is the clear understanding of who customers are, what they require and how they perceive the adequacy of the product or service they are receiving. Steps to carry out this principle include:

- increased communication with customers;
- innovative approaches that gauge and respond to customer feedback;
- development of explicit standards to define acceptable levels of program and individual performance; and
- increased provision of information services to support decisionmakers in governmental agencies and the economy at large.

## *NOAA will anticipate and respond to changing national needs related to NOAA's mission*

In the private sector, successful businesses devote considerable effort to market research and product development to serve their customers better. In an analagous manner, NOAA will systematically scan the horizon for changing national needs where NOAA can make a useful contribution. This future orientation requires significant foresight to monitor external developments on the national agenda and to couple analysis of those developments with innovative responses based upon a range of scientific, technological and programmatic possibilities. Appropriate NOAA responses can include:

- policy initiatives within the Executive Branch with supporting technical analysis;
- modification or extension of NOAA programs;
- ad hoc initiatives to mobilize NOAA's capabilities for a particular exigency; and
- leadership to encourage governmental and private actions to address problems related to urgent oceanic, atmospheric, and water resource needs.

## *NOAA will seek a standard of excellence in the management of operational programs and administration*

The task of managing operational Earth system programs involves significant complexity of subject matter, risk of expensive equipment failure or loss, and continuing attention to cost control. Administrative support to NOAA programs is also demanding because of major system acquisitions and the decentralized character of NOAA's field structure. To translate the standard of excellence from an abstract aspiration to a practical framework for action which can be measured, NOAA will strengthen management in the following ways:

- create clear program and administrative objectives that will allow every NOAA employee to identify his or her opportunity to contribute to NOAA's success;
- identify and reexamine priorities to focus program and administrative resources on the "right" efforts; and
- adopt systematic approaches to evaluate program and administrative performance, including external peer or user group reviews.

## *NOAA will take innovative steps in program implementation*

Over the years, NOAA has developed informal standard operating procedures that tend to channel program implementation actions into consistent patterns. For example, NOAA has decided to build and operate certain data collection systems to implement programs, but NOAA must also rely on data collected by other organizations to perform its mission. NOAA has also adopted standard protocols to govern field operations such as fisheries stock assessments or hydrographic surveying. Perhaps the most vexing aspect of program implementation is the procurement of major systems such as environmental remote sensing satellites. Looking to the future, NOAA will systematically explore opportunities for "new ways of doing business" including:

- new approaches to use operational environmental observing systems for research;
- alternative financing or procurement strategies that build upon the strengths of the private sector; and
- new operational protocols to carry out complex field operations based upon scientific, technological or external institutional changes.

## *NOAA will seek productivity gains as a systematic and integral part of management*

Budgetary austerity has focused attention on the need to control costs, but the pursuit of productivity gains is a central factor in management excellence. In the past, many NOAA managers have been forced to react to episodic decisions to control program expenditures through the budget process. In the future, NOAA will benefit from a more analytical and planned effort to increase productivity through the following kinds of activities:

- expanded consultation with employees involved in program implementation to obtain their ideas for productivity gains;

- periodic review of opportunities for automation, especially in the labor intensive areas of data collection analysis and distribution; and

- regular examination of innovations in other governmental, research, or academic organizations to consider lessons that could be applied in NOAA.

### *NOAA will sustain a commitment to research and development to assure that scientific and technological progress is a continuing process for all NOAA programs*

The common thread that unifies NOAA is the pursuit of scientific understanding of the Earth system that can provide a rational basis for routine prediction of future oceanic, atmospheric, and hydrologic conditions. In every NOAA program, this predictive capacity is now limited by incomplete understanding of natural processes on all appropriate scales. NOAA has made major progress during the last two decades in its predictive capabilities, but the next decade offers unusual promise for further scientific and technological advancement. A strong NOAA research and development program has been, and will continue to be, the direct means to advance the scientific and technological underpinnings of NOAA's operations. The strength of NOAA's R & D can be enhanced through:

- maintaining a balanced in-house laboratory capability with access to sophisticated scientific tools that can continue to attract the most capable scientists;

- implementing a significant extramural research effort to involve the special talents and capabilities of research community; and

- encouraging new hybrids of collaboration between NOAA operational personnel and research scientists as well as with the external research community to advance NOAA's mission and the accomplishments to science generally.

### *NOAA will emphasize integration and synthesis of effort across the entire agency to fulfill NOAA's mission*

NOAA was created in 1970 to pull together and provide focus for the nation's oceanic and atmospheric programs. NOAA has always strived to be a whole organization that is more than the sum of its parts. With the emergence of the Earth system concept, NOAA simply cannot fulfill its mission without an integrated approach to NOAA programs. NOAA will make a deliberate effort to integrate its programs including:

- establishing NOAA-wide Program Directors in high priority mission areas to mobilize NOAA capabilities; and

- applying non-traditional approaches to organize and integrate program elements (e.g. hydrologic cycle or large marine ecosystems).

### *NOAA will expand partnerships with other governmental agencies and the private sector for mutual benefit*

NOAA is interdependent with many governmental and private organizations in virtually every aspect of its mission. This interdependence is most apparent in such areas as collection of Earth system data, transformation of observations into useful products and services, and their distribution to users. Cost containment through shared or joint action is an obvious benefit, but partnerships can also lead to better results. NOAA will place increased emphasis on practical partnerships that achieve tangible results rather than partnerships on paper that give the appearances of cooperation. These results-oriented partnerships include:

- expanding agreements with private organizations to share aspects of NOAA's responsibilities such as data collection, and facilitate new technological innovations;

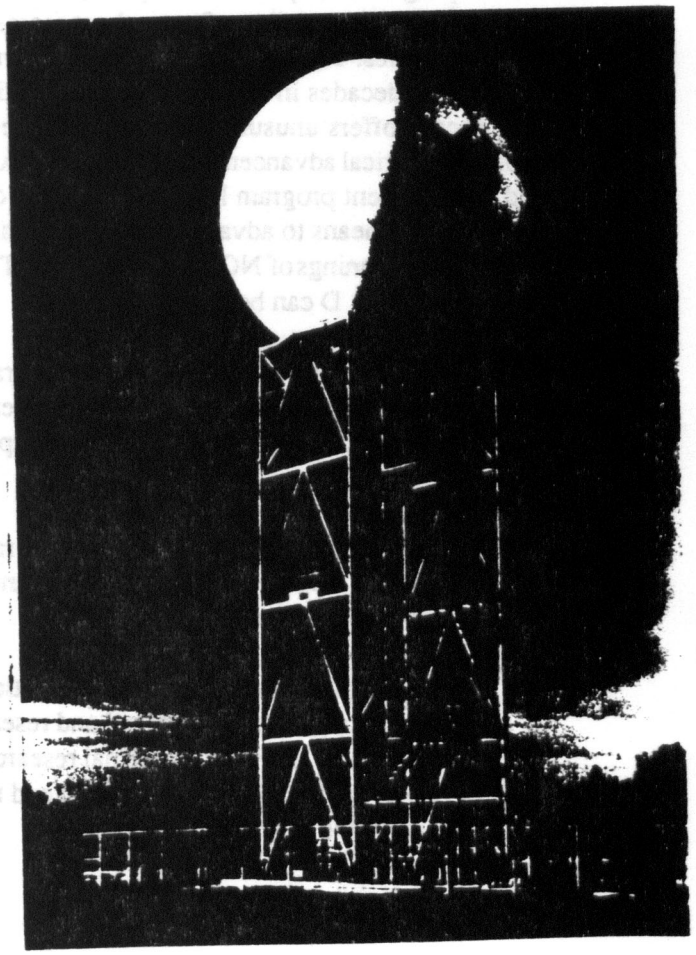
- increasing program cost sharing in direct cooperation with other foreign, Federal, state and local agencies, such as the proposed polar orbiting satellite agreement with the European Space Agency; and

- strengthening NOAA's interagency bonds in order to share the scientific results of its investigations and its expertise with other agencies which have environmental and human health and safety related missions.

## *NOAA will earn recognition as the most credible source of expertise regarding the Earth system*

NOAA's visibility in the eyes of the public and specific professional or user communities is much more than a public relations or "advertising" issue. Credibility and respect must be earned. The strategies and initiatives set forth in this strategic plan provide a comprehensive way for NOAA to earn greater public recognition. In addition, NOAA must improve its communications effectiveness in the following areas:

- at the program level, opportunities for NOAA to become involved in topics on the national agenda should be identified as far in advance as possible;
- external communication strategies should be developed and reviewed to mobilize appropriate NOAA actions to stimulate public understanding;
- an aggressive outreach effort must be mounted to inform, educate and engage external interests involved with timely topics involving the Earth system;
- expansion of NOAA's education network to provide the public with accurate information on timely issues and increase their understanding of the world around them; and
- extension of NOAA's outreach program to schools, exposing young children to the Earth Sciences and a broad range of environmental issues.



# III. National Needs of the 1990's Related to NOAA's Mission

Strategic planning is future-oriented and focuses on the exploration of likely conditions that will change in the external operating "environment" of an organization that can be anticipated and analyzed. For those changes that cannot be anticipated, strategic planning assists in creating early warning and flexible response capabilities that can produce constructive adaptations to unforeseen developments.

This section of the Strategic Plan offers a brief glimpse of the future to establish a context for thinking about the actions reflected in this "agenda for NOAA's future". Following a look at the broad outlines of the decade of the 1990's, more specific examinations will be made of the particular areas of public need in which NOAA can respond.

## *The United States and the World in the Year 2000*

If a forecast of world developments during the 1990's had been made at the beginning of FY 1990, it would have probably missed entirely such major developments as:

- abrupt termination of the Cold War;
- spontaneous pursuit of democratic values in many socialist countries;
- a major natural resource-based regional conflict in the Persian Gulf;
- an unprecedented international consensus within the United Nations about common aims as a result of the Persian Gulf crisis; and
- a softening of the global economy as oil price hikes reverberate through every economic sector.

Despite the limitations of predicting the future, forecasting of natural and world trends can be useful to the extent that it can identify patterns which are likely to prevail independent of such major shifts as mentioned above.

Various forecasts about the 1990's are available from public and private sources. For example, the U.S. Industrial Outlook published by the Department of Commerce provides detailed projections of economic changes every year. Based upon a representative sample of these public and private forecasts, the following trends will likely persist over the next decade.

*Increased competition in the world economy:*

- the U.S. economy is increasingly dispersed geographically as a result of shifts to more service-based industry, population movements into suburban and rural areas, and the emergence of growth in the South and West;
- the prosperity of the United States is increasingly interdependent with the global economy; and
- the U.S. population is aging and the workforce growth is slowing so the challenges of global competition demand increasing productivity to maintain the U.S. standard of living.

*Altering life styles and expectations:*

- Households are becoming smaller and families more geographically dispersed;
- the movement of people and goods around the U.S. and the world will continue to expand;
- Americans maintain very strong attitudes about protection of the natural environment; and
- information age trends will make the demands for information of all types a growth industry.

*A new agenda for the world:*

- mass communications have increased awareness around the world of the possibilities for progress in public health, safety, and prosperity;

- world leaders are spending more time on international economic and environmental issues than on the traditional issues of military security; and

- concerted international efforts are focusing on global problems of natural disasters, the environment and natural resources as they relate to economic prosperity, and individual well being.

With those general trends in view, the following sections review changing national needs involving public safety from natural hazards, the economy, environmental management, conservation of natural resources, and research and education.

## *Safety of life and property from natural hazards*

NOAA's mission in the area of safety of life and property from natural hazards touches many aspects of everyday life. Violent storms or dangerous sea wave conditions create physical stresses which can result in personal injury, damage to property or disrupt transportation in every mode. Extreme events — heat waves, severe cold spells, blizzards, floods, droughts, fog — can also pose deadly risks. Direct public health dangers can stem from contaminated seafood or from exposure to pollutants in the air or water, either from chronic accumulations or from accidental discharges from toxic chemical spills. In particular, the entire transportation sector is especially susceptible to oceanic or atmospheric hazards, both from adverse conditions and from obstacles to air or marine navigation.

Looking ahead, several trends highlight the urgency of public warnings and information services to help avoid the risks of natural hazards:

### *Exposure to risks*

- The United States experiences more severe weather than any nation in the world: every year on average there are:

  *10,000 severe thunderstorms*
  *1,000 tornadoes*
  *10 severe winter storms*
  *1,000 floods*
  *10 tropical storms (including hurricanes).*

Scientific evidences suggests cycles occur in storm frequency. For example, the decade of the 1990's may experience more hurricanes than in the previous two decades.

### *Demographic changes increase risks*

- The average age of American citizens is increasing; by 2020, the population older than 65 will nearly double;

- older citizens are most susceptible to weather extremes, especially heat; and

- the immigration of populations to Gulf and Atlantic coastal regions increases the risk of damage and loss from hurricanes.

### *Transportation system vulnerabilities*

- The U.S. has the largest marine port system in the world (2500 harbors); the fourth longest shoreline (11,650 miles); and the largest Exclusive Economic Zone (3.9 million acres):

  *60,000 merchant vessels enter U.S. harbors per year; and*

  *30,000 tugs, the world's largest fleet of coastal cargo vessels, and more than 17 million recreational boats make for congested coastal waterways.*

- The U.S. has the most extensive and sophisticated aviation system in the world:

  *16,582 airports (commercial and private);*

  *during the last decade, the number of commercial airline flights increased 25% from 425,000 to 550,00 per year; and*

  *passengers in commercial airline service increased 30% in the 1980's to 35 million per year.*

- The U.S. highway network consists of 3.9 million miles of roads serving more than 180 million motor vehicles:

*highway transportation is the nation's principal mode of travel; and*

*growth in motor vehicle travel has increased nearly 50% in the 1980's to 2,000 billion vehicle miles.*

With respect to the consequences of natural hazards for the American public, the following statistics apply:

*Direct fatalities from natural hazards*

- Approximately 500 fatalities per year occur from floods, tornadoes, thunderstorms, and heat waves.

- Unusual years may multiply the average fatality count. For example, a single tornado outbreak killed 300 people in 1974.

*Natural hazards as a contributing factor to loss of life*

- The transportation sector is most affected; approximately 5,500 fatalities per year occur in following transportation modes:

| | |
|---|---|
| *automobile accidents* | *4,100* |
| *recreational boating* | *500* |
| *general aviation* | *400* |
| *truck accidents* | *350* |
| *commercial aviation* | *100* |
| *waterborne commerce* | *25* |

- Transportation accidents in the United States cost an estimated $90 billion in lost income, property damage, medical and other expenses.

- The proportion of natural hazards related losses are conservatively estimated to be approximately 10% of the total, or $9 billion annually.

*Property losses from natural hazards*

- Direct business losses from natural hazards are difficult to estimate statistically, but anecdotal evidence suggests the magnitude; for example, the direct losses from one intense hail storm in Denver in June 1990 was estimated to be $.5 billion.

- Specific categories of hazard illustrate the magnitude of losses in specific years:

*$780 million form tornadoes (1988)*
*$ 3 billion from floods (1988)*
*$ 9 billion from hurricanes (1989)*

In most cases, risks to life and property from natural hazards can be avoided or mitigated by evasive action. Forecasts and warnings to the public must be accurate, timely, and understandable if actions are to be successfully taken to avoid harm. The quality and utility of NOAA's forecast and warning services in the 1990's stand to benefit significantly as a result of major scientific and technological advances in meteorology, oceanography, and space physics. These advances will depend on improved observations of the ocean, atmosphere, and space; introduction of more sophisticated computer simulation models to predict future changes; and the establishment of more timely and informative communication systems to alert parties at risk. Considerable potential for service improvement has already been demonstrated in research experiments.

Protection of life and property also involves actions in emergency situations which NOAA can provide special assistance. This assistance may occur in several ways. First, NOAA's Hazardous Material Response Program provides on-scene technical assistance to federal, state, and local authorities in cases where dangerous substances have been discharged into the environment through accidents. In a typical year, some 150 hazardous waterway response events occur in which NOAA provides assistance. This assistance deals with assessment of likely effects and the identification of suitable control measures. Second, NOAA uses its polar orbiting satellite capability to receive and locate distress signals from ships, airplanes, or vehicles stranded in remote areas through the SARSAT Program. SARSAT location services not only hasten the rescue of distressed parties, but it significantly reduces the cost and complexity of search and rescue operations. Third, episodic environmental events such as volcanic eruptions or nuclear power plant accidents can create atmospheric hazards to aviation or public health. NOAA's capabilities to detect and monitor atmospheric changes will continue to provide valuable technical information as these stress events occur in the future.

## *Economic Efficiency and Competitiveness*

The ocean and atmosphere affect the national economy in diverse and very significant ways.

Timely and effective collection, analysis and dissemination of environmental data and forecast products are critical in the national effort to improve economic efficiency and competitiveness in virtually every economic sector. Individual decision makers in the economy can use weather, water resource, marine and, ultimately, climate information to avoid costs and increase economic gains.

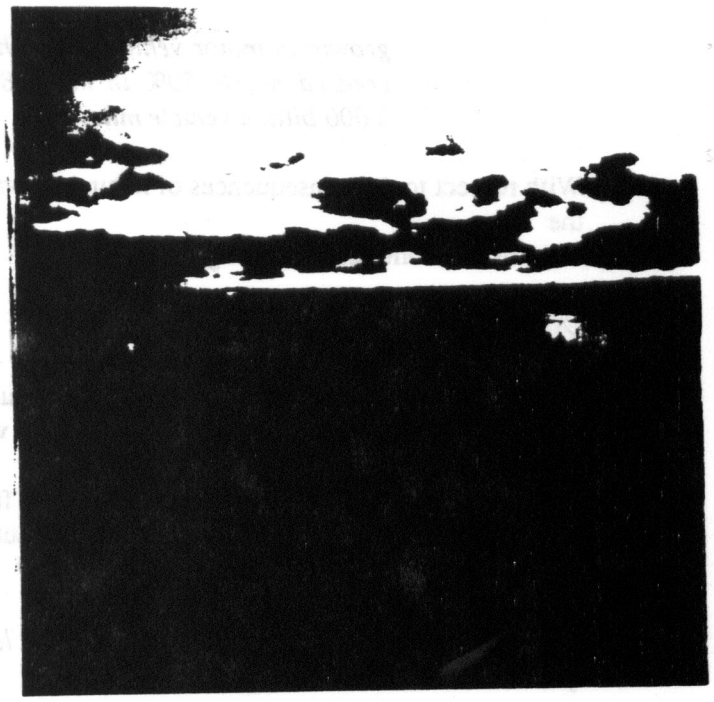
Shorter term information (1-5 days), such as weather forecasts, tends to promote the avoidance of costs. For example, decision makers can refrain from undertaking specific activities which would be jeopardized by adverse natural conditions such as rainfall or freezing temperatures. Longer term information (weeks, seasons, decades) can allow more deliberate planning to make adjustments in operating plans (e.g., oil purchases for winter heating) or basic capital investments (e.g., termination of plans to build an industrial plant in an area threatened by risk of rising sea level).

Trends in the economy relevant to the value of environmental information can be examined from several perspectives:

*The structure of the GNP*

- The U.S. Gross National Product consists of the following major functional components in terms of value added to GNP:

| | |
|---|---|
| *Food* | *15%* |
| *Housing* | *24%* |
| *Transportation* | *10%* |
| *Health* | *10%* |
| *Clothing and Personal Care* | *6%* |
| *Education* | *6%* |
| *Personal business and communications* | *5%* |
| *Recreation and leisure* | *7%* |
| *Government (all levels)* | *4%* |
| *Defense* | *5%* |
| *Exports* | *8%* |
| | *100%* |



- Cutting across these functional components are the following industries as a percentage of GNP:

| | |
|---|---|
| *Agriculture, forestry, and fisheries* | *2%* |
| *Mining* | *2%* |
| *Construction* | *5%* |
| *Manufacturing* | *19%* |
| *Transportation and public utilities* | *9%* |
| *Wholesale trade* | *7%* |
| *Retail trade* | *9%* |
| *Finance, insurance and real estate* | *17%* |
| *Services* | *18%* |
| *Government and governmental enterprise* | *12%* |
| | *100%* |

In terms of trends, these approximate proportions of GNP will likely continue except for changes in defense and energy.

From either perspective of the structure of the nation's

GNP, environmental data and information currently have utility in connection with decisions in every sector.

Looking ahead, more precise environmental information, particularly predictions, can be a significant tool in improving the economic competitiveness of each sector.

*Consumer expenditures*

From the perspective of decisions by individual American consumers, their annual expenditures follow the pattern below:

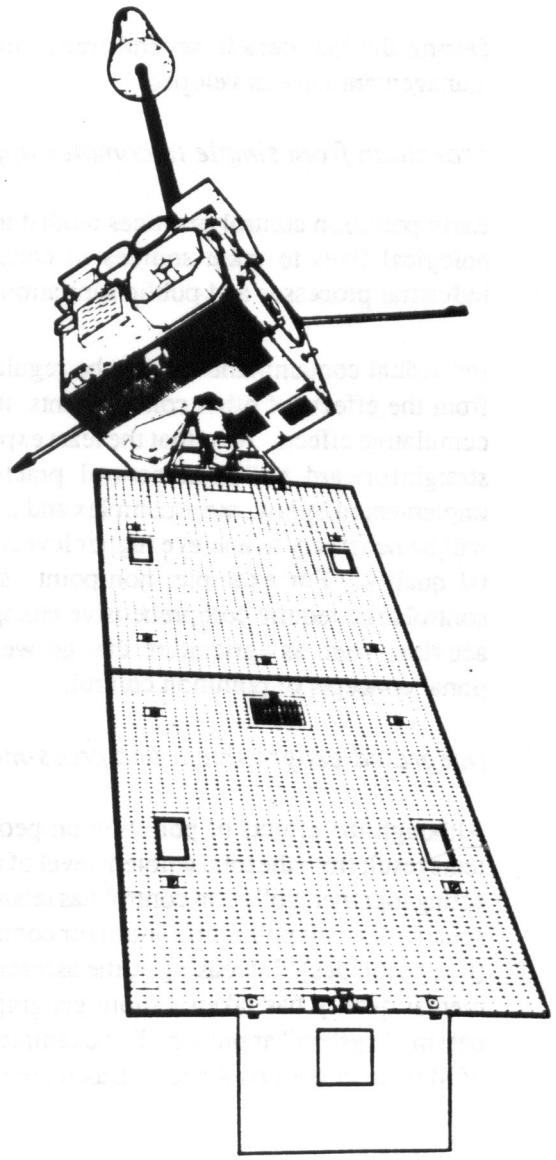
| | |
|---|---|
| *Food* | *15%* |
| *Housing* | *31%* |
| *Insurance and Pensions* | *9%* |
| *Apparel and Services* | *6%* |
| *Health Care* | *5%* |
| *Transportation* | *19%* |
| *All other* | *15%* |
| | *100%* |

Environmental information and services currently have some applications for every aspect of household budgets. Education of consumers regarding newly available environmental information in the 1990's has the potential for direct and positive effect on family discretionary spending.

*New environmental industries*

A third perspective on the economy focuses directly on industrial competitiveness in this country and in foreign markets. This perspective involves the innovative application of "environmental engineering" into manufacturing processes and final products for sale. Although this concept most generally refers to pollution control advances, it also includes the design of products resistant to environmental hazards such as high winds, waves or airborne corrosion agents. Environmental information can provide valuable data bases for designing new products with environmentally desirable characteristics. Environmental information can also provide useful evidence of the efficacy of expensive pollution control regulatory strategies. Some planned regulatory actions may not perform as intended in practice, and environmental monitoring can be a valuable tool in making midcourse corrections in environmental management to achieve maximum economic efficiency. Competitive economic decisions in the United States will increasingly rely on environmental information about the ocean, the atmosphere and the Nation's water resources.

NOAA's information products and services that can be applied in decisionmaking in the economy are generally a by-product of the service programs established for reasons of public safety. That is to say, the immense NOAA investment in weather observation, analysis, and communication infrastructure is justified by the need to forecast severe weather conditions for the protection of life and property. Once that infrastructure is in place, it can also be used to issue routine predictions of other than severe weather that can be utilized for various practical settings benefiting the economy. As NOAA improves its warning services to the public -- weather, marine, solar flare -- the necessary investments in technology for observations, analysis, and prediction will also yield payoffs for information useful for the economy. NOAA will be challenged to find ways to make its environmental information more applicable to decisionmakers throughout the economy in an effort to bolster the nation's economic competitiveness.



## *Environmental Management*

During the last quarter century, the problem of environmental protection has surged from a localized engineering focus on minimizing nuisances such as industrial smoke stack emissions or phosphate detergent foams on streams to an urgent national problem of public health and ecosystem preservation. This problem pervades virtually every sector of the economy and society at large. In fact, the prospect of global environmental change from greenhouse gas accumulation will potentially affect some of the most fundamental features of modern society, including the sustainable size of the human population itself.

Environmental management is urgent, but also very costly. The most problematic items on the Nation's environmental agenda include air pollution, water pollution, and toxic contaminants on land. Physical alteration of ecosystems such as wetland loss also create a challenge for environmental management.

During the last decade several trends in environmental management have developed:

### *Transition from simple to complex approaches*

Early pollution control practices tended to focus on technological fixes to point sources of contamination from industrial processes and public sanitation systems.

Individual contaminants tend to be regulated in isolation from the effects of other contaminants, thereby ignoring cumulative effects. Now that the least expensive and most straightforward pollution control practices have been implemented by law, more complex and costly approaches will be necessary to achieve higher levels of environmental quality. For example, non-point source pollution control may require comprehensive changes in economic activities such as agriculture that go well beyond traditional concepts of pollution control.

### *Integrated geographical and cross-media focus*

Although the effects of pollution on people and ecosystems result from the total ambient level of all contaminants acting together, pollution control has tended to be medium specific (i.e., air pollution control) or contaminant specific (i.e., pesticides). Increasingly, the assessment of environmental quality has taken a more geographically encompassing "system" approach. For example, the entire Gulf of Mexico or the Los Angeles Basin are now the units for environmental analysis. Cross media interactions are also being assessed in such cases as marine sources of substances that can contribute to acid rain. Moving from a more integrated geographical focus for environmental assessment to using that perspective for pollution control will be a challenge for the 1990s.

### *Comprehensive environmental management strategies*

Environmental management is much broader than pollution control. To fulfill the public's sustained demand for a high level of environmental quality, economically feasible approaches will require a long term national commitment to rethink virtually every aspect of modern society's interaction with the environment. This perspective will lead to designing environmentally responsible features into all sectors of the economy to prevent or limit environmental degradation. For example, end-to-end material processing strategies anticipate waste implications and economically attractive conservation practices also yield environmental benefits.

### *The global environment*

Environmental management initiatives have to be taken at the national level because of the significant socioeconomic and legal implications of environmental protection. However, the truism that "pollution knows no boundaries" has broadened from a recognition two decades ago that transboundary pollution requires international action in such cases as regional air pollution and acid rain. This broadening of perspective now includes broad recognition that there are global environmental problems that require nothing less than concerted global action. The concept of global environmental management flows logically and inevitably from the concept of Earth system.

With these trends in mind, the following environmental management problems must be faced in the 1990s.

### *Environmental problems of the 1990's*

**Air quality.** During the decade of the 90s, the United States will invest more than $30 billion per year to prevent or control air pollution. This investment is primarily targeted at controlling emissions from point sources. Expected amendments to the Clean Air Act could lead to an additional $25 billion per year expenditure by the end of the decade. If greenhouse gas reduction is viewed as a problem in environmental management, then additional

national investments of an equal or greater magnitude may be necessary during the next 10 to 20 years to arrest the growth in greenhouse gas emissions into the atmosphere.

Ozone depletion is another urgent air quality challenge. An accelerating loss of ozone in the stratosphere of the southern hemisphere was first reported in 1988. Scientific consensus has concluded that ozone levels in mid-latitudes of the northern hemisphere decreased, on average, by 1.7 to 3.0% between 1969 and 1986. Synthetic chlorofluorocarbon compounds released from human activities are believed to be the principal cause of the destruction of the stratospheric ozone. With the decrease in the ozone layer more potentially-damaging radiation reaches the Earth's surface where it can directly affect humans by increasing the incidence of skin cancers. The long-term impacts of increased radiation on the Earth's ecological system is not clear, but may well be major.

Resolution of these air pollution problems of the 1990's--from the most local to global geographical scales will depend increasingly upon underlying knowledge of natural processes responsible for atmospheric quality variation (air chemistry) and the changing concentrations and effects of air contaminants (monitoring). At present, many atmospheric processes remain poorly understood, and air quality monitoring is unreliable, particularly at regional and global scales. Effective air quality regulation that is most efficient economically will be dependent upon better information about the actual response of the complex atmospheric environment to changing societal actions, including costly air pollution controls.

**Water quality.** Water pollution is also a major national problem. During the next 10 years, the Nation's investments in water pollution control will rise from approximately $40 billion per year to more than $60 billion.

More than half of the U.S. population, 110 million people, now live in coastal areas including the Great Lakes. By 2010 this number is expected to increase to 127 million. As coastal populations increase, great pressures are put on fragile ecosystems through increased demands on water, energy, and waste treatment and disposal. The related problems of non-point source runoff and contaminated sediments in harbors and estuaries also continue to increase. The inevitable degradation of environmental quality results in the loss of marine habitat and living resources.

Increasing coastal populations compete for limited resources and effect change in land and water use. Demand increases for housing, transportation, port and marina development, and recreational facilities. Alterations in the natural habitat undermine the natural resources base. As these resources become scarce, environmental decisions become important economic decisions. A conservative estimate of the annual cost of coastal environmental degradation to the U.S. economy is $8 billion, $86 million within commercial fisheries alone.

With respect to freshwater rivers, streams, and channels throughout the nation's interior, the quantity of water (streamflow) is directly related to water quality in many cases, with adequate streanflow for downstream transport and for extractive consumption, pollution loading may be assimilated without harm. However, with water shortages because of draught or excessive extraction for such purposes as irrigation, water quality may deteriorate markedly from pollution. Prediction and management of freshwater flow in rivers and streams will be a major tool in water quality management in the 1990's.

To a growing extent, emergency response to hazardous material accidents and oil spills must go beyond immediate mitigation and control to become an integral part of more comprehensive water quality management. In connection with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), NOAA has been designated as natural resources trustee for the restoration of damaged marine habitats. During the 1990's, some 200 marine areas have been identified with significant damage or environmental contamination. Continuing accidental discharges will expand this list. Through a coordinated process of damage assessment and litigation, awards for damages will be used by NOAA to restore marine areas.

The costs of cleaning up the environment and restoring damaged resources are generally staggering compared to the costs of preventing loss and damage in the first place. Costs to clean up polluted coastal and estuarine waters reach into the billion of dollars each year. The total cost of preventing, mitigating, and correcting coastal ocean resource degradation and property loss has been conservatively estimated at $9.57 billion each year. Together with the value of the U.S. fisheries and tourism, $36 billion, these numbers represent an enormous amount of public and private wealth -- $45.57 billion -- directly affected by environmental decisions.

As in the case of air pollution management, effective public policy to control water pollution must rely upon an

adequate foundation of knowledge about natural variabilities in the characteristics of freshwater and marine environments, the effects of contaminants, and the overall trends in water quality as a result of regulatory action. During the decade of the 1990's, expensive water pollution controls may be shown to be less effective than intended or, in certain cases, unregulated sources of contamination may turn out to pose more serious threats to water quality. Systematic marine environmental monitoring will also be a necessary tool to assess trends and validate efficacy of complex pollution control strategies.

**Coastal wetlands.** Coastal wetlands play an extremely important role in sustaining the economic vitality and protecting the environmental quality of our Nation's coastal areas. Of the 1985 U.S. commercial fishery landings, about 77% (by weight) and 71% (by value) were made up of fish and shellfish species dependent on coastal and estuarine habitats such as wetlands and seagrass beds. They provide vital habitat for sensitive life stages of fish and other marine resources, of waterfowl and other birds, and of many terrestrial mammals. Coastal wetlands are estimated to contribute about $5 billion to the production of fish and shellfish in the U.S. coastal waters. These habitats protect shores from storm and wave damage and provide major recreational opportunities. Although wetlands play a vital role, alteration and development have destroyed about 50% of these areas and this destruction is continuing and expanding. It is estimated that 450,000 acres of wetlands are lost each year in the U.S. due to natural and man-made causes. In coastal Louisiana alone, recent losses of wetlands are estimated to be about 25,000 acres (40 square miles) per year.

Continuing scientific and analytical efforts will be necessary to document the consequences of wetland loss and the estimation of the value of investing in wetland protection. In the 1990's, opportunities to restore wetlands will be increasingly sought as a way to deal with the problem.

*Comprehensive coastal environmental management*

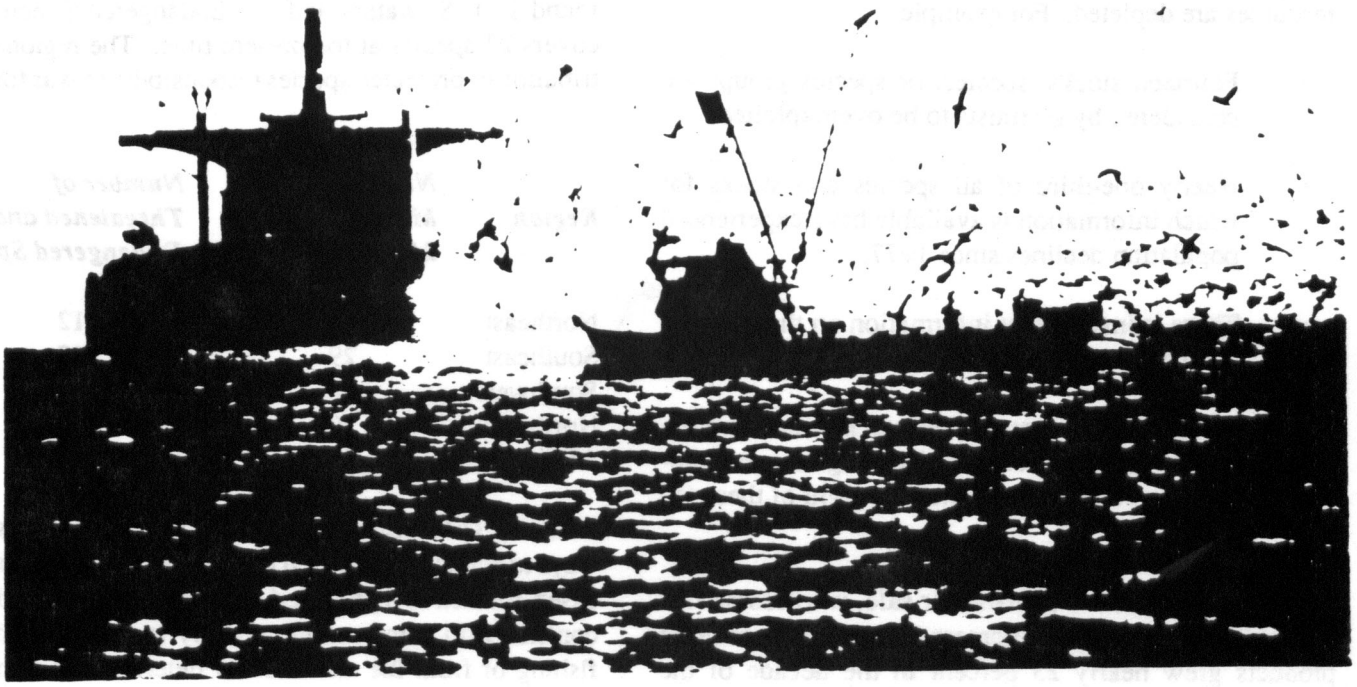
The coastal zone is biologically the most productive part of the ocean. Yet it is here that much of the waste disposed of by our society ends up either intentionally or inadvertently. As population is concentrated around our coasts so are the effects of physical modification of the environment. To make way for residential and industrial developments, natural coastal erosion protection, such as offshore bars, islands, and vegetative cover, has been modified in many areas and lead to accelerated shoreline changes. The cumulative effect of all these modifications is that the habitat provided along U.S. coasts is greatly modified and degraded from what would naturally occur.

Responsible coastal environmental management must be based upon effective actions that are sensitive to cost. A foundation for such management includes three key features:

- the ability to identify natural variabilities in the environment in contrast to those changes in society;
- the ability to monitor and predict changes in the natural environment, both from natural and human causes;
- the development of improved strategies of preventing accidents that cause environmental damage; and
- the development of environmental data bases that will allow the most cost-effective approaches to pollution control or to mitigation strategies to achieve desired objectives.

Since enactment of the Coastal Zone Management Act (CZMA) in 1972, the coastal states, in partnership with the federal government, have made significant progress in ensuring wise management of the nation's valuable coastal resources. To date, 29 coastal states now have approved CZM programs and 18 national estuarine reserves have been established. However, due to increasing population growth along the coasts and the accompanying impact on water quality, increased marine debris, reduced opportunity for public access to the nation's coastal resources, loss of coastal wetlands, and increasing numbers of life and property subjected to coastal hazards, NOAA will be increasingly challenged to expand its focus on federal/state CZM partnerships. In 1990, Congress reauthorized the Coastal Zone Management Act with strengthened provisions in the following areas:

- Federal consistency (requires all federal agency activities including OCS lease sales and ocean dumping activities whether inside or outside of the coastal zone areas to be subject to the consistency provisions of the Act if such activities affect natural resources, land uses, of water uses in the coastal zone).
- Competitive grants (to encourage each coastal state to improve its program in such areas as coastal wetlands protection, natural hazards management, improved public access, reduction of marine debris, assessment of cumulative and sec-



ondary impacts of coastal development, expanded ocean resource planning, and the rational siting of energy and governmental facilities in coastal regions).

- Coastal water quality (provisions requiring states to develop Coastal Nonpoint Pollution Control programs).

Implementation of these provisions of the Coastal Zone Management Act will increasingly require an integrated NOAA strategy incorporating all of NOAA's scientific and technical expertise to focus on these coastal environmental problems.

## *Conservation of Natural Resources*

NOAA's mission includes direct and indirect responsibilities related to virtually every natural resource issue of significance to the nation. National trends related to conservation of natural resources can be most clearly examined by various natural resource sectors.

### *Marine Living Resources*

NOAA's most direct natural resource mission involves the conservation of marine fisheries and the protection of endangered species associated with the marine environment. The National Marine Fisheries Service (NMFS) is responsible for managing living marine resources within the United States Exclusive Economic Zone (EEZ). The zone covers over two million square miles of ocean from which over 300 species are harvested commercially or are taken by recreational anglers. Fishery management objectives pursued by NMFS strive to maintain the biological productivity of the Nation's living marine resources, which is a critical element in the achievement of optimum utilization. Successful management from both a biological and economic perspective requires a continuous flow of scientifically sound information and a continued striving for

greater accuracy to reduce risk and uncertainty. In the absence of credible data, fishery managers must operate in a conservative manner to avoid jeopardizing the stocks.

Providing adequate information has become increasingly more difficult in recent years. Many traditional U.S. resources are depleted. For example:

- Fourteen stocks, species, or species groups are considered by scientists to be overexploited;
- Nearly one-third of all species and stocks for which information is available have experienced population declines since 1977;
- There is insufficient information on the status of another 29 percent of U.S. fisheries; and
- Ten of the 14 overexploited stocks would require 5 to 10 years to recover if fishing stopped altogether, yet fishing continues in eight of these ten fisheries.

On the other hand, the demand for safe, wholesome fish and shellfish products has increased. Demand for seafood products grew nearly 25 percent in the decade of the 1980's. Consumer preference for seafood in the diet will likely continue in the 1990's, particularly in light of national nutritional guidelines stressing the cardiovascular health benefits of increased fish and shellfish consumption in the diet. Much of the increased supply to meet demand may come from imported seafood products, including products from intensive acquaculture.

The NOAA mission also includes a responsibility to improve the international competitive position of the U.S. fishing industry. The agency supplies critical information to support bilateral and multilateral trade negotiations, as well as international conservation agreements. U.S. exports of fishery products amounted to nearly $5 billion in 1989. The U.S. also is a major importer of fishery products. Imports in 1989 accounted for 49 percent of the volume of seafood consumed in the U.S. The value of all fishery product imports, edible and industrial, was $9.7 billion. Improved resource information that leads to increased fishery productivity could in turn lessen the dependence of the U.S. market on imported products to satisfy demand, while accurate trade information helps to stimulate an increase in exports.

Under provisions of the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, NOAA is responsible for the protection, conservation, and restoration of all species of marine mammals in U.S. waters and the high seas and species of marine plants and animals which are threatened or endangered with extinction. The Marine Mammal Act covers 56 species of marine mammals found in U.S. waters and the Endangered Species Act covers 23 species at the present time. The regional distribution of protected species responsibilities is as follows:

| *Region* | *Number of Marine Mammals Species* | *Number of Threatened and Endangered Species* |
|---|---|---|
| Northeast | 26 | 12 |
| Southeast | 29 | 13 |
| Southwest | 18 | 15 |
| Northwest | 30 | 6 |
| Alaska | 27 | 6 |

In all cases of marine protected species, there are no simple ways to achieve the desired protection objectives. In most cases, the risk to a protected marine animal results from a conflict with some marine activity such as commercial fishing or from the alteration or deterioration of marine environmental quality. Polls have shown that public concern for the protection of marine wildlife will likely be sustained or increased in the 1990's.

As part of its overall mission as steward of marine resources, NOAA will face major challenges in the 1990's, to rebuild, maintain and protect living marine resources. Integrating its core operations with the high-priority NOAA-wide programs, the agency has established a slate of eight objectives to achieve this mission:

- Rebuild overexploited marine fisheries.
- Maintain currently productive fisheries.
- Advance fishery forecasts and ecosystem models.
- Better integrate management of fisheries and protected species.
- Improve seafood safety.
- Improve fishery habitat protection.
- Improve the effectiveness of international fisheries relationships.
- Enhance opportunities for U.S. aquaculture.

*Marine Protected Areas*

There is an historical recognition of the need to protect and manage certain marine areas of importance to the nation. These areas possess conservation, recreational, ecological, historical research, educational, or aesthetic values which give them special national significance. However, until recently, efforts to establish protected areas have been directed almost entirely to those on land. Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 provides a tool for the designation and management of such special marine areas.

Management of these areas is accomplished by controlling the mix of uses to maintain the recognized values of the site. This concept allows for multiple use of marine sanctuaries but recognizes that resource protection is the primary objective. The MPRSA provides the only opportunity under U.S. law to designate and manage discrete offshore areas as ecosystems - as opposed to managing individual resources, such as mammals or fish under several different laws. There are currently eight national marine sanctuaries and ten additional sites in active development or under study. In addition to the need for designating marine areas of national significance, Congressional intent was also to assure the following:

- A coordinated and comprehensive approach for managing these areas, as opposed to relying exclusively on resource-specific legislation;
- to the extent compatible with resource protection, allowance must be made for public and private use;
- the public should be made more fully aware of the nation's collective riches existing in these sanctuaries, that they are treasures that belong to every citizen as a public trust which each has the right to enjoy and the responsibility to protect for future generations; and
- that these protected areas afford excellent opportunities for research.

Eight national marine sanctuaries have been designated since the program began. They include nearshore coral reefs as well as open ocean, and range in size from less than one to over 12,523 square nautical miles. The sanctuaries harbor a fascinating array of plants and animals, from huge whales to tiny, brightly colored sea snails. In many cases, these protected waters provide a secure habitat for species close to extinction. One of the sanctuaries protect a historically significant shipwreck (the MONITOR). The sanctuaries are also recreational areas for diving and sportfishing in addition to supporting valuable commercial industries, such as fishing and kelp harvesting.

Within the National Estuarine Research Reserve System, eighteen reserves have been designated in fifteen states and Puerto Rico. They protect nearly 300,000 acres of estuarine waters, marshes, shorelines and adjacent uplands for educational and research use. Reserves are managed for long-term environmental monitoring and scientific research. Each site offers opportunities to monitor changes within the estuarine system and the effects of human activity on its resources. The results of scientific research programs in the Reserves are important sources of information and data to support coastal zone management and decision-making. Educational programs are developed to provide linkages between the research results and managers, decision-makers and the general public.

Looking ahead public concern for the need for marine protected areas is expected to be sustained or increased in the 1990's, with an accompanying significant increase in the size of the sanctuary system. Many scientific, technological and public policy issues will need to be addressed in the decade of the 1990's to ensure that a responsible and balanced approach is taken to preserve valuable marine areas for the sustained enjoyment by the public, now and in future generations.

*Marine Mineral and Energy Resources*

Compared to the exploitations of marine living resources, marine mineral and energy industries are relatively recent in their development. Since the 1960's, major technological advances for working offshore have established the feasibility of exploitation of various marine minerals or the conversion of ocean energy into useful forms of power. However, the production of offshore oil and gas continues to remain the only significant non-living marine resource industry. Other than locally important exploitation of offshore send and gravel, no marine mineral resource is now economically competitive with mineral supplies onshore. Similarly, ocean thermal energy conversion systems are becoming economically competitive sources of power in a few special situations such as small island communities. During the decade of the 1990's, offshore oil and gas exploitation will continue to be predominant in the marine mineral and energy industry.

At the present time offshore oil production in the United States is approximately 380 million barrels per year, 80% of which is from the Outer Continental Shelf (OCS) under federal jurisdiction (the remainder being under state control). This total offshore production accounts for approximately 10% of all oil production in the United States. In light of America's continuing dependence on oil imports, and persistent public concerns about the environmental impact of offshore oil operations, President Bush announced major OCS policy decisions on June 26, 1990. The decisions called of the cancellation and deferral of OCS lease sales in California, Oregon and Washington as well as in Florida and the North Atlantic area. The purpose of the cancellation was to insure more thorough oceanographic ecological and socioeconomic analysis of offshore oil lease options within the context of five guiding principles:

- Adequacy of Information and Analysis. Obtaining adequate scientific and technical information is the highest priority: no new leasing should take place without such information and analysis.

- Environmental Sensitivity. In some areas, even the small risks posed by oil and gas activity may be too great.

- Resource Potential Priority should be given to areas with the highest resource potential, particularly areas subject to previous development but also some frontier areas.

- Energy Requirements. We must consider the costs and benefits of various sources of energy, the trends toward higher oil imports, and the availability of conservation and alternative energy sources.

- National Security. External events, such as a supply disruption, may require reevaluation of the OCS program. Decisions regarding OCS development must be subject to a national security exemption that allows the President the flexibility needed to manage the Nation's offshore oil and gas resources under changing circumstances.

The President also called upon federal agencies to step up planning for oil spill prevention and clean up. Later in 1990, Congress passed the Oil Spill Prevention Act which significantly expanded federal agency responsibilities in the oil spill prevention and response arena. Implementation of these decisions in the 1990's will require considerable scientific, technological and planning effort by federal agencies including NOAA.

In the other natural resource areas in which NOAA has more indirect responsibilities, there is one trend that is generally shared — increasing scarcity requiring more sophisticated public policy and management approaches. The following examples highlight significant natural resource issues expected in the 1990's:

*Water Resources*

One of the most critical natural resources management problems facing the nation within the next 10 years will be the rapidly changing relationship of the water supply to user demand. The seriousness of the problem is clear in view of growing conflict among competing uses of water such as irrigation, municipal supply, hydro power, recreation, wild life preservation, commercial and sport fisheries, industrial use, and navigation. Also, legal disputes over water rights are becoming increasingly bitter, the costs of building and replacing water storage and control structures are soaring, and the value of water to various sectors of the economy has increased by more than a factor of ten in recent years. Water shortages can significantly hinder the economic and social well being of entire regions. Losses from drought in the agricultural areas and from flooding throughout the U.S. during the past several years amount to billions of dollars. This changing relationship of supply to demand is principally caused by population shifts in combination with a highly variable supply and pollution of both surface and ground water resources.

The supply and variability of the Earth's water resources is directly related to the interaction of the atmosphere, ocean, and sun. The hydrologic cycle is the description of this complex process. In a simplified way water continuously circulates from the ocean to the land, by way of the atmosphere in the form of precipitation, and eventually returns to the sea as ground-water and surface-water flow and to the atmosphere through evaporation and biological processes.

40,000 billion gallons of water vapor pass over the country each day, and, of this amount, 4,200 billion gallons fall as precipitation. About two-thirds of this precipitation (2,800 billion gallons) returns to the atmosphere daily via evaporation and transpiration from surface-water bodies, land surfaces, and vegetation, and the rest is discharged into streams, lakes, or the ocean, or seeps underground.

In 1985, approximately 399 billion gallons of water per day were withdrawn from aquifers and streams for fresh water use. In the continental United States approximately ten percent of the use was for public and rural water supply, 33 percent for irrigation, and the remainder for industry. In some parts of the country, heavy surface water withdrawals combined with irrigation return flows have caused high salt and sediment concentrations and overall poor water quality in our rivers. Low flows and discharges of pollutants stress our fisheries and wild life and seriously jeopardize ore estuaries. Since the demand for fresh water continues to increase and a large portion of it is totally consumed during offstream use, or its quality degraded, it is becoming increasingly important that fresh water in the United States be well managed.

The socio-economic dislocations associated with major, widespread, recurrent drought episodes are among the most serious water resource problems of the nation. The complex and erratic climatological and hydrological processes associated with the initiation, evolution, and "break" of drought episodes are inadequately measured and understood. Even the historic Great Plains dry period of the 1930's — why it began, why it persisted, and why it ended — is still not understood. There are many definitions of drought, reflecting its pervasive effect on society. Meteorological drought is a period of deficient rainfall; agricultural drought is a period of inadequate soil moisture; hydrologic drought is a period of inadequate water supplies. Each definition translates into a slightly different problem for those involved in water management decision-making.

The era of constructing massive projects to obtain new water resources is over. The projects have become too expensive, and most of the promising locations have been used up.

Emphasis clearly is shifting from construction to improved operation and management techniques. This new emphasis on water management is forcing new institutional relationships on Federal, State, and local governments and the regional water management agencies that pump, cleanse, distribute, and use water. The need to put water problems in perspective is forcing agencies to seek interagency solutions.

Some new state laws are being instituted mandating a change from water viewed as a property right to water valued for its "highest and best" use.

A free market approach is no panacea. Selling water to the highest bidder may significantly impact the fish and wildlife that depend on water remaining in the rivers, and may affect other seemingly low value uses which are nonetheless important to the environment and the nation's economy. Participation by the Federal government will be needed in determining "highest and best" use so that these environmental uses are not overlooked. Improved water management will help to minimized the cost to various users.

Looking to the 1990's NOAA will be called upon to provide authoritative, reliable, and unbiased water resources forecast information for the nations water managers and users and policy makers at the national, regional, and local levels.

*Forest Resources*

Forestry is a major industry that satisfies a high demand for wood and paper products in this country. In the future, NOAA will be called upon to serve the forest resources industry in several ways. First, fire weather prediction support will continue to be a major factor in forest management. Second, increasing knowledge about the causes and extent of regional air pollution will be necessary to develop strategies to protect forests from the effects of acid rain. Third, certain forest harvesting practices such as clear cutting will increasingly conflict with the protection of wildlife, and NOAA will need to continue to work with other Federal agencies and industry to protect salmon and other anadromous species from degraded stream conditions arising from logging.

## *Earth Science Research and Education*

Research and education in the Earth sciences will be important to NOAA in the 1990's for several reasons. First, increased investments in scientific research are an urgent national priority because of the overall relationship of R&D to economic competitiveness. Second, advances in the Earth sciences directly translate into opportunities for NOAA to fulfill its mission. Third, NOAA can, in turn, stimulate progress in the Earth science community through NOAA's collection of data, development of models, and publication of research findings. Fourth, research and advanced education go hand in hand in the academic community, and NOAA depends upon a continuing supply of highest caliber scientific and technological talent. Ultimately, education in the Earth sciences in the broadest sense, involving every citizen, will be a determining factor in how well the public is able to use NOAA's products and services and how well difficult public choices are made

involving the environment and natural resources of the Earth.

NOAA has direct and indirect responsibilities in the area of education. Since its inception in 1966, the National Sea Grant College Program has promoted the development of university-level education in marine fields. Through the Marine Advisory Service, the Sea Grant Program has provided practical knowledge to people of all ages who are active in the marine industries or who engage in marine recreation. In a more indirect way, NOAA's multifaceted relationships with universities does affect the quality of educational experiences for students, especially at the post-graduate level. Strengthening NOAA's ties with universities in the 1990's will be an urgent challenge that can greatly benefit education in the Earth sciences.

*Earth Science Research Policy*

The United States has invested research and development funds differently than its economic partners. Sixty-five percent of the funding for R&D projects in the United States goes to defense-related projects. On the contrary, West Germany and Japan focus most of their R&D funds on projects in the civilian arena. This trend may be changing. One recipient of the so-called "peace dividend" could be civilian R&D projects in the United States, particularly environmental research projects. Congress is already considering legislation to apply some of the vast military resources to environmental research.

The principal Earth science policy mechanism in the Executive Branch is the Committee on Earth and Environmental Sciences (CEES) of the Federal Coordinating Council for Science, Engineering, and Technology. Members of CEES review Federal Earth science programs and propose comprehensive federal approaches to urgent National scientific opportunities.

The nation now spends approximately $500 million annually for research directed to the ocean, the atmosphere and the environment. Investment in research related technologies for the Earth sciences, particularly those involving remote sensing from space is expected to quadruple in the 1990's. Today, there are approximately 12,000 oceanic and atmospheric scientists in the United States, but fewer than 20% are actively engaged in research. In view of the Earth system science challenges of the 1990's, serious issues arise regarding the size of the Earth science community and the scope of graduate education in terms of the dominance of disciplinary boundaries between the ocean, the atmosphere, etc.

*Education in the Earth Sciences*

A troublesome trend appears in the scientific workforce. Estimates by the National Science Foundation predict a shortfall of 675,000 scientists and engineers by the year 2006 and of 9,000 Ph.D.'s by the year 2000. This is because the low birth-rates of the 1960's and 1970's will lead to lower numbers of college students. College-age students will number only 24 million in the mid-1990's, whereas they were 30 million strong in 1980. On top of this reduction in the available population, only a small portion, about 5% of these students will actually earn a bachelor's degree in science.

Although the number of people employed in science and engineering jobs in private industry increased twice as fast as the general workforce since 1980, only 13% were women and 2.2% were black. It will become necessary to try to attract more women and minorities to the science/technical fields in order to make up some of this shortfall.

The decreasing proportion of students now entering science fields versus other careers is a serious problem with long-term consequences. Of the few students who plan to major in science or engineering when they enter college, fewer than half complete degrees in these fields. This is attributed to students finding the course work too difficult, finding other fields more interesting, or believing the prospects to be better in other fields.

Conferral rates for baccalaureate degrees in science and engineering have remained roughly constant for 30 years. This is somewhat surprising in view of the fact that the number of young people selecting science and engineering careers has not increased during a generation in which science and technology pervade every aspect of modern life. A variety of reasons have been advanced including uninteresting curricula in grades kindergarten (K) through 12, and teachers who are inadequately trained and poorly rewarded.

There are three major problems that the scientific community must solve in training the necessary talent needed for the coming century. These are: the general lack of national interest in science as a career among college-age and younger students, the changing aspects and skills needed by marine and atmospheric scientists in the 21st century, and the impact of "big science" and advancing technology on the individual researcher and graduate student.

*Earth System Perspective*

Marine science is undergoing major changes. These include the realization that the ocean plays a critical role in the worldwide process of global change. Similarly, the atmospheric research community is incorporating more complex hydrologic and marine understanding into research advances. To answer some of the questions related to global change, new, large-scale research programs will be necessary. These will be a decade long in duration and involve innovative ways of collecting data, including satellites and other new sensors. The oceanographer who will work in these programs will be different from the sea-going scientist of years past, as familiarity with computers may be more important than sea-going skills.

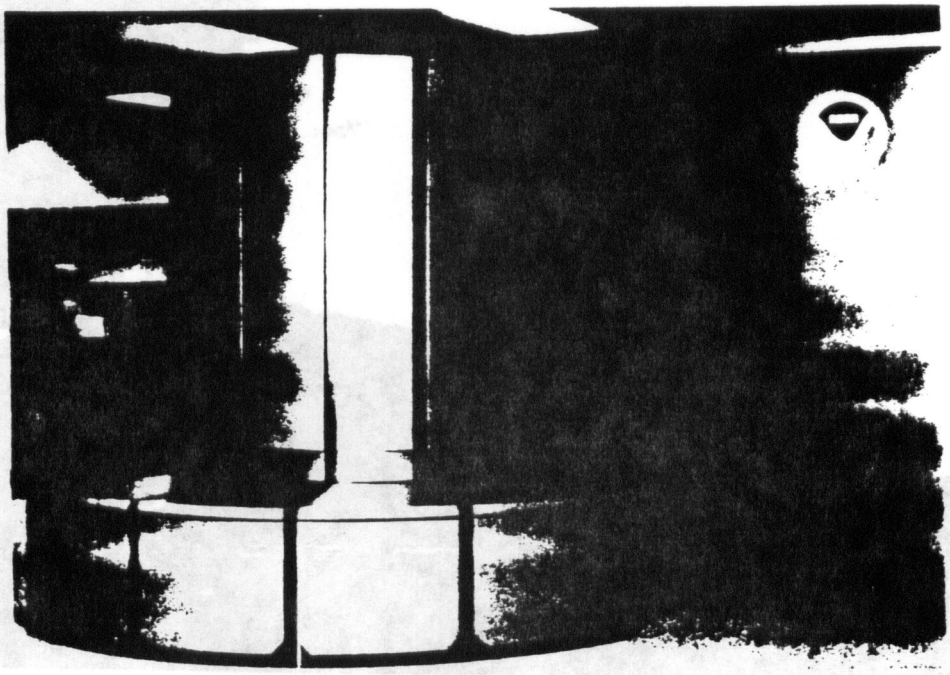
*Public Knowledge about the Earth System*

Earth science education is much more than a workforce issue for NOAA. Successful implementation of all of NOAA's mission relies heavily on an educated population of citizens who make informed decisions in their personal lives as well as in participating in the debate about decisions of public policy at the local, state and federal levels. Public education about the Earth and the environment is increasingly a prerequisite for responsible citizenship.

The ocean and marine life still have a romantic allure for most people. Professionals involved in marine education in any capacity can take advantage of that fact to interest young people in science careers and the marine sciences in particular. Weather study units have been incorporated into the curricula of many schools. A study reported in the Bulletin of the American Meteorological Society shows that approximately 25% of general-science instruction in middle an junior-high schools deals with weather. During their educational development, students can be made aware of the wide variety of career fields open to them, many of which do not require a Ph.D. A solid foundation in mathematics and natural sciences is a requirement for science careers, and it can be attained in a way that is much more appealing to students.

There are currently about 24,000 Earth science teachers and 11,000 environmental science teachers in the United States. This educational infrastructure offers a major opportunity to improve education in the Earth science. For example, elementary and secondary educational programs can be improved to make available stimulating instructional materials that can be infused into K-12 curricula in non-science as well as science courses. At the graduate school level, assistantships, and pre- and post-doctoral fellowships can also be targeted toward specific job categories to fill needs, and toward minorities and women to increase these increasingly important sources of career scientists.

Because elementary and middle school teachers tend to have backgrounds in chemistry, biology, or general science, there is a need to increase their knowledge and expertise in marine and atmospheric sciences. Improving curricula and enhancing out-of-classroom experiences for science teachers at the K-12 and post secondary levels can translate back into increased career interest by the student population.



# IV. High Priority NOAA-Wide Programs to Respond to National Needs of the 21st Century

## *Modernization of Weather Programs*

### *The Problem*

By the mid 1980s, NOAA recognized that its weather forecast and warning operations needed major changes to be able to satisfy the nation's weather information requirements of the 1990s. Three major problem areas warranted attention. First, equipment for weather observation, analysis and communication had become obsolete, unreliable and costly to maintain. Second, most of the weather-related technologies were highly labor intensive and not easily integrated into a single operational system of National Weather Service (NWS) field offices. For example, very few NWS field offices even had access to weather satellite imagery. Third, and perhaps most urgent, major service deficiencies inherent in the weather technologies limited the effectiveness of severe weather and flood warning operations. As many as half of the destructive weather and flood events in the nation were not covered by NWS warnings, as many as two-thirds of the warnings actually issued were false alarms. Scientific and technological advances of the 1980s will permit a comprehensive modernization of NOAA's weather capabilities to respond to these problem areas in 1990s.

### *Objectives*

The overall objective of the modernization of NOAA weather programs is to mobilize all of NOAA's hydrometeorological capabilities to improve the accuracy and timeliness of severe weather and flood warnings to the nation. Related objectives include:

*integration of new technologies with field operations so that weather and flood warnings are based upon routine hydrometeorological prediction rather than detection of severe weather once it has broken out;*

*maximum use of new technology to seek productivity through automation; and*

*expanded cooperation with state and local emergency management officials to lower loss of life and property.*

To fulfill these objectives, NOAA submitted to the Congress in 1989 the Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service. The modernization is scheduled to be completed by the late 1990's.

### *Strategies*

The modernization of NOAA's weather programs will involve every NOAA component. At the center of this effort will be the modernization and associated restructuring of the NWS itself. Environmental satellite and communication system capabilities will be advanced by the National Environmental Satellite, Data, and Information Service (NESDIS). The Office of Oceanic and Atmospheric Research will work closely with NWS and NESDIS to continue the Program for Regional Observation and Forecasting Services (PROFS) and storm-scale weather research advances which can be incorporated into new operational programs during the modernization and after it is completed. The implementation of the NWS marine weather program will also benefit from assistance from the National Ocean Service and the National Marine Fisheries Service.

NOAA will employ the following specific strategies for the modernization of weather programs:

*Design and implement the new technology suite as an integrated package with the following elements:*

- weather observations and monitoring

*Next Generation Weather Radar (NEXRAD)* — *network of advanced Doppler radars to measure the motion of the atmosphere responsible for severe weather such as tornadoes, to detect heavy rainfall, and to increase lead times for predictions.*

*Next Generation Geostationary Operational Environmental Satellites (GOES NEXT)* — *a new series of geostationary meteorological satellites to provide higher spatial and temporal resolution imagery and data to aid shorter-range warnings and forecasts; a new series of polar orbiting meteorological satellites to provide improved, all-weather atmospheric guidance for medium and long-range forecasts.*

*Class VII Computers* — *computers with a tenfold increase of computing power. This will allow more complex numerical modeling of the atmosphere that will improve national guidance for short-range warnings and forecasts, as well as more reliable guidance for medium and long-range forecasts.*

*Automated Surface Observing Systems (ASOS)* — *an automated electronic sensor instrument system to replace manual weather observations now taken at 250 NWS sites.*

*Wind Profiler Demonstration Program* — a state-of-the-art Doppler radar system, designed to be unstaffed, and provides output system diagnostic information every 6 minutes. The demonstration network consists of 30 stations.

*Maintenance of continuing programs for operational observations*—*including the Polar Orbiting Environmental Satellite Program and the Hurricane Reconnaissance Program*

*Replacement of aging operational systems*—*such as Upper Air Network and the Cooperative Climate Network.*

- data analysis and communication

*Advanced Weather Interactive Processing System (AWIPS)* — an advanced computer/telecommunication system to help the forecasting integrate all sources of weather data at field offices, to assist them in analyzing fast breaking storms, and to aid in the timely preparation and dissemination of warnings and forecasts.

*NOAAPORT direct satellite broadcast information dissemination system* — component of AWIPS will provide the direct broadcast link between the national guidance center and NWS field office, and will be the source of NWS data and information to external, private sector users.

*Improve dissemination systems with the implementation of the NOAA Weather Radio console replacement system.*

*Restructure field office locations and internal operations to facilitate consolidation and productivity of field structure, including:*

- organization of forecasting personnel on shift into an integrated team responsible for all forecasting and warning products emphasizing the next 36 hour period

- coupling of meteorological and hydrological forecast operations, including collocation of River Forecast Centers with weather forecast offices.

*Increase automation of centrally prepared products and services from the National Meteorological Center for routine forecasts for the period of 1 to 1 1/2 days to a week.*

*Maintain a continuing program of weather and flash flood research, closely coupled with operations, to facilitate further advances in capabilities using the new weather monitoring technology at the storm scale.*

*Manage the transition to the new technology and restructured operations on a carefully planned basis to avoid interrution of services, including:*

- step-by step implementation plans that explicitly involve each NWS field office and all personnel actions

- adequate risk-reduction activities to try out and evaluate key steps in the transition to minimize unforseen problems before full-scale transition occurs

- field demonstration involving a network of nine

new weather forecast offices for at least 1 year to verify the overall approach and identify opportunities for fine tuning during full national conversion

*Adopt a conservative approach to transition implementation based upon policy established by Public Law 100-685 specifically including:*

- intensive communication with affected user groups at the local area covered by each new weather forecast office prior to and throughout the transition process.

- thorough verification of service adequacy prior to certification by the Secretary of Commerce that the commissioning of a new weather forecast office will not lead to any degradation of service to every community served by that office.

## *Significant Actions*

The complex transition to modernize NOAA's weather programs by the end of FY 1997 will involve seven action areas: procurement of major systems, construction or modification of facilities, risk reduction, training, operational demonstration, national conversion and supporting weather and flash flood prediction research.

*Procurement of major systems*

- NEXRAD procurement will be completed by FY 1996

- GOES NEXT procurement will be completed in FY 1992 for I spacecraft and FY 1993 for J spacecraft

- AWIPS production phase procurement will begin in FY 1991

- ASOS procurement will be completed by FY 1994

- Second Class VII computer will be required in FY 1992

*Construction or modification of facilities*

- new facilities have been constructed in Sterling(VA), Melbourne (FL), and Amarillo (TX)

- facilities in the demonstration program will be constructed by FY 1992

- all 115 Weather Forecast Office facilities will be constructed or modified by FY 1996

*Risk Reduction*

To ensure that changes to NOAA's weather and hydrologic programs are successful, a number of risk reduction exercises are being conducted across the country. Some representative examples are:

- Simulation of a future Weather Forecast Office (WFO) operation at WSFO Norman, Oklahoma in FY 91 to assess the staffing patterns, workload constraints, and the ability to produce more timely and specific warnings and forecasts.

- Evaluation of new aviation forecast products at the forecast office in Denver, CO.

- Evaluation, in Denver, of the Government-Helping-Government concept of a two-way sharing of critical weather information between the forecast office, the emergency management community in a six county area, and the private sector.

- Evaluation, at the forecast office in Sterling, Virginia., of the feasibility of combining data from sattelites, radar, lightning detection systems, and automated surface observing systems to provide timely information on convective storms to the aviation community.

- Evaluation of the prototype River Forecast Center (RFC) operations at selected RFC's to demonstrate the effective use of the next generation of river forecast models, the exchange and use of hydrometeorological support services, and the application of NEXRAD-based basin-wide quantitative precipitation estimates and enhanced hydrologic guidance.

*Training*

Every NWS employee in the field will have to undertake significant training to prepare for the modernization. Extensive training and education programs for NWS employees will be necessary to ensure they will gain maximum benefit from the new technology. In addition to training in the new technology, NWS meteorologists,

hydrologists, and hydrometeorologists will be provided enhanced educatin in atmospheric and hydrologic processes, as well as application of new analysis techniques and scientific advancements to daily operations.

*Operational Demonstration*

The Modernization and Associated Restructuring Demonstration (MARD) will be undertaken in FY 1995 over a large area that includes most of the states of Kansas and Oklahoma and portions of Texas, Colorado, and Nebraska. This will be a full operational demonstration to illustrate that the present services can be provided in a more cost-efficient manner and that there will be no degradation of the warnings and forecasts of the modernized NWS. As a result of the MARD, the NWS will evaluate the service performance and user reaction as well as the possible added efficiencies that have been derived. Furthermore, the NWS will refine new operational services and will resolve implementation issues that have arisen during the MARD. The National Academy of Sciences will evaluate the service performance of the NWS and user reactions

*National conversion*

Conversion to the modernized operations will be placed in a tiered structure, with the NWS Strategic Plan as the top-level plan.

- The second tier, the National Implementation Plan, will provide a planning framework and general strategies for accomplishing the transition, and establish basic transition management principles that will be used throughout the entire transition period in fulfilling the fundamental goals and objectives in the Strategic Plan.
- The third planning tier, the Regional Transition Plans, will provide management flexibility and recognize both the decentralized nature of the agency's and the NWS Regions' responsibility to maintain ongoing operations throughout the transition period. These plans, intended for internal use, will set a course that will ultimately achieve the modernization and associated restructuring goals and objectives within each Region, while taking into account unique conditions at each site, such as weather variations and user needs.
- The final planning tier, Site Implementation Plans, will contain specific, detailed schedules for accomplishment. A separate Site Implementation Plan will be prepared for each WFO or WFO/RFC, and will address transition of all sites in its area of responsibility. Each Regional office will be responsible for the deveilpment and integration of Site Implementation Plans, with the support of the area managers.

*Supporting weather prediction research*

NOAA has developed a coordinated national scientific research effort to advance weather and flash flood forecasting techniques and to improve the basic understanding of severe weather events. NOAA will support this weather research with:

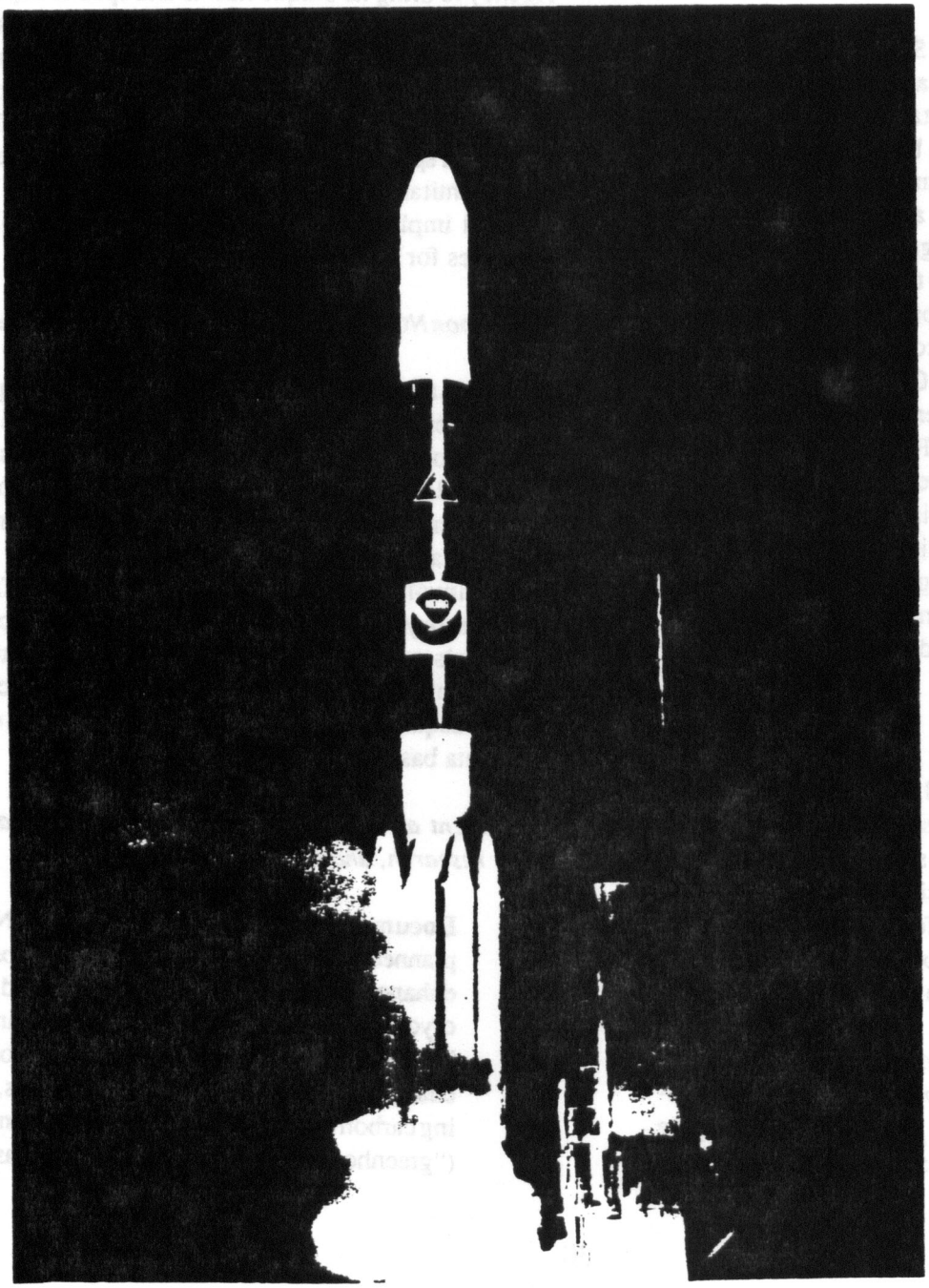
- intensive multi-scale geographical scale field experiments in conjunction with new observation data access to the scientific community through data archive centers such as NESDIS's National Climate Data Center, the NWS's National Meteorological Center (NMC), and OAR's Forecast Systems Lab (FSL).
- higher resolution models intended to improve operational forecasts at the local and regional scale.
- Analysis of wind patterns from the new suite of remote sensors which can form the basis for short-term forecast techniques of precipitation occurrence combined with observed and projected rainfall amounts from NEXRAD.
- Experimental Forecast Centers physically located in space adjoining NWS forecast office workspace to develop and test new approaches for improving warnings and forecasts.

NOAA weather studies must also rely on the use of sophisticated atmospheric research aircraft. In the case of aging airframes, eventual replacement must be contemplated. New research approaches, coupled with advances in instrumentation, may also require the acquisition of new kinds of aircraft.

## *Expected Benefits*

The future value of these NOAA investments will be extensive. The result will be reduced operating costs as the organization operates more efficiently and becomes more productive with a smaller overall staff. NOAA will deliver

organization operates more efficiently and becomes more productive with a smaller overall staff. NOAA will deliver to the public a more accurate forecast and warning system with greater lead time and more specificity in the warnings— both large-scale warnings and the smaller-scale destructive meteorological phenomena. The sciences of meteorology and hydrology will benefit from the closer working relationship between the operational and research communities as new operational technology and the enhanced observational network will spur new research methods nnd techniques. A faster communications system will give local and state Emergency Managers and other decisionmakers more time to implement life-saving hazard evasion and disaster mitigation programs prior to the occurrence of these storms, saving lives and property across the nation. The private sector will benefit from the increased amount of high quality hydrometeorological data that will be available for the incorporation into their value-added services for specialized users. Weather and river forecasts in general will become more reliable and for longer periods of time, thus providing economic benefits for those parts of the economy that have weather and water resources as critical elements.



# Climate and Global Change Program

## The Problem

The geologic record and evidence from historic times demonstrate that global conditions on the Earth have changed markedly because of natural processes. In recent years, scientific evidence suggests that human activities have begun to rival the magnitude of natural forces in reshaping the prevailing environmental conditions upon which modern economies and social infrastructures have been built during the last century.

World leaders are focusing Summit discussions on the significant economic, social, and national security ramifications of global environmental issues. Rational response and sound policy can only be built upon reliable information. Predictions and assessments of the variety of complex phenomenon involved are the highest priority requirements for a national program in "global change."The United States has recognized that an effective response to the impacts of global environmental change required a focused, well-coordinated commitment by responsible Federal agencies. NOAA's Climate and Global Change Program is a critical component of the U.S. Global Change Research Program (USGCRP), a high-priority Presidential initiative in FY 1990. The Program is overseen by the Committee on Earth and Environmental Sciences (CEES) under the auspices of the President's Office of Science and Technology Policy. The program is designed to establish the scientific basis for national and international policy-making related to natural and human-induced changes in the global Earth system.

## Objectives

NOAA's Climate and Global Change Program focuses on the most societally relevant aspect of global environmental change—the global climate system. The CEES looks to NOAA to provide the principal operational monitoring, research, prediction, and information services in the national effort. The long-term objective of NOAA's Climate and Global Change Program is:

> *To establish a new national information service based on the achievement of reliable assessments and quantitative predictions of changing global climate by providing reliable predictions of global climate change and associated regional implications on timescales ranging from a season to a century or more.*

By establishing this "service," NOAA will be able to fulfill its responsibilities as a primary source of global environmental information—providing high-quality predictions and assessments of changing environmental conditions to other Federal agencies, the Executive Office of the President, Congress, the public and private sectors, and the national and international scientific communities.

## Strategies

NOAA's Climate and Global Change Program enables the Agency to bring its unique talents and special capabilities to bear on some of the highest scientific priorities identified by the Committee on Earth and Environmental Sciences and will complement those of other participating agencies. In support of the stated objectives of the USGCRP, and with a special focus on providing reliable assessments and quantitative predictions of climate change and its regional implications, NOAA will pursue the following strategies for the 1990s.

*Build upon NOAA's strong track record in the climate area*

NOAA maintains a long-standing balanced program of observations, analytical studies, climate prediction, and information management. NOAA will continue to be responsible for operational in situ and satellite observations and monitoring programs; mission-directed research on physical and biogeochemical processes in the climate system involving greenhouse gases, including effects on marine ecosystems; development, testing, and application of models and diagnostic techniques for detection and prediction of natural and human-induced climatic changes; and the acquisition, maintenance and distribution of long-term data bases and related climate information.

*Implement an expanded program focusing on analysis, field research, and modelling, including:*

- **Documenting Earth System Change** - NOAA's planned activities will fill significant gaps in: (1) enhancing operational upper ocean and marine cryosphere observations; (2) implementing a global sea level monitoring network; (3) monitoring changes in key atmospheric constituents, including carbon dioxide and other radiatively important ("greenhouse") gases such as methane, as well as

stratospheric components like ozone (jointly with NASA); (4) developing and testing of new and improved measurement techniques/technologies; (5) documenting changes in solar variability; (6) developing and providing of important climate and global change measurement products derived from operational satellites and in situ observations; and (7) establishing an effective NOAA and national data and information management system in support of the USGCRP.

- **Focused Process Studies** - NOAA's Climate and Global Change research projects will provide significantly improved understanding of: (1) clouds, water vapor, and the global hydrological cycle, including NOAA contributions to the evolving international Global Energy and Water Cycle Experiment (GEWEX); (2) the role of tropical ocean-atmosphere interactions in determining inter-annual climate variability, primarily through support of planned enhancements to the international Tropical Oceans-Global Atmosphere (TOGA) Program which NOAA leads on behalf of the U.S.; (3) the role of ocean circulation and dynamics in climate change, with a particular emphasis on the importance of Atlantic Ocean circulation patterns on decadal climate change and the role of the ocean in the global carbon cycle; (4) the sources, sinks, and behavior of greenhouse gases in the atmosphere; (5) the importance of sulfur compounds produced by marine organisms as cloud condensation nuclei; (6) the effect of climate and related stresses on marine ecosystems and resources (including the Great Lakes); and (7) the influence and response of human beings and their social and economic institutions to changes in the global environment, particularly climate change.

- Climate Modelling and Prediction - NOAA will pursue: (1) development and application of operational ocean models; (2) near-term forecasting improvements to extend operational predictive capability on monthly and seasonal timescales; and (3) design and implementation of an effective multi-agency program to significantly advance climate modelling, prediction and analytical capabilities on inter-annual and decadal timescales.

*Emphasize synthesis as an organizing concept*

The single word that captures the unique nature of NOAA's strategy in the U.S. Global Change Research Program would be synthesis. NOAA's Climate and Global Change Program must strive to synthesize the results of individual monitoring, research, modelling and data management projects into higher-order information products and predictive services that provide an integrated view of how the Earth's climate system currently behaves and is likely to change in the future. This ultimate goal of producing quantitative predictions and reliable assessments of climate change provides the focus and establishes the priorities for NOAA's Climate and Global Change Program.

*Innovative scientific program planning and management*

NOAA's program management strategy for Climate and Global Change is designed to integrate the Agency's unique scientific and operational assets and join them with those of the university community and other Federal agencies to provide a sustained long-term contribution to the U.S. Global Change Research Program. New resources acquired through the CEES process build on a strong foundation of environmental monitoring, research, prediction, and information management. By leveraging these established capabilities, NOAA brings far more to the USGCRP. Similarly, these new resources enable the Agency's line organizations to acquire new scientific talent, upgrade technical capabilities, and establish new collaborations with other Federal agencies and the academic research community. The management structure adopted for the Climate and Global Change Program consists of three complementary elements:

- a central Program Office to carry out the day-to-day management of the Program and serve as the focal point for overall program/agency integration and interagency coordination; and

- a Program Review Board representing NOAA top management responsible for Program integration, resource allocation, and technical problem-solving;

- an external scientific review body (the NOAA Panel on Climate and Global Change) to advise on planning, development, testing, and application of new Earth system measurement techniques/technology.

*Sustained extramural scientific interactions*

NOAA's Climate and Global Change Program, like the national Program it supports, recognizes that an effective research program must involve the broadest possible mix of investigators—inside and outside of Government. To achieve the maximum benefit from a partnership with the broad scientific community, the Climate and Global Change Program assumes that approximately 30-40% of the new resources will support work at academic institutions. An annual grants program, with funding to support extramural proposals which contribute explicitly to the objectives of the Climate and Global Change Program, is a critical element of the Program.

## *Significant Actions*

During the next decade, NOAA's Climate and Global Change efforts will focus on the following programmatic opportunities for near-term contributions to the U.S. Global Change Research Program:

*Oceanic and atmospheric monitoring*

- establishment and operation of the joint NOAA/NASA Network for the Detection of Stratospheric Change;
- implementation of critical monitoring and research responsibilities in support of the International Global Atmospheric Chemistry Program and related international efforts to improve our understanding of the sources, sinks, and behavior of atmospheric greenhouse gases;
- development and routine provision of a series of high-priority climate and global change measurement products, such as global precipitation, global sea level, sea surface temperature, ozone, vegetation, snow and ice cover and extent;
- design and implementation of new CEES initiatives in the areas of: long-term observing system planning and the development, testing, and application of new Earth system measurement techniques/technology; and

*Field experiments*

- completion of the TOGA Coupled Ocean-Atmosphere Response Experiment (COARE) in the western Pacific and Indian Oceans and the transition of TOGA from a field monitoring/research program to a program modelling and analytical studies;
- development and implementation of an effective NOAA and U.S. contribution to the evolving Global Energy and Water Cycle Experiment proposed by the World Meteorological Organization and its IGBP counterpart program on the role of vegetation in the global hydrological cycle; and
- improvements in understanding of the role of the ocean in affecting climate change on interdecadal and longer timescales including initiation of the Atlantic Climate Change Program and support for related efforts of the World Ocean Circulation Experiment (WOCE), implementation of required enhancements to the global ocean observing system, and contributions to national and international programs to characterize and quantify the role of the ocean in the global carbon cycle (e.g., the Joint Global Ocean Flux Experiment-JGOFS).

*Improved predictions*

- successful implementation and leadership of a multi-agency program of Earth system modelling and prediction with an early emphasis on significantly improving climate predictions on interannual and interdecadal timescales;
- initiation and routine provision of a new line of regular prediction products including seasonal climate forecasts (30- to 90-day average atmospheric conditions) for selected regions, including North America; and initial attempts at projections of year-to-year climate variability based on a greatly improved understanding of how the tropical (Pacific) ocean affects global climate patterns;
- development and implementation of a program to understand and predict the response of critical marine ecosystems and resources to climate change and related global environmental stress.

*Climate data*

- design and implementation of high-priority data and information management activities involving archived as well as new data streams in support of the USGCRP.

## *Expected Benefits*

The U.S. Global Change Research Program, and agency contributions like NOAA's Climate and Global Change Program, represent a significant policy commitment by the U.S. Government. Specifically, the NOAA and national global change research programs will:

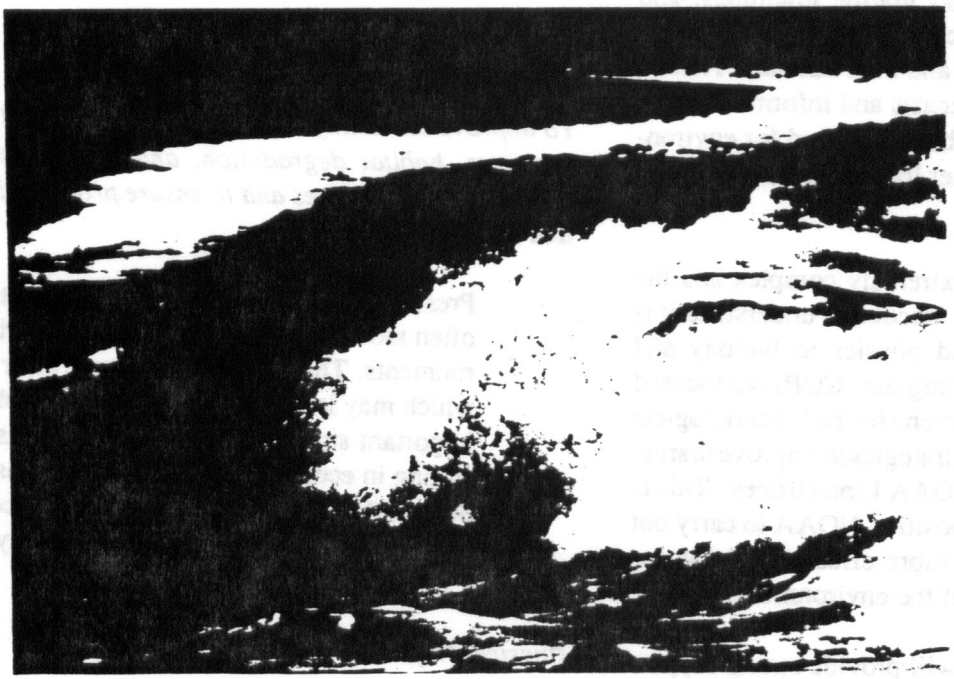
- provide the information base to support evolving policy decisions associated with changes in the global environment;

- demonstrate a Federal commitment to address the scientific, technological, and public policy issues associated with global environmental change to provide a strong scientific foundation for future legislative, administrative, and business decisions and forestall potentially very costly or unnecessary actions;

- enhance the domestic economy and strengthen the competitive position of the U.S. in world markets by improving the effectiveness of economic decisions in areas such as agriculture and energy; and

- contribute to efforts to regain the competitive edge in science and technology by providing a focus for investments; provide an incentive for U.S. industry to invest in the development and application of state-of-the-art technologies and strengthen the U.S. scientific and technological infrastructure.

Changes in the global environment, particularly climate change, pose significant social, economic, public safety, and national security issues which national leaders have begun to address. Effectively anticipating the timing and nature of such changes, and the influence of human activity, can offer major opportunities to develop and maintain a new partnership with nature based on such knowledge



# Coastal Ocean Program

## The Problem

Complex, ever-increasing problems face the nation's coastal waters — from decreased fisheries productivity and coastal pollution to habitat loss, coastal flooding, and erosion. These impacts not only endanger living marine resources and human life, they also have significant impacts on the U.S. economy.

Although the nation has addressed many environmental issues, its ability to respond to the many urgent problems of the coastal ocean has often been hampered by limitations of scientific understanding; insufficient financial resources; inadequate technology for observing, describing, and predicting the changes in the coastal environment; and by an outmoded data and information exchange system to get findings to decision makers.

## Objectives

Every NOAA Line Office has a vital role in developing and implementing solutions to many of the problems confronting our responsibilities as the Nation's steward for living marine resources such as conserving marine fisheries, responding to oil and hazardous chemical spills, protecting coastal habitats and marine mammals, and regulatory permit review and comment on actions which affect living marine resources and their habitats. NOAA Line Offices also provide forecasts and information, advice, and the sound scientific basis required for environmental decisions made by other local, state, and Federal agencies.

The marine environment is extremely complex and the range of scientific knowledge needed to understand it is broad — from chemistry and physics to biology and ecology. The Coastal Ocean Program (COP) is a focused effort to integrate NOAA's scientific and technological capabilities into well-framed strategies to improve marine products and services of all NOAA Line Offices. This is a continual process that will position NOAA to carry out its mandated responsibilities more effectively in an increasingly problematic area of the environment.

The Coastal Ocean Program will provide strong support for NOAA's Marine Resources and Oceanic Services 2000 Program which seeks to modernize NOAA's marine operational infrastructure in each Line Office. The Coastal Ocean Program will seek to improve the science — research, modeling and prediction capabilities, applications, and information synthesis — that feeds into and supports NOAA's operational marine programs.

Coastal Ocean Program objectives will address three principal problems that pose economic and environmental concerns for the Nation:

### *Environmental Quality*

*To develop better strategies through more effective planning, data analysis, and interactions with other Federal, state and local decision makers.*

*To increase the ability to predict changes in the quality of the coastal environment and its living marine resources to help prevent further habitat degradation and to recommend mitigative measures.*

- Over 70% of the Nation's economically important fisheries species depend on estuarine habitats during some phase of their life, yet these habitats are under increasing pressure from society. Coastal development, excessive nutrients from agricultural runoff, effluent from sewage treatment plans, and freshwater diversion have lasting impacts on the coastal environment and the fisheries they support.

### *Fishery Productivity*

*To improve the ability to predict the influence of fishing activities, habitat degradation, and natural forces on living marine resources and to ensure productivity today and in the future.*

- Present models used to predict fishery stocks are often too simple to reflect complex marine environments. This results in very large error margins which may lead to over-harvesting, depleting an important stock of fish, or under-harvesting, resulting in economic hardships for the fishing industry. A balance between responsible conservation and reasonable harvesting is urgently needed.

### *Physical Impacts*

*To increase the ability to predict the occurrence of natural physical hazards, for both short-term warnings and long-*

*term planning, and to prevent or minimize adverse effects of storms, flooding, and erosion on coastal communities.*

- Unprecedented urbanization and industrial development of coastal areas, continued expansion of fisheries, and growth in offshore mineral and oil exploration expose ever-increasing numbers of people and property to the dangers of natural physical impacts.

Critical decisions regarding these coastal issues are made each day throughout the U.S. Who are the people making the decisions that impact coastal resources? They are thousands of policy makers in Federal and state agencies; resource managers, municipalities, and planners in 600 coastal counties; reviewers of the over 15,000 permit applications processed by the Corps of Engineers each year; weather forecasters; fishery forecasters; sanctuary and reserve managers; Sea Grant Marine Advisory offices; Fishery Management Councils; commercial and recreational fishermen; scientists in the academic community; and developers and planners.

These decision makers need environmental information based on a sound scientific foundation. Activities in the COP will focus on improving science and developing routine operational capabilities to convert data and predictions into useful information for distribution to users in flexible, problem-targeted, and timely ways by NOAA Line Offices.

## Strategies

The overall strategy of the NOAA Coastal Ocean Program is to mobilize NOAA's capabilities to strengthen the scientific underpinnings of all Line Office programs related to the coastal environment, especially in prediction. Specific strategies include:

*Innovative program planning and implementation*

- The Coastal Ocean Program is a NOAA-wide effort in which each Line Office plays a direct role in determining and initiating program direction and strategy.

- The Coastal Ocean Program Office coordinates and manages the overall program; however, in most cases, specific implementation activities are managed and carried out under the direction of a lead Line Office.

- Program direction and activities are influenced by day-to-day involvement by the Coastal Ocean Council (one representative from each Line Office) and substantial input from the Program Review Board (Assistant Administrators and the Chief Scientist).

*Responsiveness to information users*

- To ensure COP continues to meet user needs, NOAA will actively solicit user requirements through processes overseen by User Advisory Panels, composed of NOAA and other state, federal, and private users of information generated by and incorporated into the COP. They will help ensure that both short-term and long-term program activities lead to useful and accessible data and information.

*Peer review*

- The COP will maintain the highest scientific standards through active participation of academic scientists and the oversight of an external science advisory panel created by the National Academy of Sciences (NOAA Panel on the Coastal Ocean). This panel will analyze and review all scientific aspects of existing and planned COP activities to ensure consistency with national and international goals for scientific advancement.

*Strategic approach to program design*

- The Coastal Ocean Program responds to today's issues, seeking flexibility in dealing with an ever-changing suite of problems, yet stable enough to establish long-range programs for innovative solutions to the complex issues of the next decade. The COP strategy superimposes environmental impact-driven research over natural-variability research and uses prediction as the centerpiece for

information generation and delivery in the following ways:

***Information Delivery***. *This is the pinnacle of the Program. Delivery mechanisms (e.g. communication systems, computer information systems and human resources) must be in place to provide decision makers with timely, accurate information. Effective management of data and information is especially critical in a world where satellites and computers generate massive streams of data about selected coastal conditions each day, yet decision makers lack some of the most basic information and knowledge needed to solve serious coastal problems.*

*COP will focus on converting existing and new coastal ocean data into useful information for distribution to decision makers in a flexible, program-targeted, and timely way. NOAA will also develop socio-economic information for lawmakers, decision makers, and regulators for improved coastal resource management. This will become increasingly important as demands on coastal resources escalate.*

***Product Development***. *This includes data, predictions, warnings, and advice. Products are generally developed to address site-specific problems and may take many years to develop. However, some products can be available on more immediate time scales (6 months to 2 years) because similar longer-term, impact-driven research and development efforts are already underway.*

***Observations & Monitoring***. *This is the scientific foundation of COP's effort. Many activities planned for improving the nation's research and decision-making capabilities rely on similar sets of basic observations such as traditional surface and subsurface data gathered from buoys, ships, and other platforms, as well as from aircraft and satellites. NOAA already conducts a wide range of data collection, storage, and delivery operations, but the COP will support some enhancements necessary to press forward NOAA's coastal ocean observational activities into the next decade.*

***Impact-Focused Research***. *This integrates multidisciplinary programs to increase understanding and predictability of the impacts that human activities (e.g., coastal development, freshwater diversion, agricultural/industrial runoff) have in coastal waters.*

***Natural Variability Research*** *Assessing human impacts on coastal systems cannot be done without basic understanding of natural variability. Understanding and predicting natural variability helps establish the context and the parameters within which meaningful conclusions can be drawn about the health, productivity and changing physical conditions of coastal environments.*

***Data Management*** *To ensure that information and data generated by the Program are useful and accessible, the COP is creating a data management protocol. All activities in COP must comply with specific data management guidelines to ensure data are transferrable, meet user requirements, and support NOAA-level wide data management procedures.*

***Interagency coordination*** *To strengthen NOAA's leadership in coastal ocean science, the COP leads the effort to create a U.S. Coastal Ocean Science Program (USCOSP). The goal of the USCOSP is to coordinate efforts of federal agencies to develop assessment and forecast capabilities in support of coastal ocean policy.*

***Extramural research support*** *The benefit of enlisting the talents of the academic community are especially important in advanced areas of coastal research. The COP is designed to include qualified scientists outside of NOAA. The selection of projects and principal investigators in research components of COP will be based upon peer- reviewed proposals from the academic community as well as NOAA.*

## *Significant Actions*

Over the next 10 years, COP will:

- Assess and inventory the environmental quality of coastal waters with regard to nutrient over-enrichment and improve our ability to predict the impacts such as oxygen depletion.

- Assess the levels and effects of toxic contamination in the coastal environment and develop the capability to predict their effects on marine resources.

- Develop a strategic plan for habitat conservation to monitor trends, understand variability, assess threats, and improve damage assessment and restoration techniques to help protect estuarine habitats and the living resources that depend on them.

- Develop and improve tightly coupled observation/modeling capabilities to predict physical impacts — coastal flooding, extreme winds, and hazardous ocean conditions.

- Improve current conservation and management of fisheries by identifying the processes that control recruitment and the mechanisms that lead to biological feedback.

- Develop the capability for a nationwide coastal ocean prediction system to observe, model, and predict conditions in the coastal ocean and Great Lakes by integrating satellite observations with in situ data and operational models and deliver those data and forecasts through improved NOAA communications networks.

- Develop and advance both high-tech and low-tech means of synthesizing and integrating data and information for use by coastal resource decisionmakers.

## *Expected Benefits*

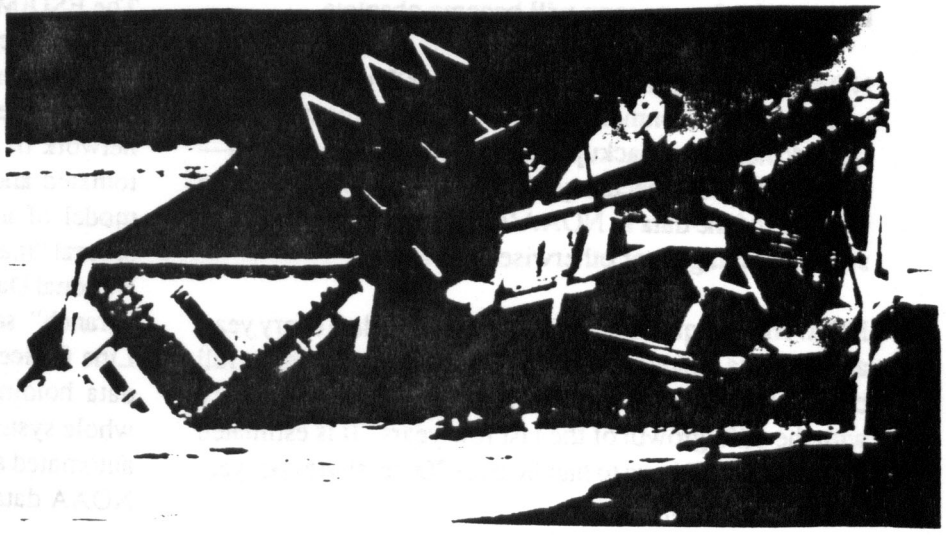
NOAA's Coastal Ocean Program will provide important benefits to NOAA and the nation by:

- Preventing loss and damage of coastal resources by providing timely assessments and forecasts of natural and human impacts. This will lead to improved fishery productivity, healthier estuarine habitats, cleaner waters, and reduced life and property damage due to coastal hazards.

- Stimulating the nation's marine science advancement from cooperative efforts with the academic community through the use of NOAA resources.

- Strengthening NOAA Line Office marine programs, including new fishery recruitment models, which will enable NMFS to make better stock assessments; expanded physical impact models; and improved observation systems, which will enable NWS and NOS to reduce damage associated with coastal hazards.

- Increasing NOAA's leadership in the U.S. Coastal Science Program through an integrated approach to improve prediction of complex coastal environmental changes.



# *Earth System Data and Information Management Program*

## *The Problem*

As an environmental science agency, NOAA cannot perform its mission without extensive measurements and observations that describe changing conditions of the ocean, the atmosphere and the solid Earth. NOAA must have an effective system for acquiring, quality controlling, storing, protecting, and providing access to all of its scientific data bases. This is both a prerequisite for NOAA to carry out its mission as well as a service for the multitude of external users that also rely on these data. NOAA routinely acquires large amounts of environmental data and information as part of its observation, monitoring, and prediction responsibilities and indirectly receives data from a very large number of outside sources. Much of this material is used on a real-time or near real-time basis and then saved for retrospective use. Over time NOAA has built up a treasury of Earth system data and information, literally the most comprehensive, long-term, and up-to-date description of the Earth that exists today.

Unfortunately the present state of management of environmental data and information in NOAA is such that large amounts are inaccessible, incompatible, or deteriorated to an unusable state. Many of the problems stem from the lack of coordinated data collection and processing procedures or from aging technological infrastructure which does not have the capacity for adequate data communication, handling and storage. There is no effective NOAA-wide data management protocol, so data and information tend to be passed hand-to-hand around the agency and saved eclectically by individuals. Even the so-called "permanent" records are kept on a variety of incompatible storage media that are obsolete or soon will become obsolete.

NOAA presently archives about 200,000 magnetic tapes containing environmental data. Eighty percent of these tapes do not have a backup, and half are over 10 years old—the typical life expectancy of these tapes. Overall, more than half of the data in NOAA's treasury are inaccessible, suspect, damaged, or otherwise at risk.

NOAA now acquires about 20 terabytes of data every year, and its data management systems are operating at full capacity. In fact, NOAA has not been able to keep pace with the 10% growth of the last few years. It is estimated that NOAA will have to handle over 200 terabytes per year by the year 2000.

## *Objectives*

NOAA has initiated the Earth System Data and Information Management (ESDIM) Program to integrate common elements of data and information management through modernization of technological infrastructure, and is keyed to the research and operational needs of all NOAA programs. The ESDIM program recognizes that a number of data centers exist throughout NOAA and will support them.

Specific objectives of the ESDIM Program are:

*To build a top-level consensus within NOAA on data and information topics and a vision of the agency's data and information management strategy for the 1990s;*

*To rescue critical NOAA data and information currently at risk of being lost;*

*To improve access to NOAA data and information for research scientists and other users;*

*To modernize processing and storage facilities at NOAA data centers by taking advantage of technological advances;*

*To make preparations—in policy, procedures, and technology—for the major new influxes of environmental data and information that NOAA must handle in the 1990s, including access to data from other agencies and nations.*

## *Strategies*

The ESDIM program is a long-term effort that will affect every aspect of NOAA's activities and require the active participation of the industrial, scientific, and academic communities. The foundation of the ESDIM Program is a network of environmental data centers that are fully automated and distributed across the agency. Built on the model of a multi-campus library system, there will be several "main" data centers—developed from the existing National Data Centers—and numerous, semi-autonomous "branch" sources of data supporting NOAA's specific Line Offices and Program Offices. Personal or "office" data holdings will also be recognized. Integrating the whole system will be a top-level master directory—itself automated and distributed—identifying all holdings in the NOAA data and information network.

In general, a user will gain access to NOAA's data and information remotely, through a personal computer system attached to high-speed telecommunications networks. The user's computer will be conversant with the master directory and will assist the user in browsing the data and information interactively—an "electronic librarian".

NOAA's data centers will aggressively recruit and validate new data and information from sources inside and outside NOAA. "Curatorial" operations in the data centers will continuously review holdings for accuracy, completeness, quality, and relevance. User-generated corrections and comments will also be merged back into the holdings. Actively used data and information will be automatically updated and migrated forward onto new, higher-performance storage media.

### *Specific Strategies include:*

*Establishing a formal project management system to coordinate and monitor the extensive anticipated activities of the ESDIM Program;*

*Developing the NOAA master directory. A pilot NOAA Earth System Data Directory was started in FY 1989 and is now well into the development stage;*

*Setting up a data tracking system that will provide information on data acquisition, storage, and usage;*

*Documenting and publishing NOAA's data management plans via in-house publications, journal articles, seminars, and workshops;*

*Inaugurating an external R&D program with universities; inviting participation from industry on a cooperative R&D basis;*

*Establishing Scientific Advisory Boards in various disciplines to review and certify data and information holdings and advise on priorities;*

*Participating in national and international standards bodies on data base, data communications, and data management issues; and*

*Developing an educational program in NOAA on data management issues.*

## *Significant Actions*

The Environmental Data and Information Management Program is overseen by the Earth System Data and Information Management (ESDIM) Program Office which is advised by, and coordinates with, NOAA's Line Offices and NOAA-wide Program Offices through a NOAA-wide Data Management Council (DMAC). The Director of the ESDIM Program Office serves as Chair of DMAC. Other members of DMAC are the Assistant Administrators of the various NOAA Line Offices and the Directors of the NOAA-wide Program Offices (or their representatives).

Through this organizational framework, the following significant actions will occur:

### *Distributed Data Access*

- Access to Centers of Data—Providing more powerful and robust facilities for the handling of data and information at the National Data Centers and other sources of NOAA data, and for browsing and delivery of data and information from data centers to users.

- Rescue of Data and Information at Risk—Immediately migrate high demand NOAA satellite data from deteriorating tapes to more stable media, and commence digitization of endangered analog and tabular data presently on deteriorating media.

- Data Exchange and Networking—Installing and operating a wide-area electronic network for handling high-volume environmental data and information; coordinating across the scientific community to ensure efficient and timely flows of data and information from points of observation to points of use.

- Information Systems—Developing and maintaining a comprehensive master directory of environmental data and information holdings, technical publications, and "grey literature" across NOAA and other organizations; and tracking requests for, and utilization of NOAA-provided data and information.

### *Basic Data Preparation*

- New Data Acquisition—Developing policies and procedures for assimilation and processing of new

environmental data and information emerging from major national and international programs.

- Data Assembly and Quality Assurance—Assembling, validating, and documenting reference-quality data and information products describing Earth system behavior over significant spatial and temporal extents.

- Continuity of Data—Assuring stability and intercomparability of data and information products over time; developing diagnostic and corrective techniques, as necessary.

*Standards and Technology*

- Standards Specification—Fostering development and adoption of a standard nomenclature for environmental data and information (particularly metadata); promoting compatibility of NOAA computer hardware, software, and networks, internally and with outside organizations.

- Advanced Technology—Experimenting with advanced mass storage/retrieval and graphics display systems for environmental data and information products; adapting artificial intelligence technologies to assist with data and information management chores.

## *Expected Benefits*

Earth system science and various user communities will benefit greatly from improved access to NOAA's data and information. Responding to such challenges as global change, coastal ocean prediction, and improved weather and water resources forecasting will require new levels of effort in measuring, understanding, and predicting Earth system processes. In addition, national and international priorities are increasingly entwined with environmental matters. The information available to policy makers must rest on a secure basis of quality data. The ESDIM Program has been designed to address these imperatives.

*Deliverables and benefits of the ESDIM Program will be:*

- NOAA environmental data currently at risk will be rescued and made readily accessible;

- Upgraded technology infrastructure across NOAA sufficient to handle the increase in Earth system data and information volume expected to occur in the 1990s;

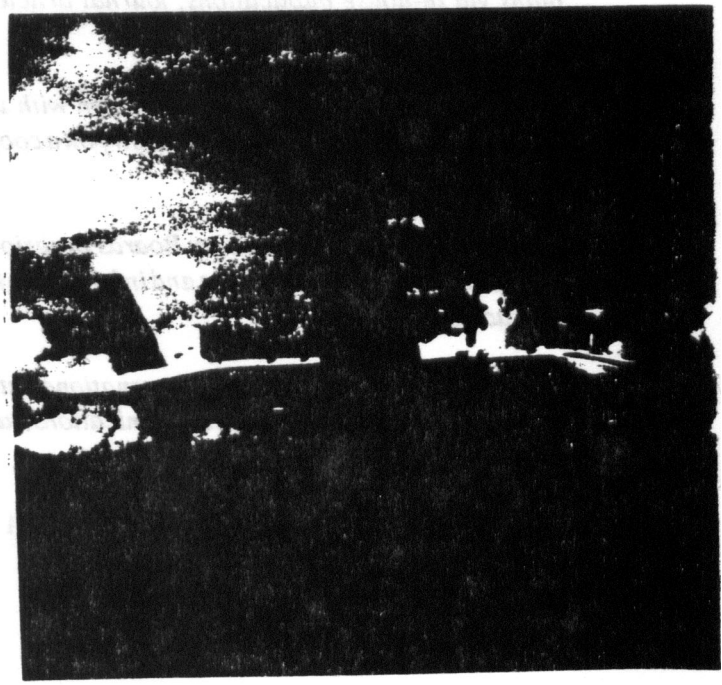
- Increased operating efficiencies in all agency units involved with data and information, utilizing standardized technologies and a compatible system of policies and procedures;

- Increased scientific productivity and improved scientific judgment, based on more accessible and reliable data and information;

- Environmental data and information management efforts in NOAA and other agencies will be identified and encouraged to become compatible;

- All NOAA's treasury of environmental data and information that is now being generated piecemeal and recorded eclectically (if at all) will be brought under a compatible system of management and distribution; and

- Advanced technology transfer programs, developed cooperatively with industry and universities; possibly leading to development of major new private sector enterprises involved with environmental data and information.



# *Marine Resources and Oceanic Services 2000 Program*

## *The Problem*

NOAA's marine programs now provide a spectrum of products and services to respond to national needs in connection with safety of life and property, economic development, conservation of marine resources, protection of the marine environment, and advancement of oceanic research. In the decade of the 1990's, NOAA's marine operational programs will focus on two distinct but inter-related aspects of the marine environment: the oceanic border and the global ocean system. From the perspective of the oceanic border, public needs will intensify in such cases as:

- more accurate hurricane surge predictions to warn coastal populations;
- more efficient navigation in congested harbor entrance areas;
- restoration of depleted commercial and recreational fisheries;
- protection of endangered species, marine mammals and damaged habitats;
- better identification of coastal waters suffering rapid declines in environmental quality; and
- innovative new approaches to coastal zone management to solve such problems as non-point sources of pollution, destruction of wetlands, and protection of special areas.

From the perspective of global ocean dynamics, national needs will center on:

- more complete fundamental understanding of the natural variabilities and resilience of the ocean as a major element of the Earth system, from estuaries to the size of the global ocean.
- increased confidence in predictions of the future state of the global ocean system through improved observations, more realistic computer models, and synthesis of results into information useful to decision makers.

To carry out these operational marine programs, NOAA employs approximately 4,000 employees at 30 laboratories or field facilities. NOAA also has the largest dedicated oceanographic fleet in the world with an inventory of 23 vessels, and a data buoy network of approximately 25 large moored units. NOAA manages eight marine sanctuaries and maintains coastal zone management partnerships with 29 states and territories.

NOAA's ability to respond to the opportunities of the 1990's and beyond will depend upon the translation of important marine scientific and technological developments into NOAA's operational infrastructure.

In most cases, NOAA's operational infrastructure suffers from significant deficiencies which inhibit the successful performance of NOAA's mission involving the marine environment. In general these deficiencies include:

- obsolescent or labor intensive technology for observation, sampling, and analysis, dating in some cases to 1960's state-of-the-art;
- outdated operational techniques for assessment and prediction that do not incorporate scientific advances from the 1980's;
- an aging scientific personnel pool;
- an absence of a capital investment strategy and program for marine operations, including the fleet; and
- ad hoc approaches to the synthesis and dissemination of marine resource and environmental information to decision makers in fisheries and coastal zone management.

As a result of these deficiencies in the past, NOAA has forfeited opportunities to increase productivity through automation and to improve the precision and quality of NOAA products and services to meet highest priority public needs. Research and development advances, especially those from the NOAA Coastal Ocean Program, can be successfully translated into NOAA's operational infrastructure with tremendous benefits through improved products and services.

## *Objectives*

NOAA's objective is to develop and implement a comprehensive approach to modernization of operational marine programs to improve marine information products and services in those cases where improvements are necessary to respond to urgent national needs, and to seek maximum productivity through automation and streamlining of operations.

This objective has six major components that cut across NOAA's organizational structure:

*Develop and maintain coordinated ocean-observing systems in concert with other nations that can monitor marine processes from the most local coastal scale to global ocean circulation dimensions;*

*Provide comprehensive descriptions of the physical, chemical, and biological features of the Exclusive Economic Zone of the United States to facilitate navigation and orderly development of marine resources;*

*Implement new marine prediction services to forecast hazardous conditions at sea or near shore, including those hazards caused by human actions (e.g. chemical discharges in the marine environment);*

*Create a more advanced scientific basis for observation, description and prediction of the status of economically important marine fish stocks to facilitate greater fulfillment of the national policy objectives af the Magnuson Act;*

*Expanded scientific understanding of the population dynamics of endangered marine species and marine mammals as a step toward more effective protection strategies; and*

*Application of NOAA's scientific and technological expertise in a more focused manner to achieve objectives of the Coastal Zone Management Program, the Marine Sanctuaries Program, the National Estuarine Reserve Research System and NOAA's trusteeship responsibilities under the Superfund Act and Oil Spill Act.*

## *Strategies*

NOAA will employ a multifaceted strategy to achieve this objective.

- First, NOAA will focus all of its marine program talent on this effort to obtain maximum leverage of all of NOAA's capabilities. Because the modernization of marine operational infrastructures involves investments in technologies and changes in operations, the NOAA Coastal Ocean Program and the NOAA Climate and Global Change Program can provide considerable assistance in identifying marine research and development advances that can be converted into operational marine programs. These two NOAA-wide R&D programs also provide useful mechanisms to involve the entire oceanographic community in the effort.

- Second, NOAA will seek a coordinated operational approach across marine programs for such common activities as:

  *field sampling and observation efforts;*

  *data assimilation and compilation;*

  *model development and application;*

  *preparation of forecasts, products and services; and*

  *advanced information dissemination techniques.*

  Coordination in this sense does not mean that the distinct operational protocols and techniques of specific operational marine programs have to be identical or shared in every case.

- Third, NOAA will seek a greater degree of interdisciplinary integration in marine operational programs. For example, fisheries stock assessments can benefit from more physical and chemical data; similarly marine environmental assessment and prediction can benefit from greater biological understanding. Such interdisciplinary integration does not require organizational restructuring but it does imply increased attention to joint action or operations.

## *Significant Actions*

NOAA's Marine Resources and Oceanic Services 2000 Program ("Marine 2000" for short) will be designed and implemented through a strategic plan setting forth specific program objectives, analysis of alternative investment trade-offs, and priorities for action. The Strategic Plan will

be prepared during FY 1991 and implementation will span the period FY 1992-FY 2005. The Strategic Plan will address the following significant actions:

*Identification of new program objectives for marine programs, involving:*

- mapping, charting, and geodesy;
- ocean monitoring;
- fishery stock assessment;
- marine protected areas;
- marine environmental assessment;
- marine hazardous material response;
- endangered species and habitat protection;
- marine forecasting; and
- oceanographic research.

*Exploration of technologies for marine observation, including:*

- satellite sensors to observe chemical, biological, and physical parameters;
- photogrammetric instruments and laser technology aboard aircraft;
- acoustic sensing technologies, including hydroacoustic biological sensors, side scan sonar, and multibeam hydrographic surveying equipment;
- low cost, expendable sensors for real-time, in-situ measurements of chemical parameters in sea water;
- biological indicators of physical and chemical parameters; and
- precise position control for observations using GPS technology.

*Implementation of an integrated observational platform strategy to seek an optimal balance between:*

- environmental remote sensing satellites;
- submersibles;
- research and survey vessels;
- remotely operative robotics technology;
- buoys and unmanned instruments;
- aircraft, shore-based remote sensing (e.g. radar, lidar); and
- voluntary platforms of opportunity.

*Establishment of marine data processing and communications networks, involving:*

- real-time data acquisition systems;
- artificial intelligence capabilities;
- data assimilation, quality control, and data base management systems; and
- advanced computer networking technology.

*Development of operational models for routine assessment and prediction, employing:*

- increasingly sophisticated biological process simulations using multi-species ecosystem models incorporating physical, chemical and biological data, as well as effects of exploitation, habitat alteration, and environmental changes;
- area-specific hazard parameters to facilitate warnings for tsunamis, storm surge, and erosional changes
- more realistic physical and chemical process features that can use expanded data sets.

*Investigation of new product and service delivery systems, including:*

- digital data and information transmission to users;
- electronic charts using digital data bases; and
- interactive PC based systems.

*Implementation of a comprehensive approach to NOAA's marine program infrastructure and facilities modernization, including:*

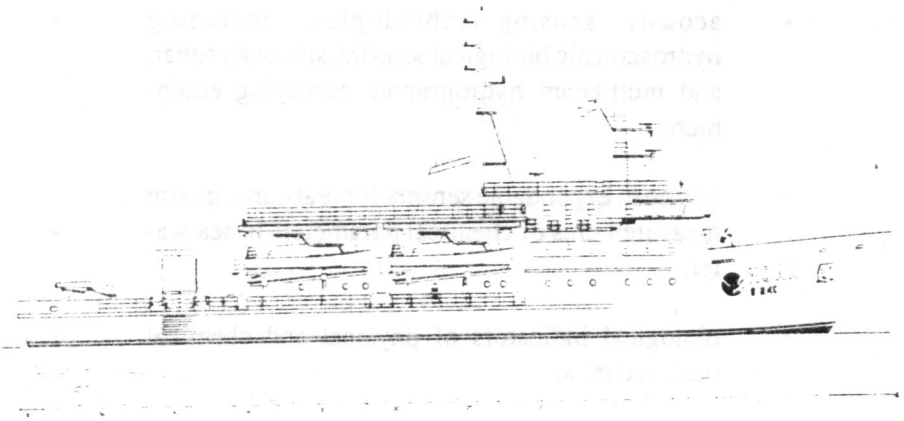
- laboratories;
- vessel staging centers;
- computers; and
- modelling and product centers.

*Creation of streamlined operational procedures for marine programs that integrate and capitalize on scientific and technological advances through:*

- automation of labor intensive activities;
- new forms of communication, cooperation and joint action between NOAA marine programs;
- comprehensive training and education; and
- new working relationships with NOAA's marine customers.

## *Expected Benefits*

By design of the modernization program for NOAA's marine operations, NOAA will improve those products and services that will yield significant payoffs to the American economy. For example, improved fishery stock assesments could produce an increase in permissible harvest levels by as much as 10 to 25 percent. Exploitation of the Nation's Exclusive Economic Zone can be facilitated by better information about its characteristics. Hazards to public safety and property can be predicted to a significantly better extent. National objectives in coastal resource management will be fulfilled to a significantly greater extent because of improved understanding of the changing status of coastal environments arising from natural and human causes. For all of NOAA's marine programs increases in productivity will produce savings or cost avoidance. Ultimately, the development of a coherent ocean observing program can produce benefits that extend beyond the oceanic sector to the unraveling of the principles of climate change within the context of Earth system science.



# V. NOAA's Agenda for the 1990's

**In view of NOAA's mission, its management philosophy and public needs of the 1990's, NOAA will literally adopt the following agenda to define the agency's aspirations for the next decade:**

- *Apply NOAA's basic management principles to every program mandated by law to achieve the goal:*

> **"NOAA will seek to be recognized as the best managed scientific agency in the nation, providing effective services to the public and responding to urgent national problems related to natural hazards, the environment and natural resources."**

- *Complete the modernization of NOAA's weather and marine operational infrastructures to increase productivity and improve services.*

- *Plan and initiate a twenty year comprehensive program to modernize all of NOAA's observational platforms -- satellites, ships, aircraft, buoys -- to enhance efficiency and improve data bases.*

- *Invest in NOAA's data management infrastructure to prepare for the data requirements of the 21st century while preserving the utility and access to data holdings from the past.*

- *Mount comprehensive, long-term research and development programs to improve NOAA's predictive capabilities in the 21st century in the following high priority areas :*

  - *Climate and Global Change*

  - *Coastal Ocean Prediction*

  - *Weather prediction*

- *Support national policy development in urgent problem areas, including:*
    - *Coastal resources management*
    - *Greenhouse gas stabilization or reduction*
    - *Clean Air Act amendments*
    - *Environment and economic competitiveness*
- *Respond to urgent needs on the national agenda that involve NOAA's mission including:*
    - *Policy initiatives to achieve more fully the conservation and economic objectives of the Magnuson Act, and to protect fisheries and wildlife on the high seas;*
    - *Programmatic initiatives such as marine hazardous material response activities, water resources forecasting and the monitoring of selected regional air chemistry processes (e.g rural ozone concentrations).*
    - *Aggressively fulfill NOAA's responsibility as a natural resources trustee to ensure the protection and restoration of the nation's coastal resources*
- *Explore new ways of doing business, including:*
    - *New career tracks for NOAA Corps officers in the management of field operations such as marine sanctuaries or restoration projects*
    - *Innovative approaches to collect and finance Earth system observations*
    - *Expanded external partnerships, especially with the Department of Defense*

- *greater use of volunteerism to supplement every field program*

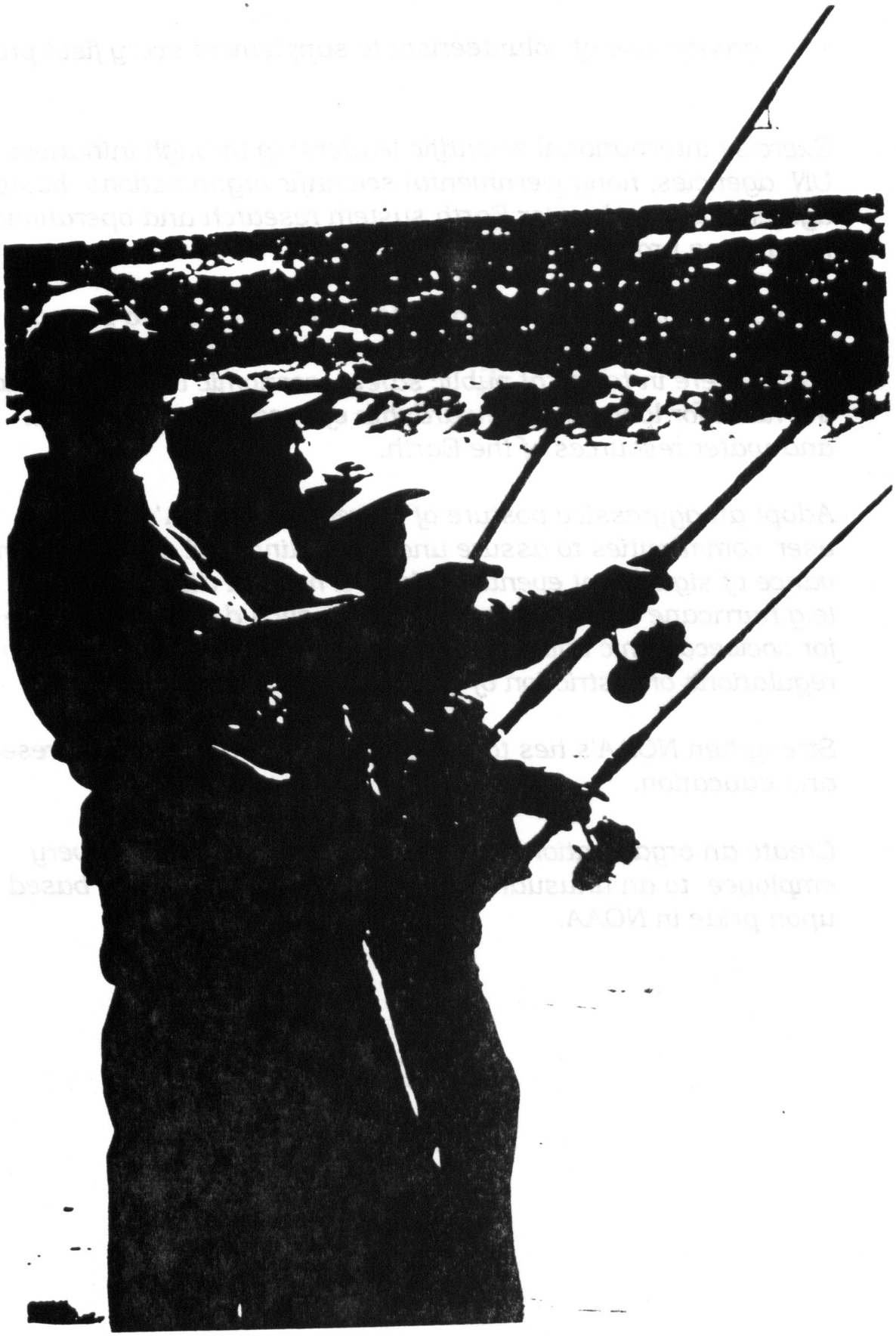
- *Exercise international scientific leadership through initiatives in UN agencies, nongovernmental scientific organizations, bilateral agreements, and major Earth system research and operational monitoring programs.*

- *Increase general public awareness and education to promote greater understanding of the importance of the ocean and atmosphere in terms of public safety, economic well-being and the need for long-term stewardship of oceanic, atmospheric, and water resources of the Earth.*

- *Adopt an aggressive posture of outreach to NOAA's various user communities to assure understanding and awareness in advance of significant events such as a natural disaster (e.g.hurricane land fall) or a pending policy decision with major socioeconomic implications (e.g. protected marine species regulations or restriction of greenhouse gas emissions).*

- *Strengthen NOAA's ties to universities in connection with research and education.*

- *Create an organizational environment that motivates every employee to an unusual level of personal commitment based upon pride in NOAA.*



# VI. The Challenge Ahead

Investments in NOAA are investments in the nation's future. Building upon its tradition of service, NOAA has much to offer to the American public as we face the 21st century.

To the individual citizen and in various components of the private sector, NOAA can provide increasingly useful information to assist in important day-to-day decisions related to safety of life and property as well as the pursuit of economic well being. NOAA can also make important contributions to urgent public policy decisions that the nation must make collectively concerning problems of the environment and natural resources. These choices will affect our common future in view of natural resource scarcity and environmental change. The stakes are high.

A glimpse of the last 30 years of progress suggests the magnitude of the opportunities for NOAA. The first large scale and sustained scientific attempt to comprehend the Earth system can be traced to the International Geophysical Year (IGY) in 1957. At that time, major areas of the Earth had never been observed or sampled scientifically. The tools for observation were largely primitive by contemporary standards. For example, the United States did not have a single oceanographic vessel that was designed and constructed specifically for the requirements of science at sea. Radiosondes, bathythermographs and Nansen bottles were the instruments of choice. In that year, the grapefruit-sized Sputnik became the first environmental sensing satellite to orbit Earth. Mainframe computers had just emerged from the vacuum tube era, and microprocessors were not even foreseen. In fact, the most powerful computer for scientific use in 1957, the IBM 7090, had no more computing power than a modest personal computer available today.

Every decade since the IGY, revolutionary changes have occurred in the oceanic and atmospheric sciences. These changes resulted from the interplay between increased scientific understanding and technological advances to observe, analyze, and model the underlying process of the ocean and the atmosphere.

Looking to the next 30 years, this pattern of progress in oceanic and atmospheric understanding will be inexorable. More precise technology to observe Earth system elements are already planned. Instrumentation for physical and chemical parameters has become extremely precise. Instruments for biological sampling and observation are not yet as highly developed; this biological capability will be an important technological challenge for the future. Very high-speed computers will permit complex modeling that can begin to capture the robust character of natural interactions in the Earth system.

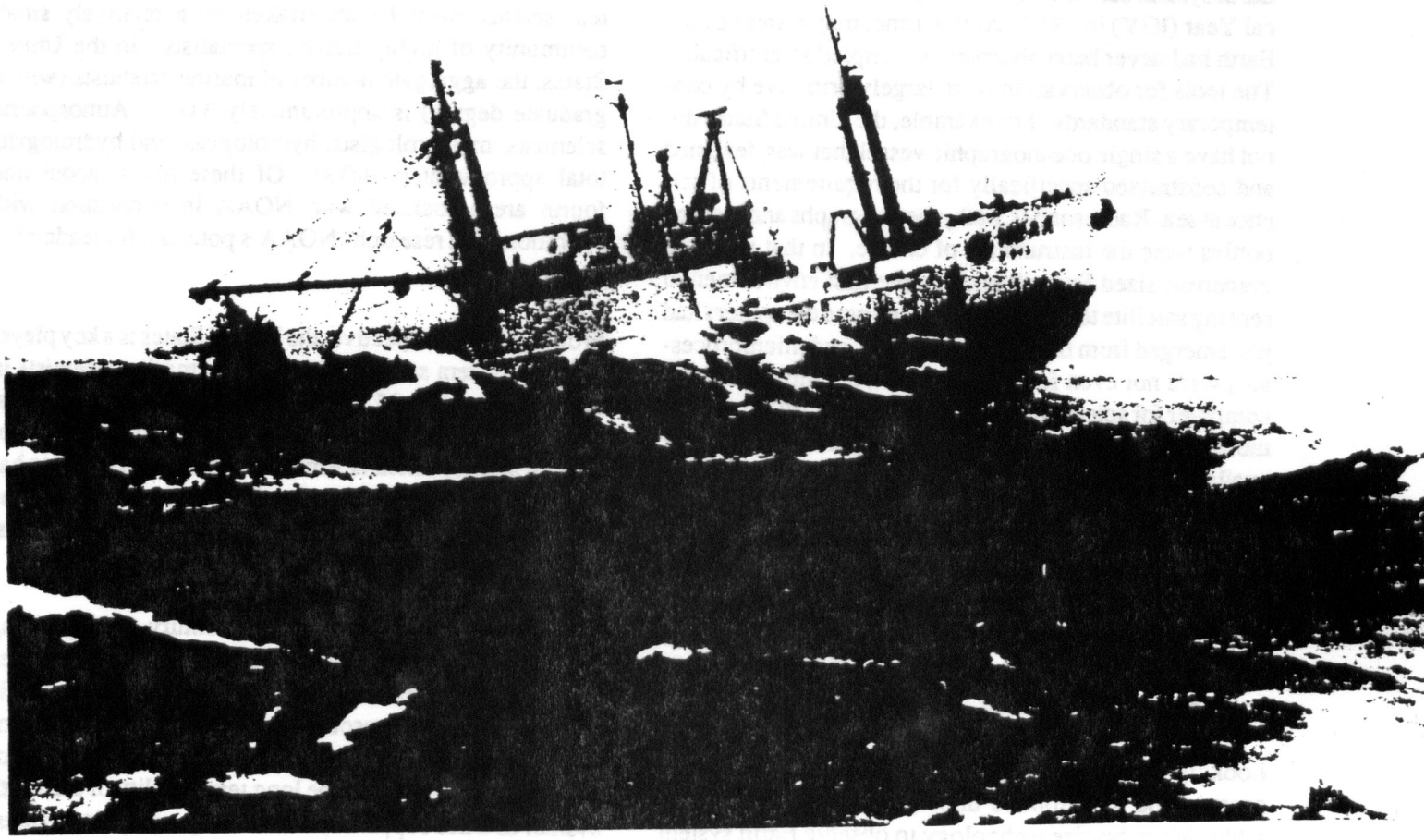
Coupled with these technological developments, sophisticated expansion of scientific knowledge will point the way for constructive lines of further investigation to unravel the Earth system. Oceanic and atmospheric researchers now know where and when to look for promising answers to questions about natural variability from scales ranging from estuaries to the entire global environment. Systematic monitoring will allow for detection of human effects on the Earth system. The objective of prediction appears achievable, at the least to a significantly greater extent than at present.

The scientific and technological challenges of Earth system science must be undertaken by a relatively small community of highly trained specialists. In the United States, the aggregate number of marine scientists (with a graduate degree) is approximately 3,000. Atmospheric scientists, meteorologists, hydrologists, and hydrologists total approximately 9,000. Of these totals, about one fourth are associated with NOAA in connection with operations and research. NOAA's potential for leadership is obvious.

From a global perspective, the United States is a key player in Earth system science. Of all of the marine scientists in the world, about 25 percent are in the United States. Similarly, approximately one eighth of all of the atmospheric science talent is American. The United States has also been consistently at the forefront of oceanic and atmospheric observation technology, operational analysis, and systematic prediction.

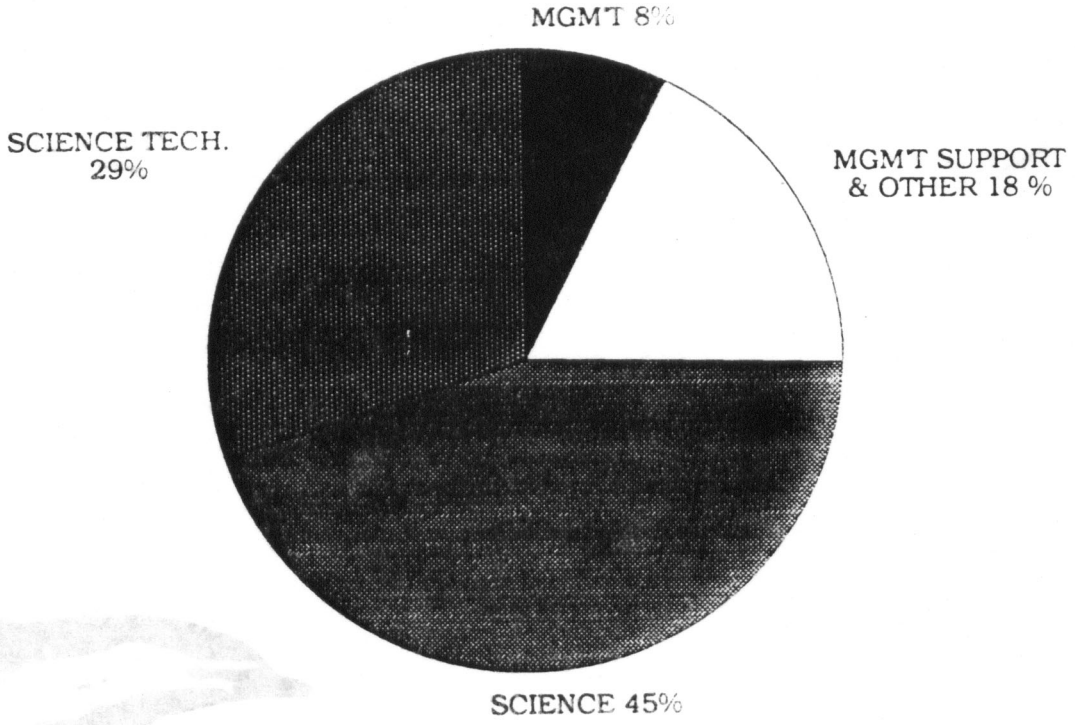
Looking from the 1990s to the 21st century, the expanding population of the Earth will be confronted with complex and pressing decisions involving sustainable economic prosperity, natural resources stewardship and environmental management. The decisions may well have profound consequences for the long term vitality of the Earth system as a life support system at all geographical scales. The United States can exhibit significant leadership in the next decade to increase understanding and anticipation of

changes in the Earth system from natural and human causes. In the final analysis, a United States commitment will largely determine whether or not meaningful choices for action will be available to the nations of the world in the 21st century. This will be the ultimate challenge to NOAA as the nation's Earth system agency.



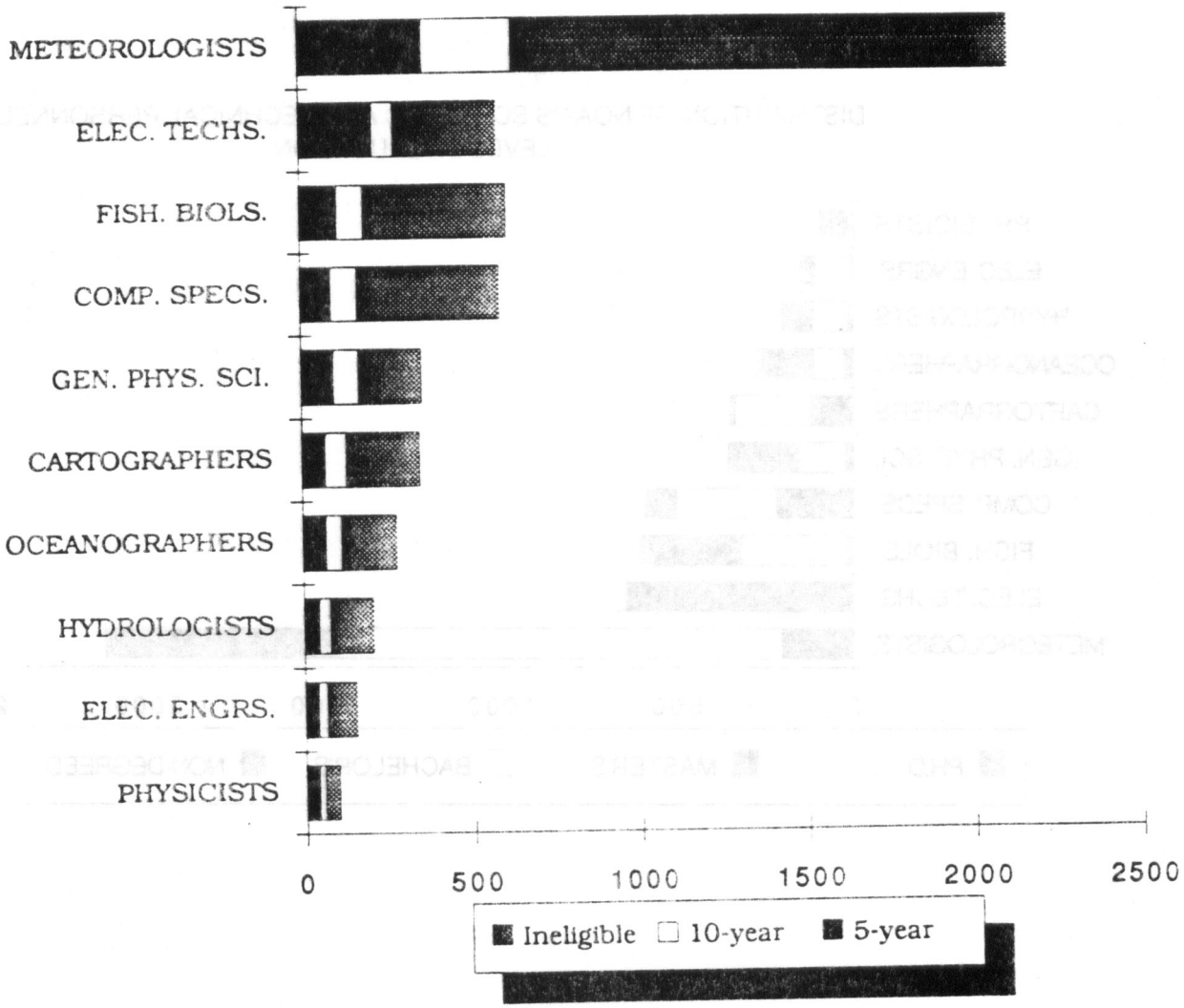
# Appendix

## DISTRIBUTION OF NOAA EMPLOYEES BY OCCUPATION

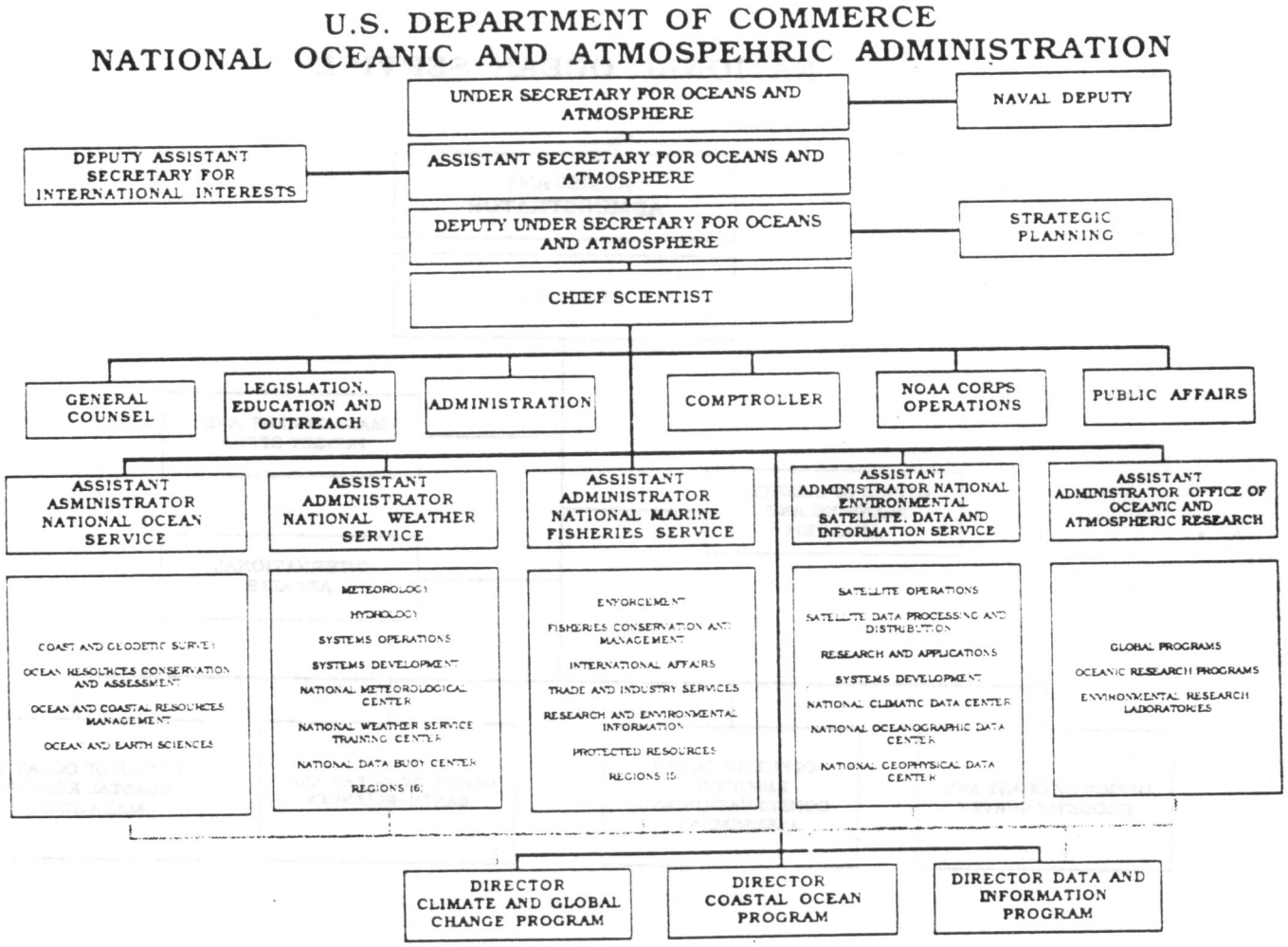


DISTRIBUTION OF NOAA'S SCIENTIFIC AND TECHNICAL PERSONNEL BY LEVEL OF EDUCATION

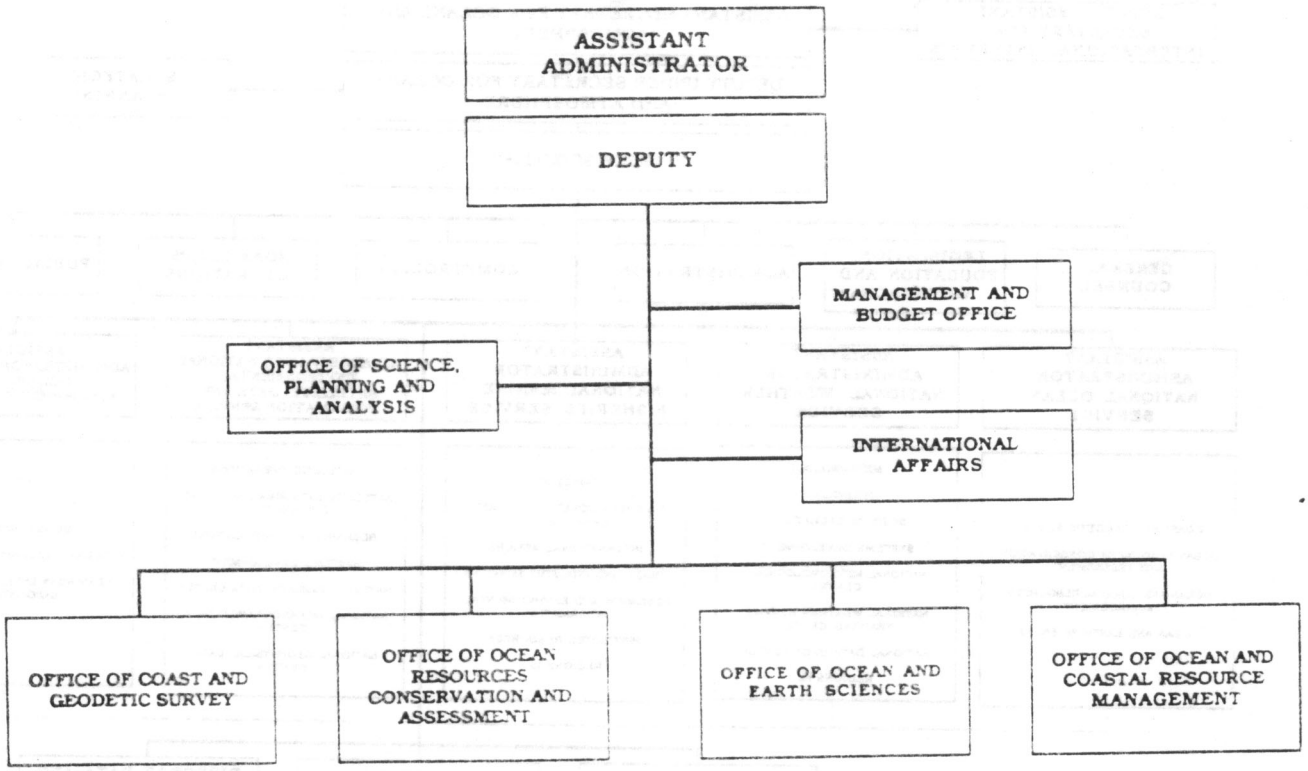
**PROJECTED RETIREMENT ELIGIBILITY FOR NOAA SCIENTIFIC AND TECHNICAL EMPLOYEES**



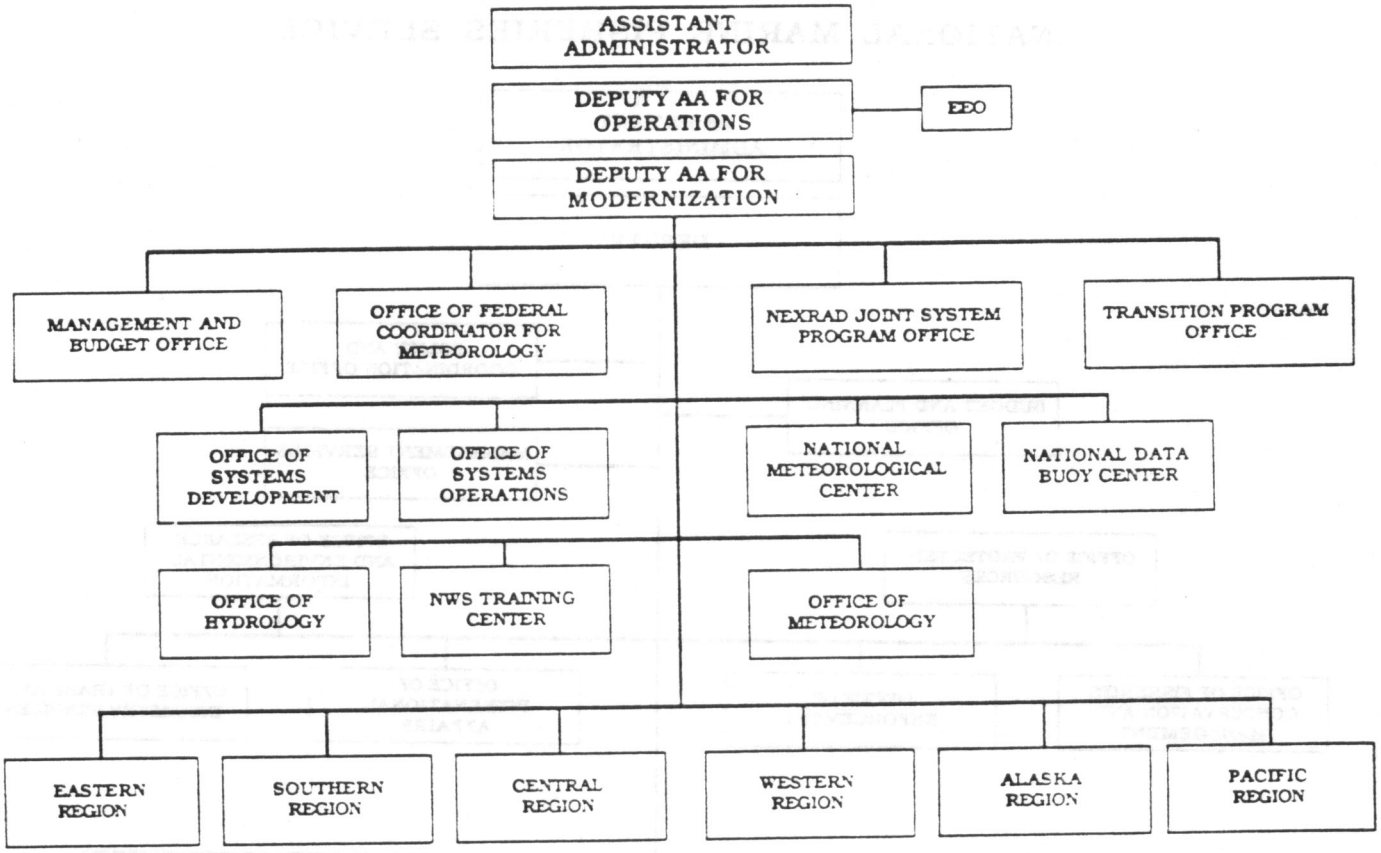
# APPENDIX B


U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPEHRIC ADMINISTRATION
UNDER SECRETARY FOR OCEANS AND ATMOSPHERE
NAVAL DEPUTY
DEPUTY ASSISTANT SECRETARY FOR INTERNATIONAL INTERESTS
ASSISTANT SECRETARY FOR OCEANS AND ATMOSPHERE
DEPUTY UNDER SECRETARY FOR OCEANS AND ATMOSPHERE
STRATEGIC PLANNING
CHIEF SCIENTIST
GENERAL COUNSEL
LEGISLATION, EDUCATION AND OUTREACH
ADMINISTRATION
COMPTROLLER
NOAA CORPS OPERATIONS
PUBLIC AFFAIRS
ASSISTANT ASMINISTRATOR NATIONAL OCEAN SERVICE
ASSISTANT ADMINISTRATOR NATIONAL WEATHER SERVICE
ASSISTANT ADMINISTRATOR NATIONAL MARINE FISHERIES SERVICE
ASSISTANT ADMINISTRATOR NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
ASSISTANT ADMINISTRATOR OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
COAST AND GEODETIC SURVEY
OCEAN RESOURCES CONSERVATION AND ASSESSMENT
OCEAN AND COASTAL RESOURCES MANAGEMENT
OCEAN AND EARTH SCIENCES
METEOROLOGY
HYDROLOGY
SYSTEMS OPERATIONS
SYSTEMS DEVELOPMENT
NATIONAL METEOROLOGICAL CENTER
NATIONAL WEATHER SERVICE TRAINING CENTER
NATIONAL DATA BUOY CENTER
REGIONS (6)
ENFORCEMENT
FISHERIES CONSERVATION AND MANAGEMENT
INTERNATIONAL AFFAIRS
TRADE AND INDUSTRY SERVICES
RESEARCH AND ENVIRONMENTAL INFORMATION
PROTECTED RESOURCES
REGIONS (5)
SATELLITE OPERATIONS
SATELLITE DATA PROCESSING AND DISTRIBUTION
RESEARCH AND APPLICATIONS
SYSTEMS DEVELOPMENT
NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANOGRAPHIC DATA CENTER
NATIONAL GEOPHYSICAL DATA CENTER
GLOBAL PROGRAMS
OCEANIC RESEARCH PROGRAMS
ENVIRONMENTAL RESEARCH LABORATORIES
DIRECTOR CLIMATE AND GLOBAL CHANGE PROGRAM
DIRECTOR COASTAL OCEAN PROGRAM
DIRECTOR DATA AND INFORMATION PROGRAM

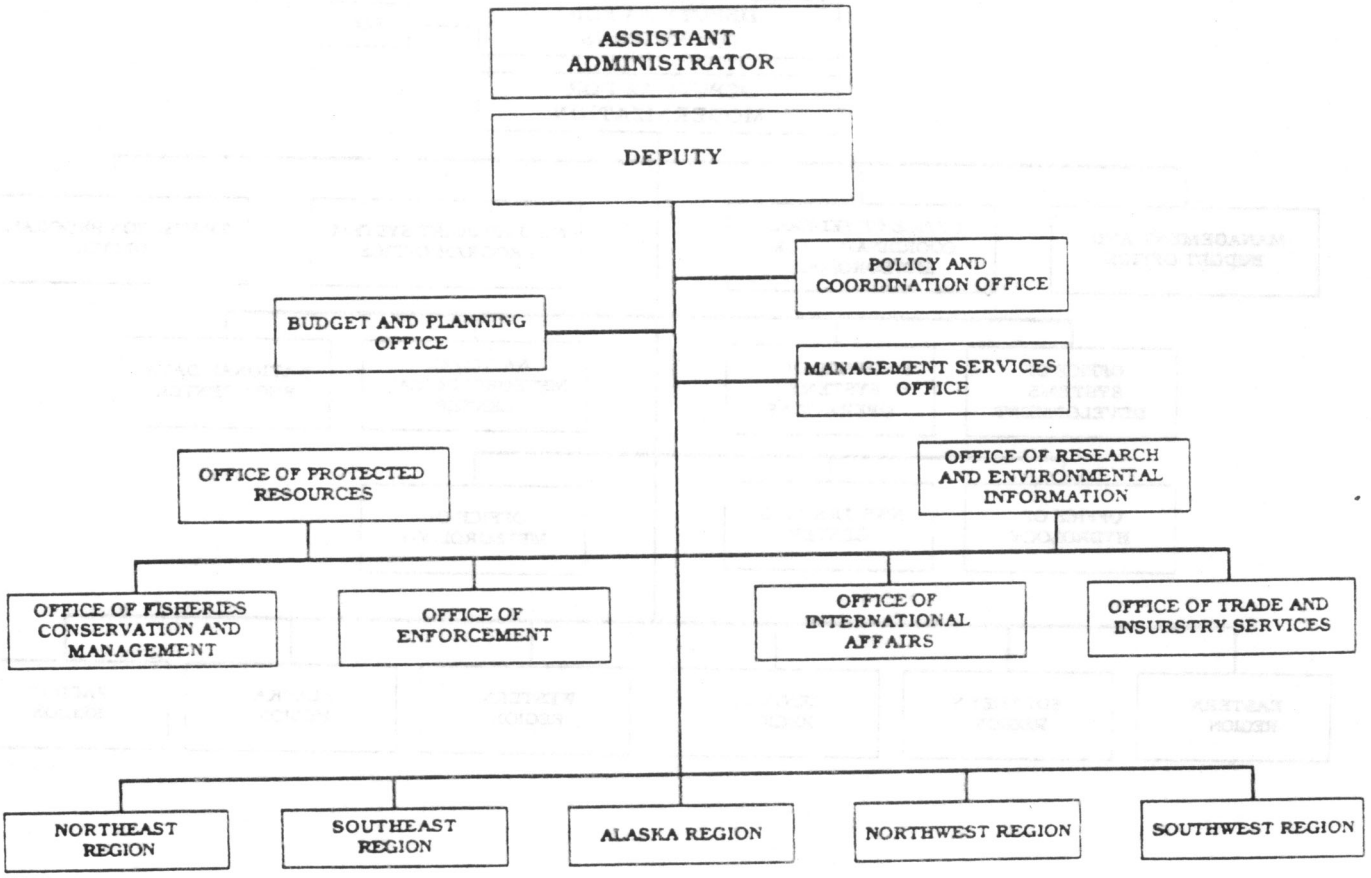
# NATIONAL OCEAN SERVICE



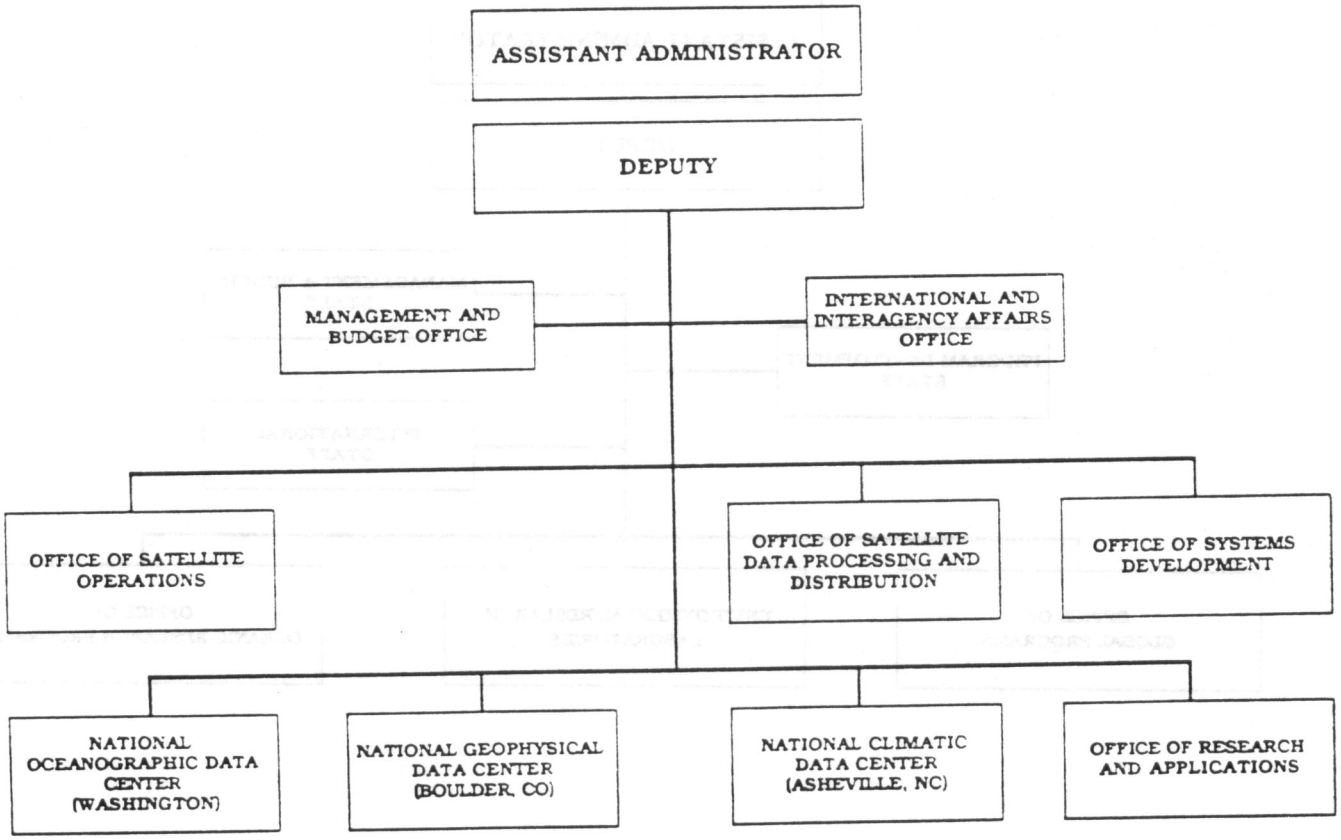
# NATIONAL WEATHER SERVICE



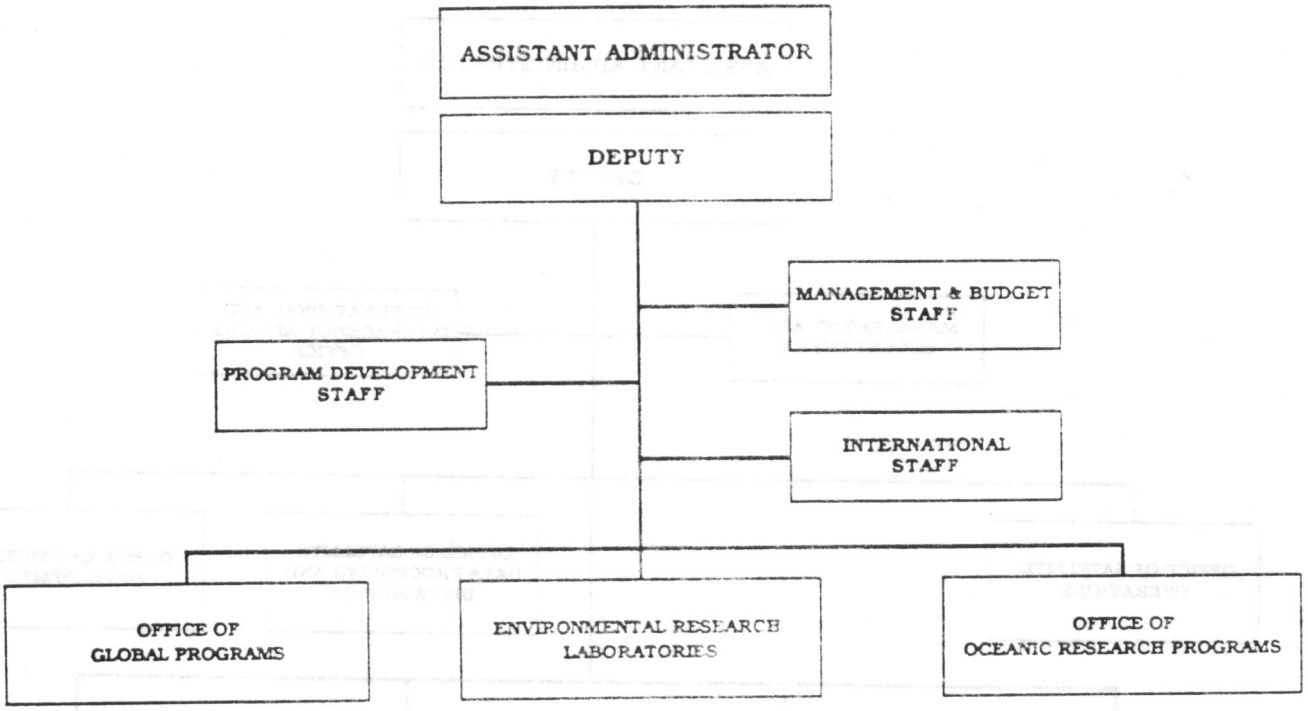
# NATIONAL MARINE FISHERIES SERVICE



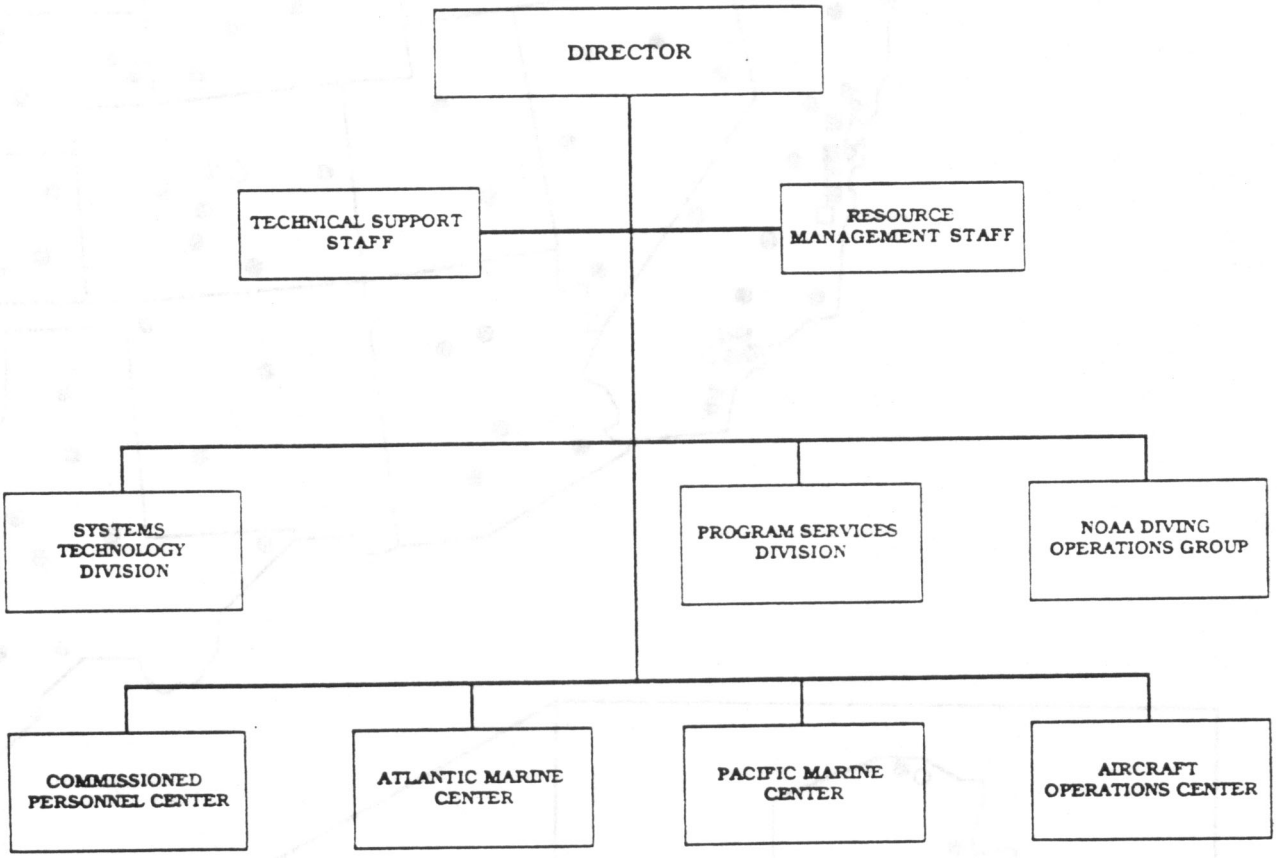
# NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE



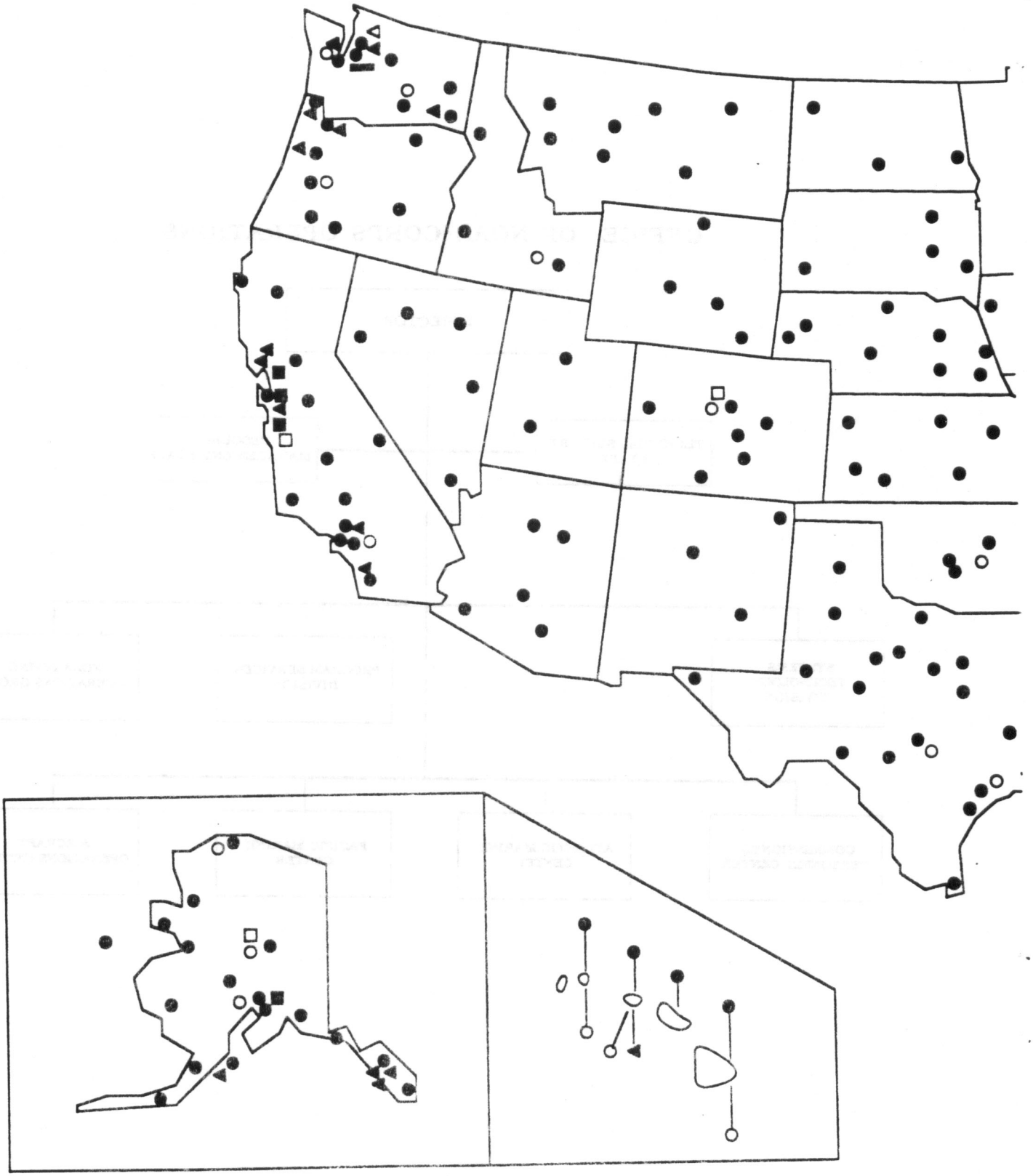
# OFFICE OF OCEANIC & ATMOSPHERIC RESEARCH



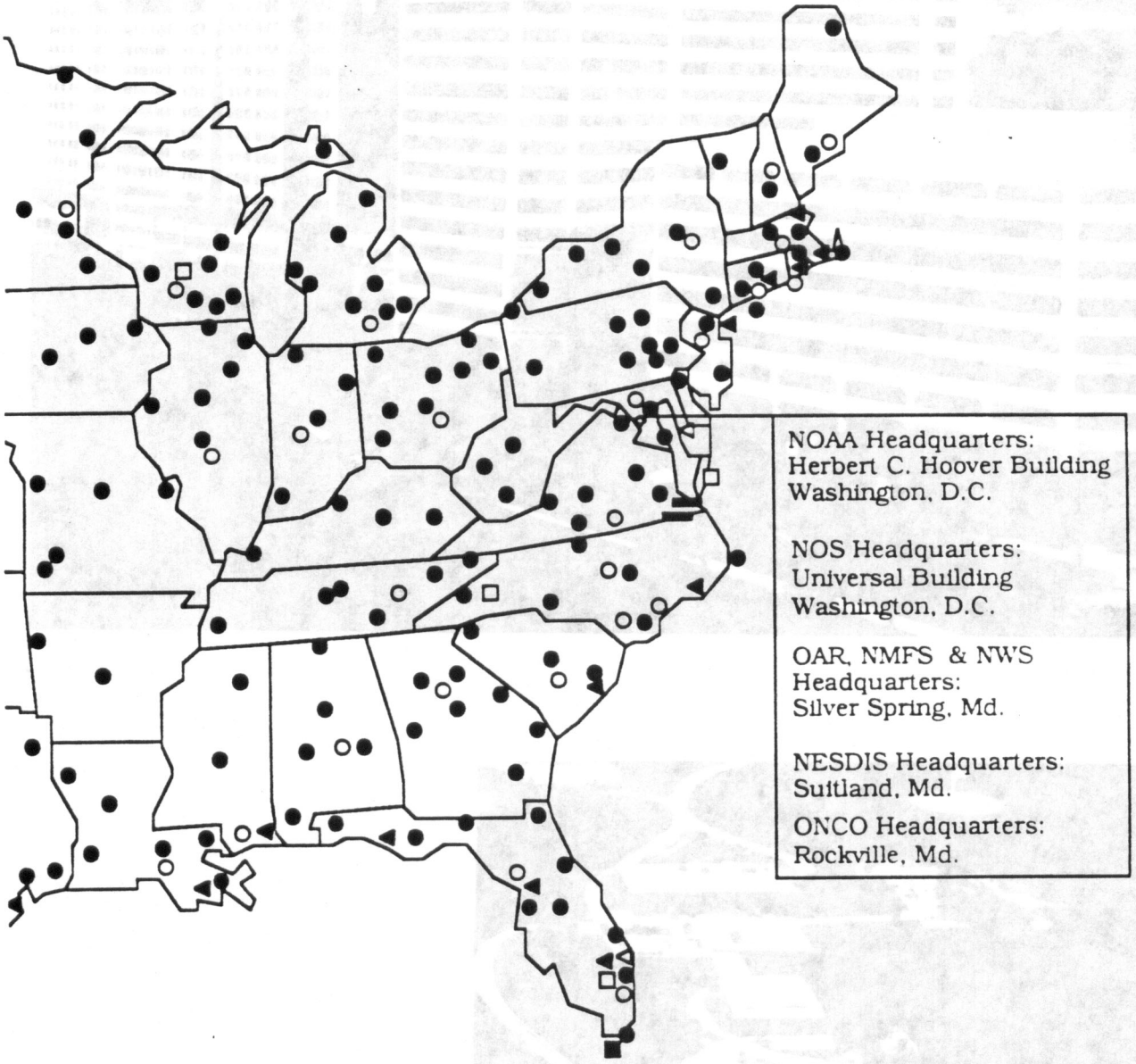
# OFFICE OF NOAA CORPS OPERATIONS



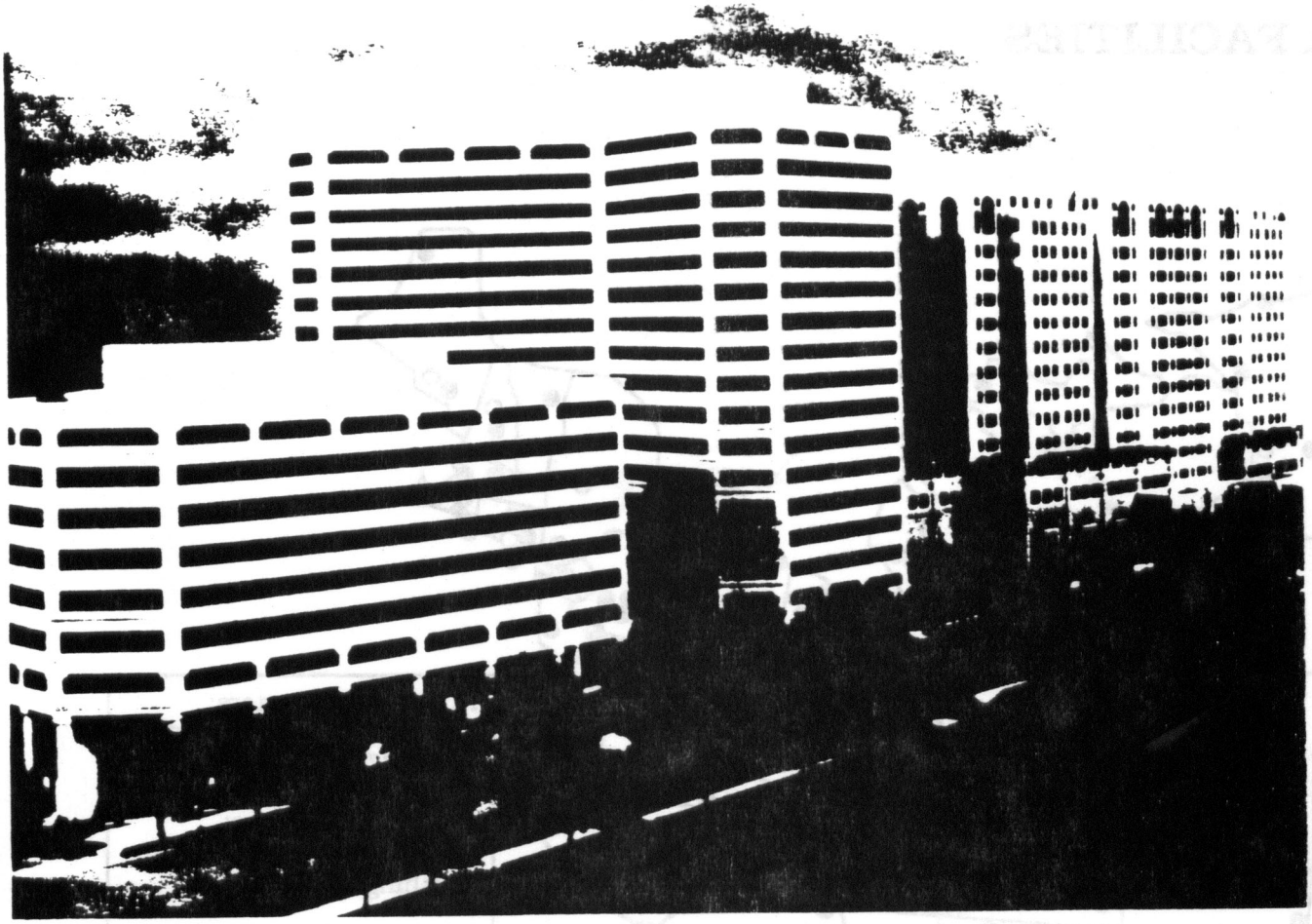
# PRINCIPAL NOA

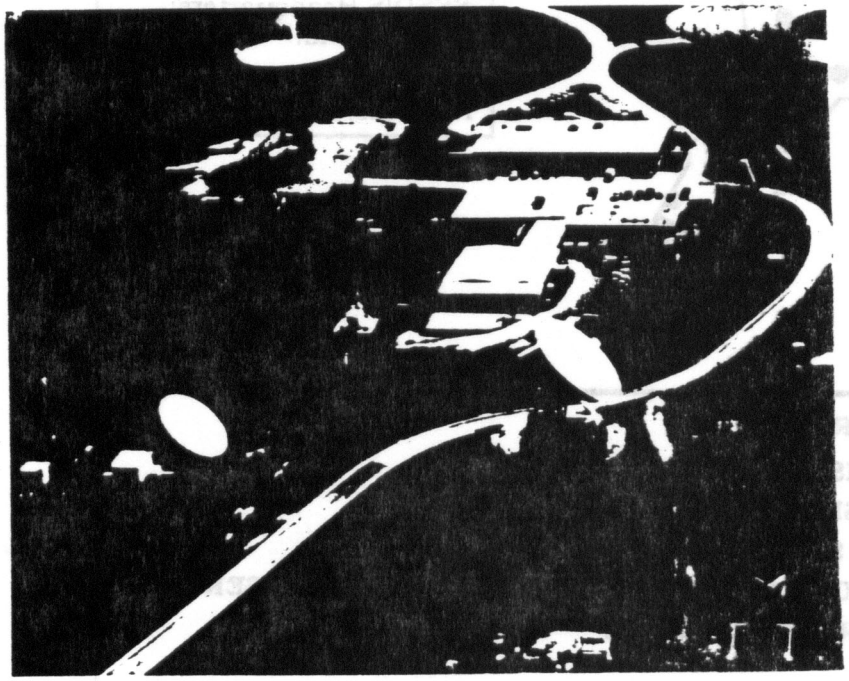


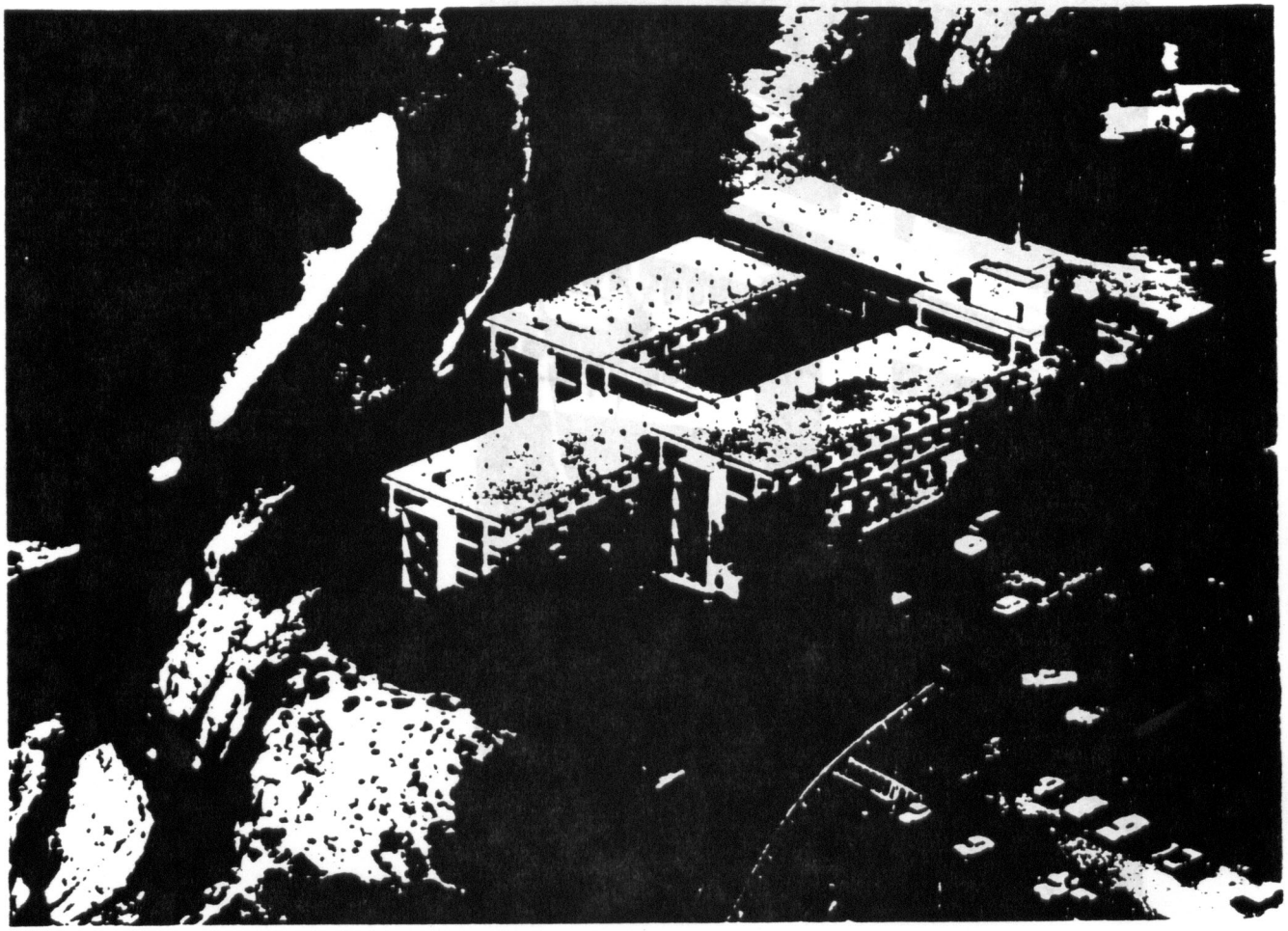
# A FACILITIES

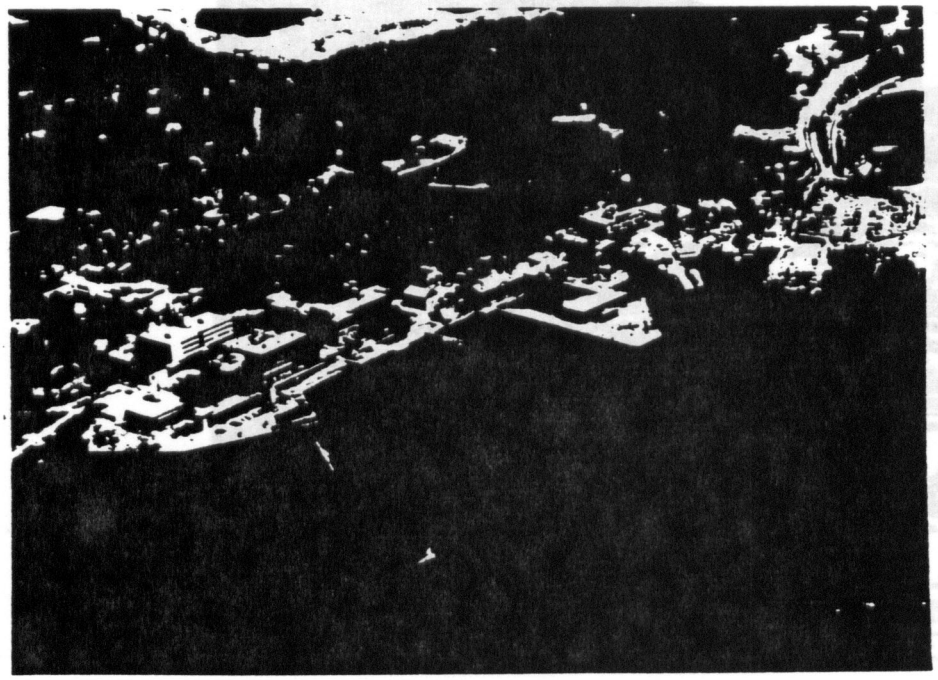


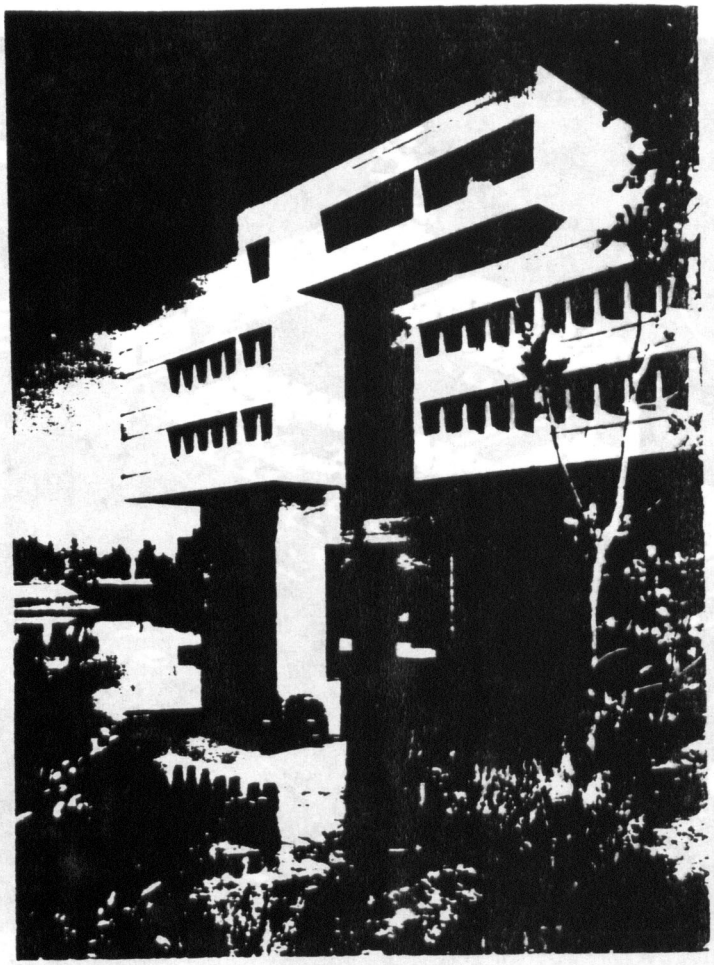

- ■ NATIONAL OCEAN SERVICE
- ◀ NATIONAL MARINE FISHERIES SERVICE
- ○ OCEANIC AND ATMOSPHERIC RESEARCH
- ● NATIONAL WEATHER SERVICE
- □ NATIONAL ENVRIONMENTAL SATELLITE DATA INFORMATION SERVICE
- ◁ OFFICE OF NOAA CORPS OPERATIONS
- ▬ REGIONAL CENTERS

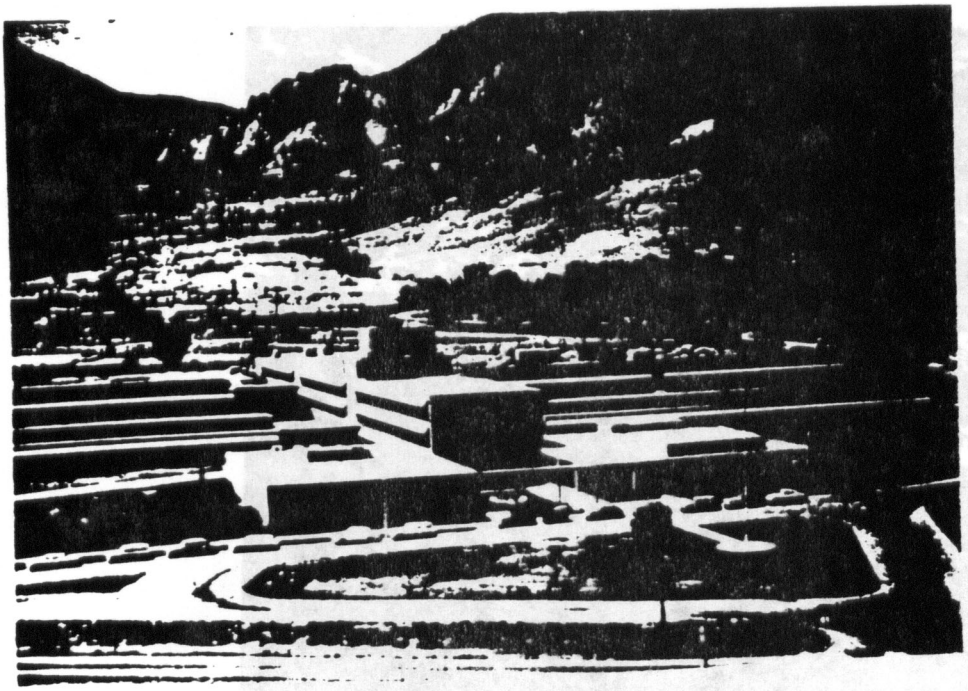




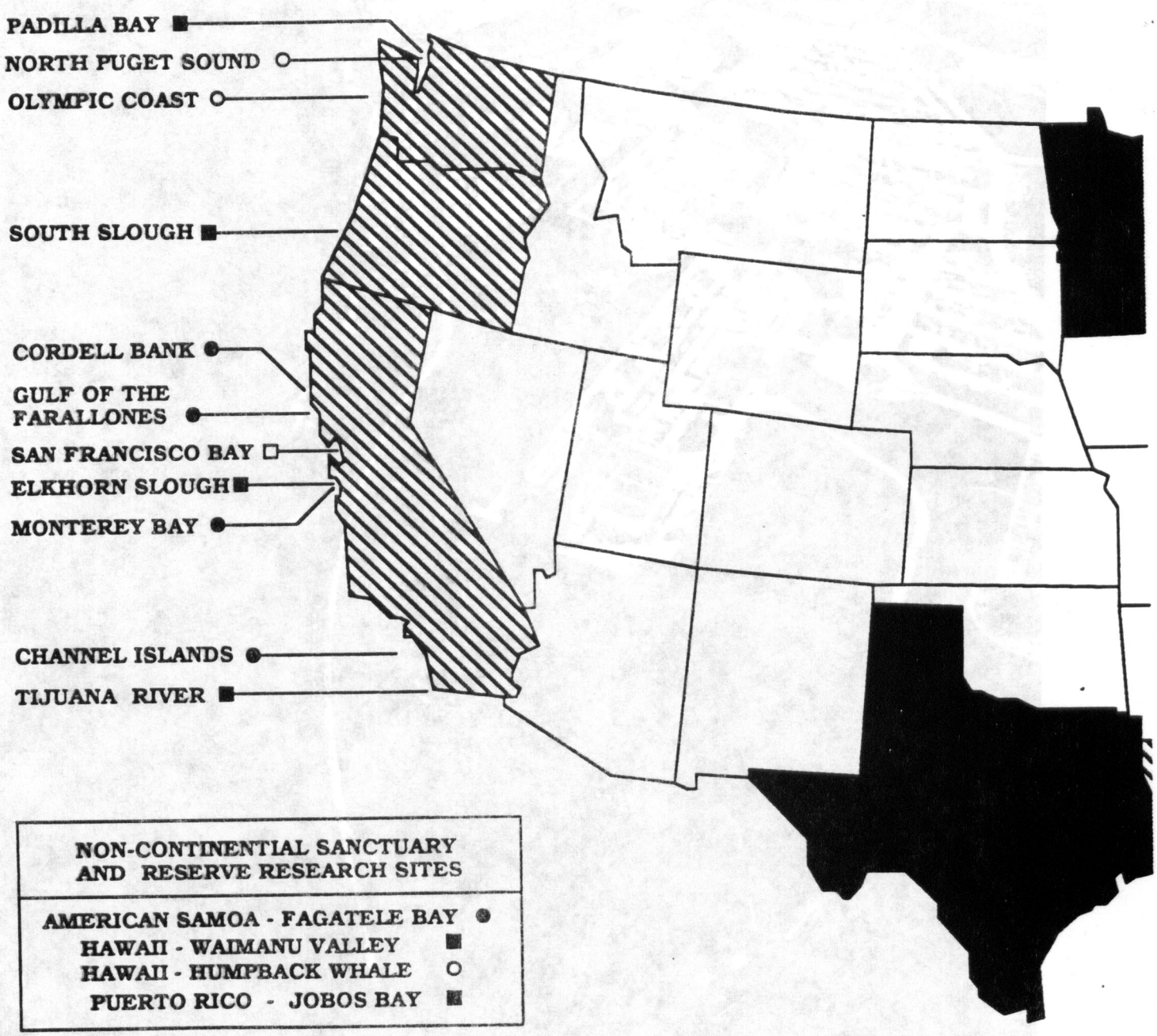






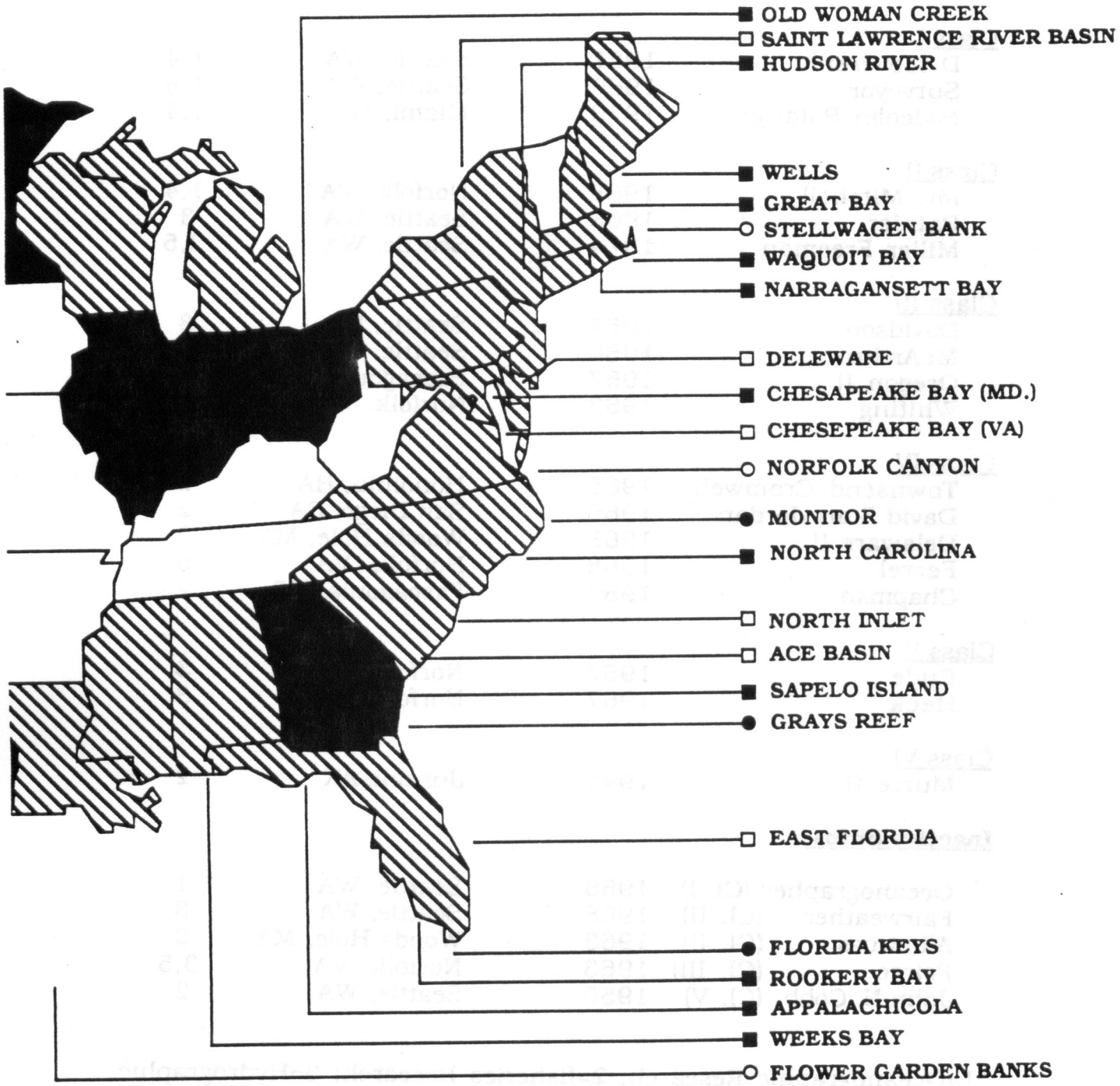


THE NATIONAL MARINE S/
THE NATIONAL ESTUARINE RES
THE COASTAL ZONE MAN.




- ○ PROPOSED MARINE SANCTUARIES
- ● DESIGNATED MARINE SANCTUARIES
- □ PROPOSED ESTUARINE RESEARCH RESERVE SYSTEM
- ■ DESIGNATED ESTUARINE RESEARCH RESERVE SYSTEM
- ▨ PARTICIPANT COASTAL ZONE MANAGEMENT PROGRAM *
- ▬ ELIGBLE, BUT NO APPROVED COASTAL ZONE MANAGEMENT PROGRAM

ANCTUARY PROGRAM
SERVE RESEARCH SYSTEM
AGEMENT PROGRAM




• COASTAL ZONE MANAGEMENT PARTICIPANTS ALSO INCLUDE: ALASKA, AMERICAN SAMOA, GUAM, HAWAII, NORTHERN MARIANAS, PUERTO RICO, AND THE VIRGIN ISLANDS.

pch. strategic planning staff 4/15/91

# NOAA SHIPS

| Active Ships: | Year Commissioned | Homeport | *Mission |
|---|---|---|---|
| **Class I** | | | |
| Discoverer | 1967 | Seattle, WA | 1,4 |
| Surveyor | 1960 | Seattle, WA | 1,4 |
| Malcolm Baldrige | 1970 | Miami, FL | 1,4 |
| **Class II** | | | |
| Mt. Mitchell | 1968 | Norfolk, VA | 1,4 |
| Rainier | 1968 | Seattle, WA | 3 |
| Miller Freeman | 1974 | Seattle, WA | 2,5 |
| **Class III** | | | |
| Davidson | 1967 | Seattle, WA | 3 |
| McArthur | 1966 | Seattle, WA | 2,5 |
| Oregon II | 1967 | Pascagoula, MS | 2 |
| Whiting | 1963 | Norfolk, VA | 3,5 |
| **Class IV** | | | |
| Townsend Cromwell | 1965 | Honolulu, HA | 2 |
| David Starr Jordan | 1966 | San Diego, CA | 2 |
| Delaware II | 1968 | Woods Hole, MA | 2 |
| Ferrel | 1968 | Norfolk, VA | 5 |
| Chapman | 1980 | Pascagoula, MS | 2 |
| **Class V** | | | |
| Rude | 1967 | Norfolk, VA | 3 |
| Heck | 1967 | Norfolk, VA | 3 |
| **Class VI** | | | |
| Murre II | 1945 | Juneau, AK | 2 |
| **Inactive Ships:** | | | |
| Oceanographer (Cl. I) | 1966 | Seattle, WA | 1 |
| Fairweather (Cl. II) | 1968 | Seattle, WA | 3 |
| Albatross (Cl. II) | 1963 | Woods Hole, MA | 2 |
| Peirce (Cl. III) | 1963 | Norfolk, VA | 3,5 |
| John N. Cobb (Cl. V) | 1950 | Seattle, WA | 2 |

*1=Oceanographic Research; 2=fisheries Research; 3=Hydrographic Surveys; 4=Bathymetric Mapping; 5=Environmental Assessment

# NOAA SHIPS

| Active Ships: | *Designator | Length | Gross Tons |
|---|---|---|---|
| **Class I** | | | |
| Discoverer | R102 | 303 FT | 3,701 |
| Surveyor | S132 | 292 FT | 2,653 |
| Malcolm Baldrige | R103 | 278 FT | 2,802 |
| **Class II** | | | |
| Mt. Mitchell | S222 | 231 FT | 1,591 |
| Rainier | S221 | 231 FT | 1,591 |
| Miller Freeman | R223 | 215 FT | 1,515 |
| **Class III** | | | |
| Davidson | S331 | 175 FT | 854 |
| McArthur | S330 | 175 FT | 854 |
| Oregon II | R332 | 170 FT | 703 |
| Whiting | S329 | 163 FT | 696 |
| **Class IV** | | | |
| Townsend Cromwell | R443 | 164 FT | 564 |
| David Starr Jordan | R444 | 171 FT | 873 |
| Delaware II | R445 | 156 FT | 483 |
| Ferrel | R492 | 133 FT | 349 |
| Chapman | R446 | 127 FT | 427 |
| **Class V** | | | |
| Rude | S590 | 90 FT | 150 |
| Heck | S591 | 90 FT | 150 |
| **Class VI** | | | |
| Murre II | R663 | 86 FT | 189 |
| **Inactive Ships:** | | | |
| Oceanographer (Cl. I) | R101 | 303 FT | 3,701 |
| Fairweather (Cl. II) | S220 | 231 FT | 1,591 |
| Albatross (Cl. III) | R342 | 187 FT | 1,115 |
| Peirce (Cl. III) | S328 | 163 FT | 696 |
| John N. Cobb (Cl. V) | R552 | 94 FT | 185 |

*The designator is a three digit number proceded by the letter, "R" for research vessel, or "s" for survey vessel. The first number of the three digit identification is the class grouping for NOAA vessels and is determined from a combination of gross tonnage and the propulsion plant's rated horsepower. The remaining two digits are hull numbers.

## NOAA AIRCRAFT

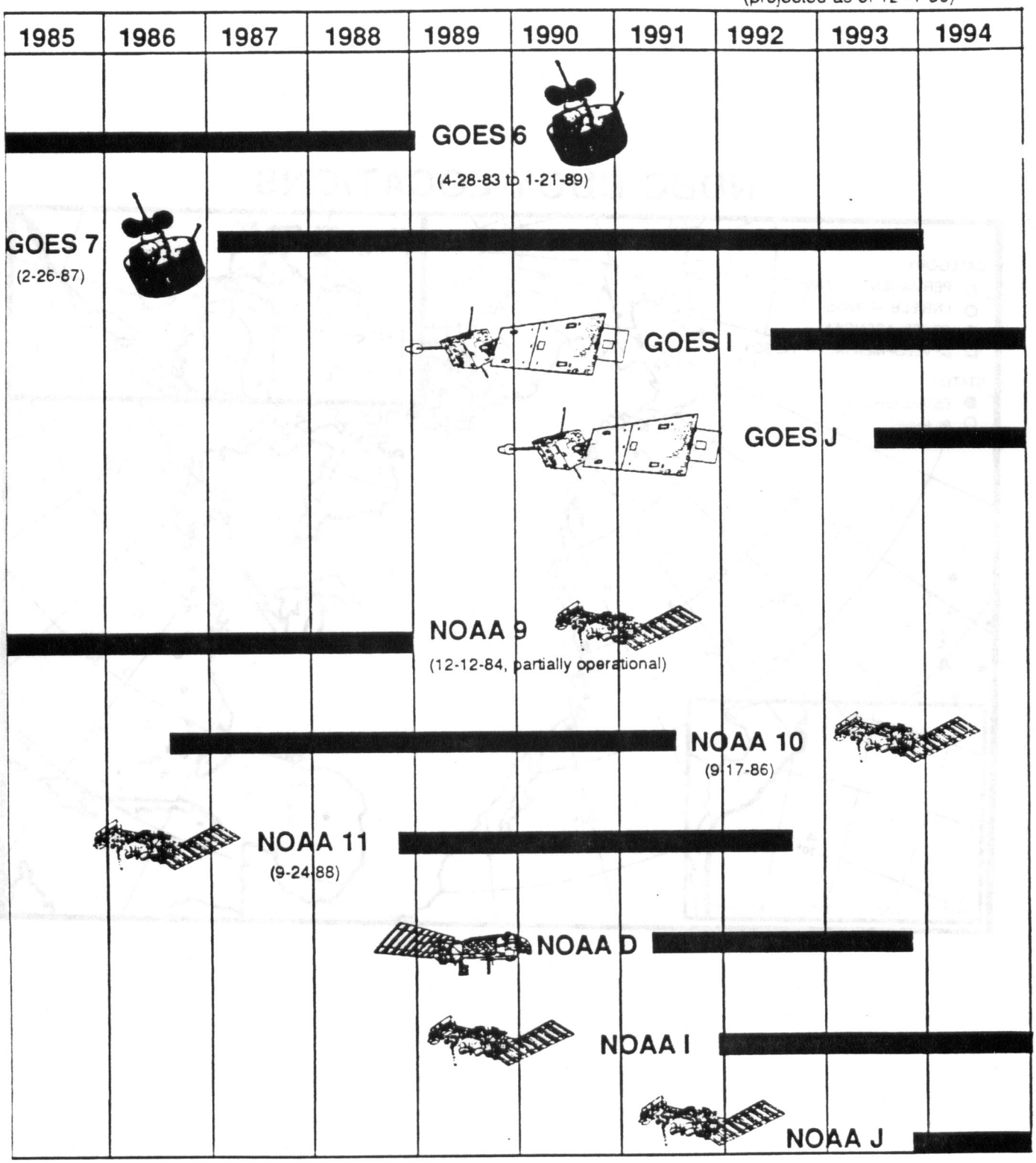
| Fixed Wing/Aircraft (9) | Year Built | Crew/ Pass. | Mission | Station |
|---|---|---|---|---|
| (2) Lockheed WP-3D 4 engine turbo prop | 1975 | 10/7 | Atmospheric Research Hurricane Reconnaissance | Miami, FL |
| Beechcraft King Air C90-2 engine turbo prop | 1972 | 2/2 | Air Quality Research | Miami, FL |
| Dehavilland Twin Otter DH6 2 engine turbo prop | 1981 | 2/6 | Aerial Surveys | Miami, FL |
| Cessna Citation II 2 engine turbo prop | 1978 | 3/1 2/2 | Photogrammetry Atmospheric Research | Miami, Fl Rockville, MD |
| Rockwell Aero Commander 690A 2 Engine turbo prop | 1974 | 3/0 2/1 | Photogrammetry Snow Survey | Rockville, MD |
| Rockwell Shrike 500S 2 engine reciprocating | 1977 | 1/3 | Snow Survey | Minneapolis MN |
| Rockwell Shrike 500S 2 engine reciprocating | 1975 | 2/1 | Flight Edit | Rockville, MD |
| Cessna 210 Centurion 1 engine reciprocating | 1977 | 1/3 | Aerial Surveys Atmospheric Research & Training | Miami, FL |
| **Helicopters (5)** | | | | |
| (2) Bell 212 2 engine helicopter | 1979 | 2/7 | Remote over-water operations/ ship support | Miami,Fl/ Anchorage, AK |
| (2) UH-1H (Bell 205)** 1 engine helicopter | 1966 | 2/7 | Remote logistics support | Miami, FL/ Anchorage |
| McDonnel Douglas 500D 1 engine light helicopter | 1979 | 1/3 | Aerial Surveys & Logistics | Miami, FL |

** One UH-1H to be disposed of in the near future

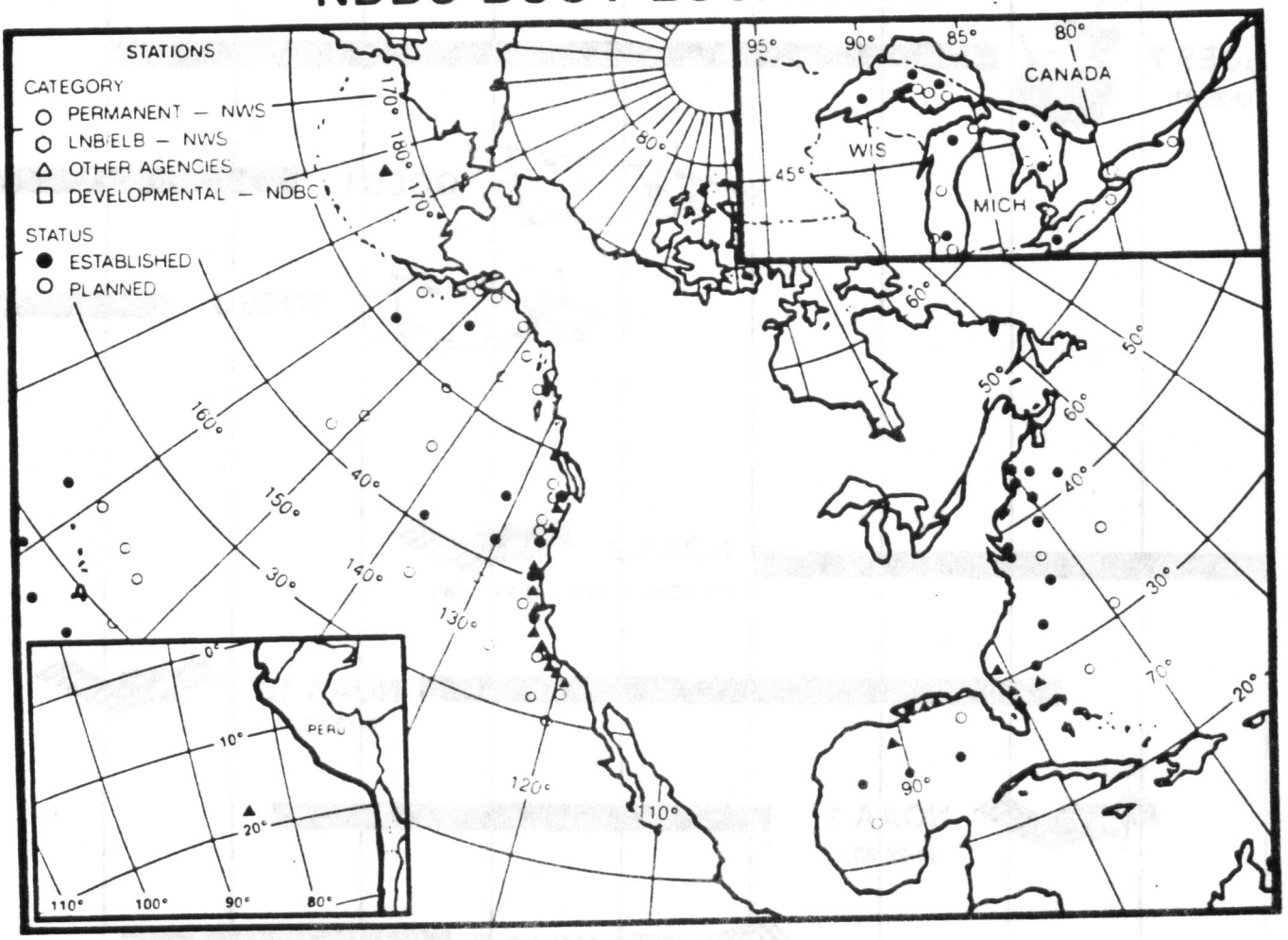
# NOAA SATELLITES

*Satellites Under NOAA Control 1985 - 1994*

(projected as of 12 -1-90)



# NDBC BUOY LOCATIONS



# NOAA'S PRIMARY INTE

**CANADA**
MOA ON CLIMATE
JOINT ICE WORKING GROUPS
PACIFIC SALMON
FISHERIES FREE TRADE ACTIVITY
INT'L JOINT COMMISSION

**UNITED KINGDOM**
STRATOGRAPHIC &
ADVANCED
MICROWAVE
SOUNDING UNITS

**INT'L PACIFIC HALIBUT COMMISSION**

**INT'L N. PACIFIC FISHERIES COMMISSION**

**IRELAND**
GIFA

**EEC**
GIFA

**FRANCE**
OCEANOGRAPHY
ARGOS

**GERMANY**
GIFA

**UN**
**IOC WMO**
**IMO FAO**
**COPUOS**

**NW ATLANTIC SALMON CONVENTION**

**MEXICO**
S&T COOPERATION

**N ATLANTIC FISHERIES ORGANIZATION**

**SPAIN**
S&T COOPERATION

**CARIBBEAN**
REGIONAL METEOROLOGICAL
ASSISTANCE

CARIBBEAN ENVIRONMENTAL
PROGRAM

**MOROCCO**
FISHERIES COOPERATION

**EMERGING ISSUES**
CLIMATE & GLOBAL CHANGE
LAW OF THE SEA
UNCED
ENVIRONMENT & TRADE LINKAGES
TURTLES (TEDS)
POPPOISE MORTALITY
DRIFTNETS
ANTARCTIC NON-LIVING RESOURCES
BERRING SEA POLLOCK FISHERIES
TRADE & FISHERIES MANAGEMENT
STRATOSPHERIC OZONE DEPLETION
LANDSAT

**COSPAS-SARSAT**

**INT'L COUNSIL FOR THE EXPLORATION OF SEAS**

**LONDON DUMPING CONVENTION**

**INT'L HYDROGRAPHIC ORGANIZATION**

**ATLANTIC TUNA COMMISSION**

**ICCAT**

**WORLDWIDE INT'L COOPERATIVE EFFORTS**
INT'L CIVIL AVIATION ORGANIZATION

INTERGOVERNMENTAL PANEL ON

CLIMATE CHANGE
WORLD CONSERVATION UNION

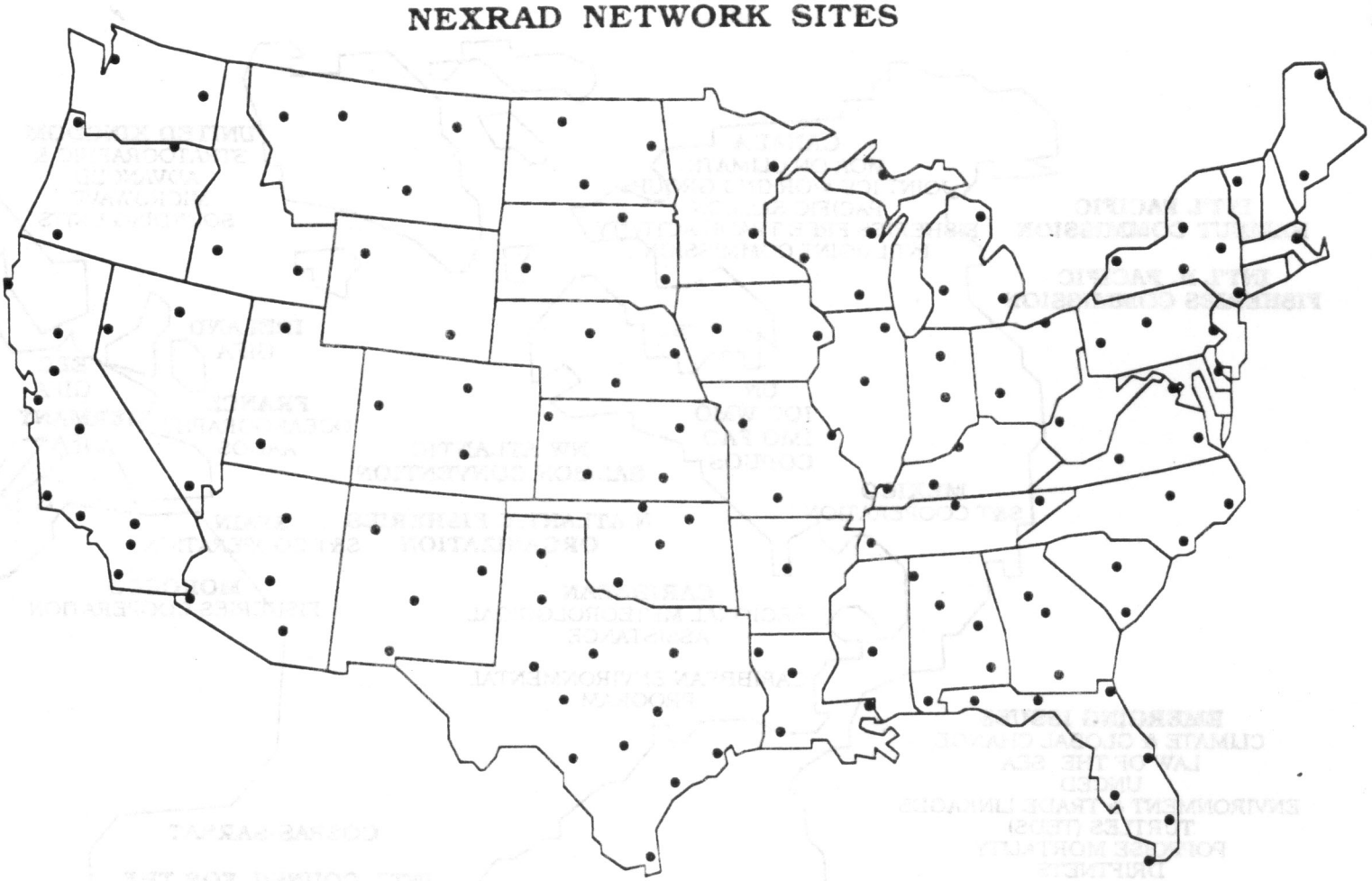
INT'L POLAR ORBITING METEOROLOGICAL
SATELLITE GROUP

COMMITTEE ON EARTH OBSERVATION
SATELLITES

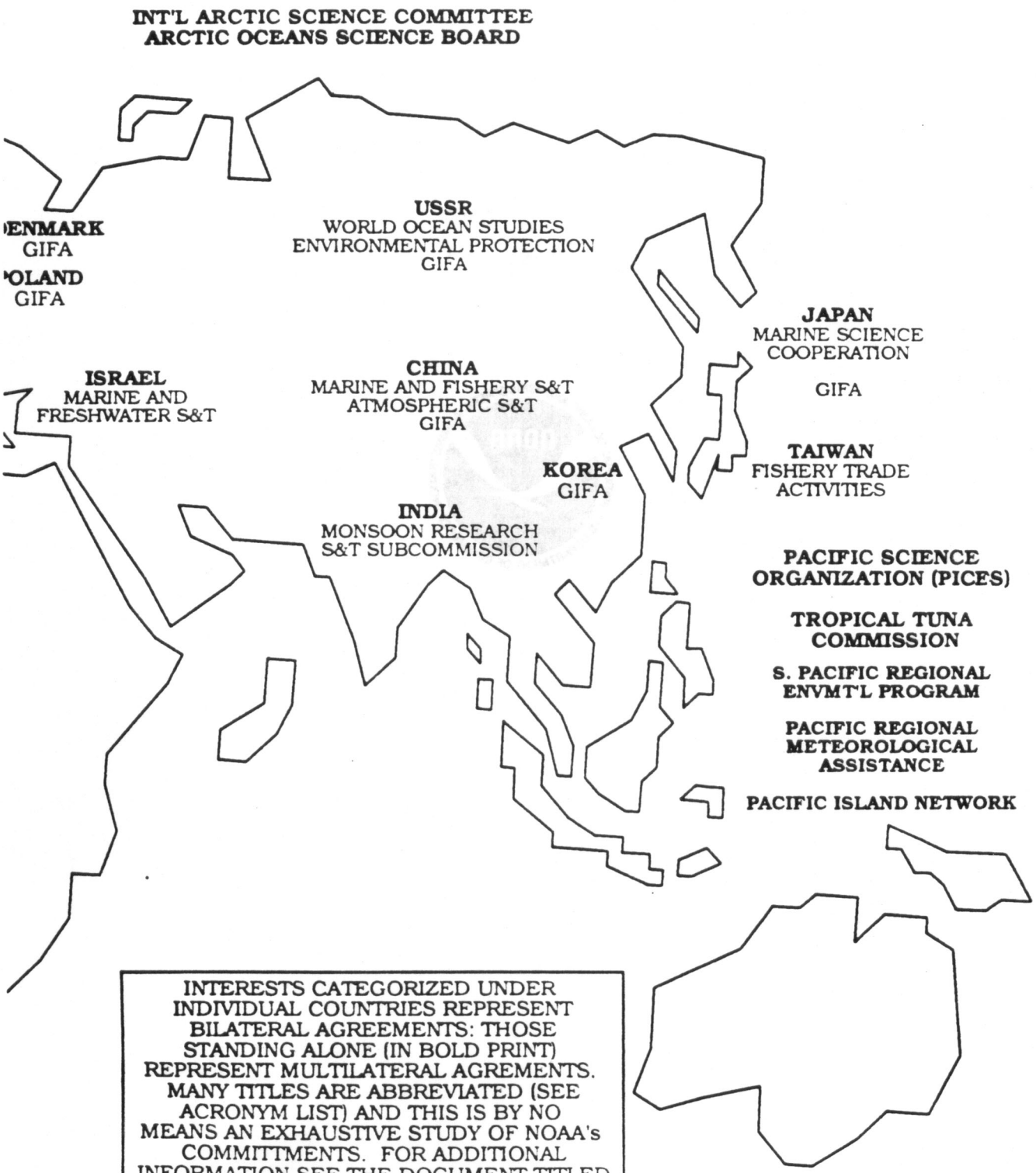
COORDINATION ON GEOSTATIONARY
METEOROLOGICAL SATELLITES

**ANTARCTIC TREATY**
**ANTARCTIC MARINE LIVING RESOURCE COMMISSION**
**INTERNATIONAL WHALING COMMISSION**
**CONVENTION FOR THE CONSERVATION OF ANTARCTIC SEALS**
**CONVENTION ON INT'L TRADE IN ENDANGERED SPECIES**

## NEXRAD NETWORK SITES



# RNATIONAL INTERESTS




INTERESTS CATEGORIZED UNDER INDIVIDUAL COUNTRIES REPRESENT BILATERAL AGREEMENTS: THOSE STANDING ALONE (IN BOLD PRINT) REPRESENT MULTILATERAL AGREMENTS. MANY TITLES ARE ABBREVIATED (SEE ACRONYM LIST) AND THIS IS BY NO MEANS AN EXHAUSTIVE STUDY OF NOAA's COMMITTMENTS. FOR ADDITIONAL INFORMATION SEE THE DOCUMENT TITLED "NOAA's PRIMARY INTERNATIONAL RESPONSIBILITIES" AVAILABLE THROUGH THE INTERNATIONAL AFFAIRS OFFICE (202) 377-8196.

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE