NOAA CoastWatch
August 1989

NOAA CoastWatch

VERSION 4.3
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U.S. Department of Commerce
National Oceanic and Atmospheric Administration

NOAA CoastWatch

Implementation Plan

National Environmental Satellite, Data, & Information Service
National Marine Fisheries Service
National Ocean Service
National Weather Service
Office of Oceanic & Atmospheric Research

August 1989

Version 4.3

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BACKGROUND

The Coastal Ocean of the United States faces a number of critical crises requiring urgent action. Since the late 1970s, environmental and fisheries scientists have been acutely aware of the impacts of natural environmental variability and man-made influences on marine ecosystems, habitat, and living marine resources. These events include: diminishing tidal marsh and wetland areas throughout the southeast and Gulf Coast region; negative effects of sewerage outfalls in the Los Angeles bight area of California and pollution in Boston Harbor; the effect of Great Lakes water level changes and water quality; and the effects on ecosystems of commercial and residential over development in the coastal zone throughout the country.

A number of specific, recent events have been headline news for the past few years. In 1987, a "red tide" event devastated the commercial and recreational shell fisheries in the Carolinas. In 1988, medical waste from offshore dumping washed ashore in New Jersey, threatening tourism and the fishing industry. In 1989, a commercial oil tanker ran aground in Prince William Sound, Alaska, threatening salmon and pollack stocks, as well as damaging an extremely fragile and pristine ecosystem.

These natural and man-made events appear to be increasing in frequency of occurrence and geographic coverage. They threaten the Nation's natural resources, economic health, food supplies, and environmental quality. To address these and other similar problems, the National Oceanic and Atmospheric Administration has established NOAA CoastWatch within the broader Coastal Ocean Program. NOAA CoastWatch is designed to provide a rapid supply of up-to-date, coordinated, environmental (remotely sensed, chemical, biological and physical) information to support Federal and state decisionmakers and researchers who are responsible for managing the Nation's living marine resources and ecosystems.

NOAA CoastWatch focuses on specific regional and national priorities, such as noxious algal blooms (i.e., red tides), algal biomass (contributing to oxygen depletion), and mapping tidal wetland change. NOAA Line Offices (National Marine Fisheries Service (NMFS), National Ocean Service (NOS), National Weather Service (NWS), Office of Oceanic & Atmospheric Research (OAR), and National Environmental Satellite, Data, and Information Service (NESDIS) will cooperatively develop and operate NOAA CoastWatch.

Relevant NOAA resources will be brought together to provide a cohesive and near real-time delivery system to allow for time-critical "decision support" in response to rapidly emerging coastal environmental situations. Each Line Office within NOAA contributes from its existing base of expertise to provide comprehensive multidisciplinary information to the regions of concern

for analysis and further dissemination to local governmental scientists and managers. NOAA CoastWatch directly supports agency statutory responsibilities in estuarine and marine science, living marine resource protection, and ecosystem monitoring and management contained in the Magnuson Fisheries Conservation and Management Act, the Fish and Wildlife Coordination Act, and other federal environmental statutes.

PROTOTYPE EFFORTS

Two prototype NOAA CoastWatch activities presently exist - one in the southeast and the other in the Chesapeake Bay.

The Southeast CoastWatch grew from a successful research effort to determine the cause of a severe and unprecedented 1987 red tide on the North Carolina coast. It is now established as a cooperative support program between NOAA Satellite, Ocean and Weather Services in Washington, D.C. and the NOAA Fisheries Service in Beaufort, in NOrth Carolina. The Beaufort staff now analyzes satellite images and weather forecast model data to monitor the coastal water mass and dispatch sampling vessels when environmental conditions dictate.

The weekly CoastWatch Bulletin, an experimental hard copy publication, was the initial vehicle for providing NOAA Fisheries with this information. In order to expedite the flow of products and make them the most useful to decision makers, the initial system was enhanced and established as operational with the implementation of a PC image display system at the Beaufort Laboratory. This PC-based interactive system currently allows the Laboratory to integrate and analyze a number of important environmental data sets, such as: digital satellite data, and atmospheric numerical model output. The provision of digital image data and wind field estimates is coordinated through NOAA activities in Washington, DC. An ocean feature analysis chart is provided directly to Beaufort from the NWS National Hurricane Center (NHC), based on data from the GOES satellites and integrated with ocean thermal structure charts produced by NOAA's Ocean Products Center (OPC). Figure 1 illustrates generalized data flow for water applications of NOAA CoastWatch sites.

Chesapeake Bay CoastWatch began in early 1989 as a pilot cooperative effort through the summer of 1989 between NOAA and the multi-state/Federal agency Chesapeake Bay Program. The primary objective of the project is to improve spatial and temporal resolution of spring algal blooms in the Bay by use of a developmental NASA water color instrument being flown over the Bay in a light aircraft. Additionally, the Chesapeake Bay prototype includes the initiation of a tidal habitat mapping effort to compare land remote sensing imagery from 1978 and imagery from 1988. For the first time basin wide habitat changes can be evaluated, including marine, wetland, submerged aquatic vegetation, and open water areas.

In summary, the advent of recent technological innovations in data acquisition, handling and display methods makes practical a near real-time decision support system for researchers and managers of large scale natural systems. As the primary Federal agency with responsibility for operational collection and dissemination of data for the atmosphere, oceans, fisheries, and remote sensing, NOAA is the lead agency in this interdisciplinary program.

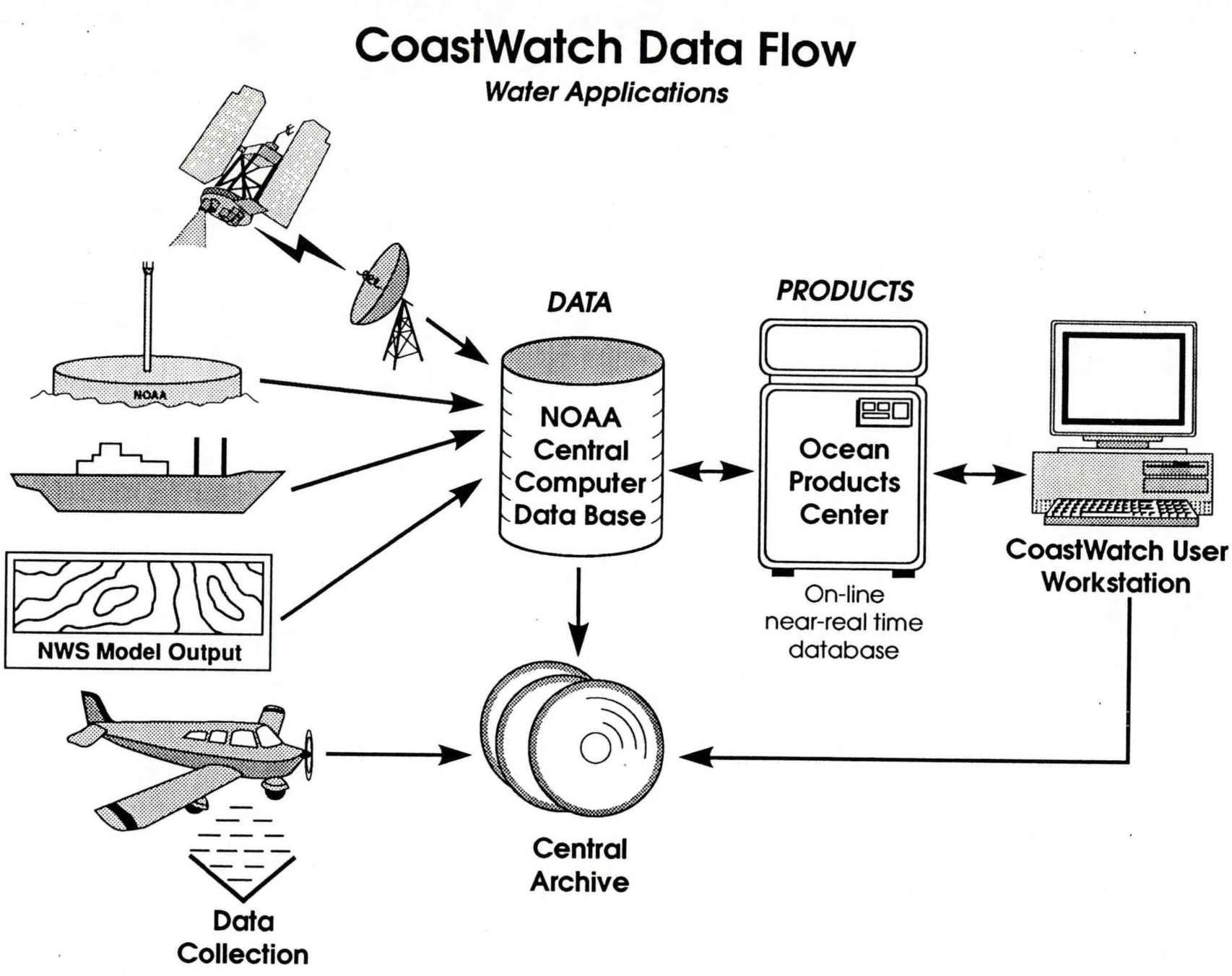
CoastWatch Data Flow
Water Applications
DATA
PRODUCTS
NOAA
Central
Computer
Data Base
Ocean
Products
Center
On-line
near-real time
database
CoastWatch User
Workstation
NWS Model Output
Central
Archive
Data
Collection

Figure 1

APPROACH AND METHODS

NOAA CoastWatch provides the information acquisition and delivery infrastructure for a comprehensive understanding of the coastal environment. The program has two major applications: coastal water and land. Water applications generally utilize near real-time observing and dissemination methodologies for responding to dynamic specific environmental concerns. Land applications are on longer time scales and are focused on land cover/habitat mapping. Although the approaches, methods and schedules between land and water applications of NOAA CoastWatch are presently different, within the next two to three years the development of both applications will converge to enhance land/water, water/land linkage. Whenever possible, common systems will be utilized across all parts of the Coastal Ocean Program.

Water Applications of NOAA CoastWatch

NOAA-wide capabilities are utilized for coastal water applications of CoastWatch involving unusual environmental events such as noxious algal blooms and anoxia/hypoxia. Two prototype CoastWatch areas are currently being developed, one covering the central North Carolina coast, and another covering the Chesapeake Bay. During FY 89 and 90 functional requirements analysis, research, product development, sample product production, image display software development, information integration, and prototype demonstrations will be conducted. During FY90, products for these regions will be operationally implemented, including automated production of products, archive and access system development, and high-speed communication of products and data. Activities are underway, or are planned for the following NOAA CoastWatch regions (Figure 2):

- maintain and enhance the Southeast U.S. effort (through the NMFS Laboratory in Beaufort, NC);
- expand the Chesapeake Bay CoastWatch in cooperation with the EPA Chesapeake Bay Program, possibly including areas of the Middle Atlantic Bight;
- develop future CoastWatch regions (FY 90 and beyond) for:
    - -- the Gulf of Mexico
    - -- the West Coast,
    - -- the Great Lakes,
    - -- the Northeast,
    - -- Alaska, and
    - -- Hawaii

General requirements include:

(1) On -line access to near real-time remotely sensed environmental data, derived products, and model output - including retrospective access to data of these types including <u>in</u> <u>situ</u> data,

COASTWATCH DEVELOPMENT

Phased approach to monitoring environmental quality of the Nation's coast

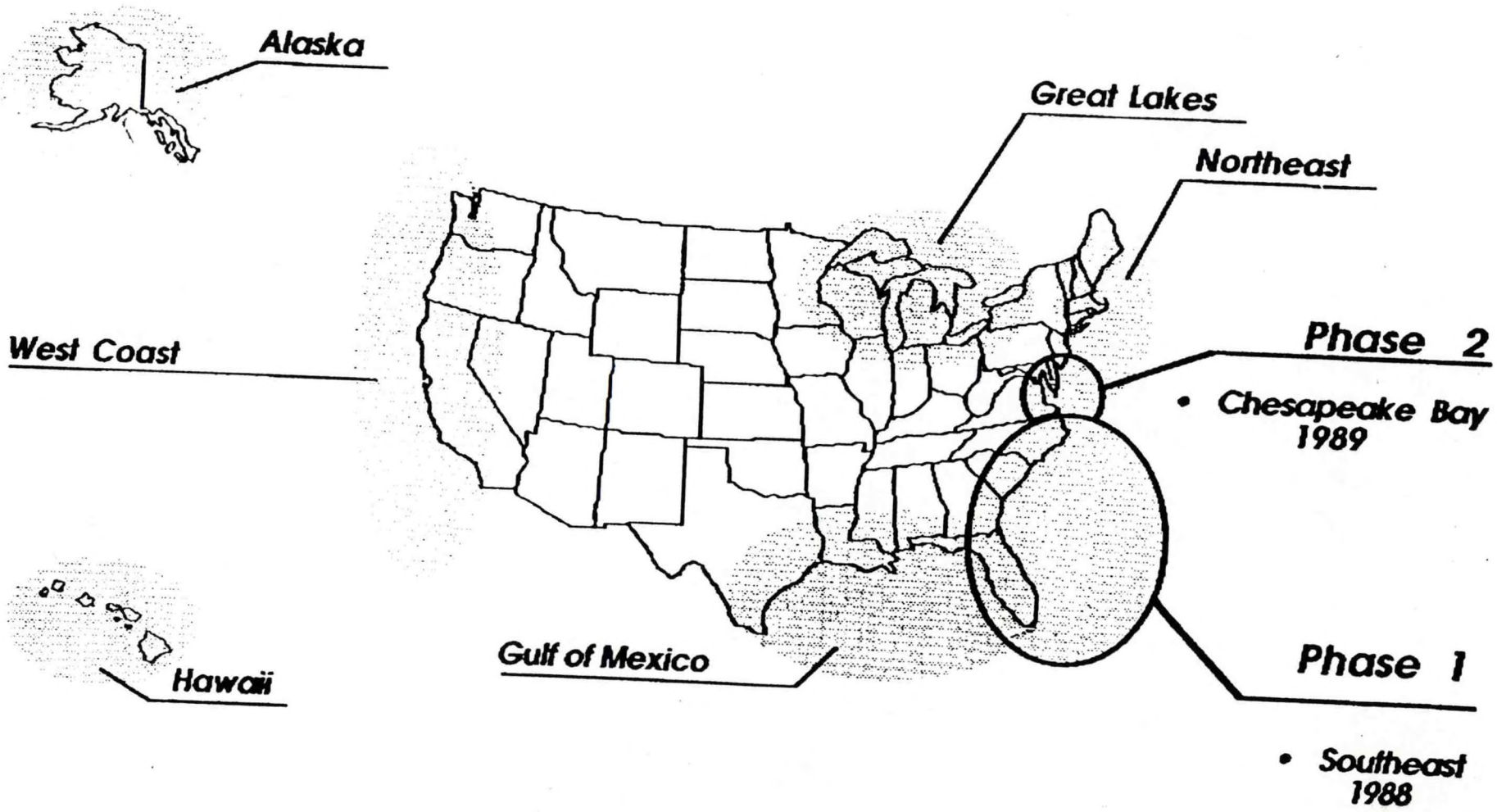

Figure 2

(2) Low to modest cost equipment and associated procedures to display these data, products and model output to provide integrated analyses of environmental quality and coastal hazards, and

(3) Support to Federal and state regulatory agencies providing timely and useful information for environmental systems management decisions.

Essential information for NOAA CoastWatch falls into the following categories: remotely sensed data from satellite and aircraft; conventional observations (real-time and historic); National analyses and forecast guidance; numerical model output; and other regional analyses and forecasts. Satellite and aircraft remotely sensed data undergo preprocessing to enable interactive analysis and GIS workstations at CoastWatch sites to receive and display the information. Conventional (in situ) observations are collected and quality controlled prior to distribution to CoastWatch sites. Environmental (surface and subsurface) analyses and forecast guidance information, as well as numerical model output, produced by National Prediction Centers (ie. NMC, OPC, JIC, COAP, and NHC) are routed to CoastWatch sites. Other regional analyses and forecasts (prepared for neighboring CoastWatch areas) will be available as input information.

Input information, including locally collected data, are assimilated into the local workstations, synthesized, and interpreted to produce customized output for specific regional and local applications. Each CoastWatch site will identify product requirements for their specific region (through the OAR Sea Grant program, the regional Fisheries Councils, state/local government officials, local university cooperatives, etc.), and develop a suite of customized products tailored to meet the region's unique requirements. Figure 3 depicts the process employed in developing both water and land NOAA CoastWatch applications. The products may focus on specific applications, such as: noxious algal blooms, algal biomass (i.e., oxygen depletion); wetland loss.

Each CoastWatch region will have its own suite of products; however, there will be many similarities among products for different regions. The exact list of products will be determined as each CoastWatch region is established. Some likely products include:

CoastWatch Process

Land and Water Applications

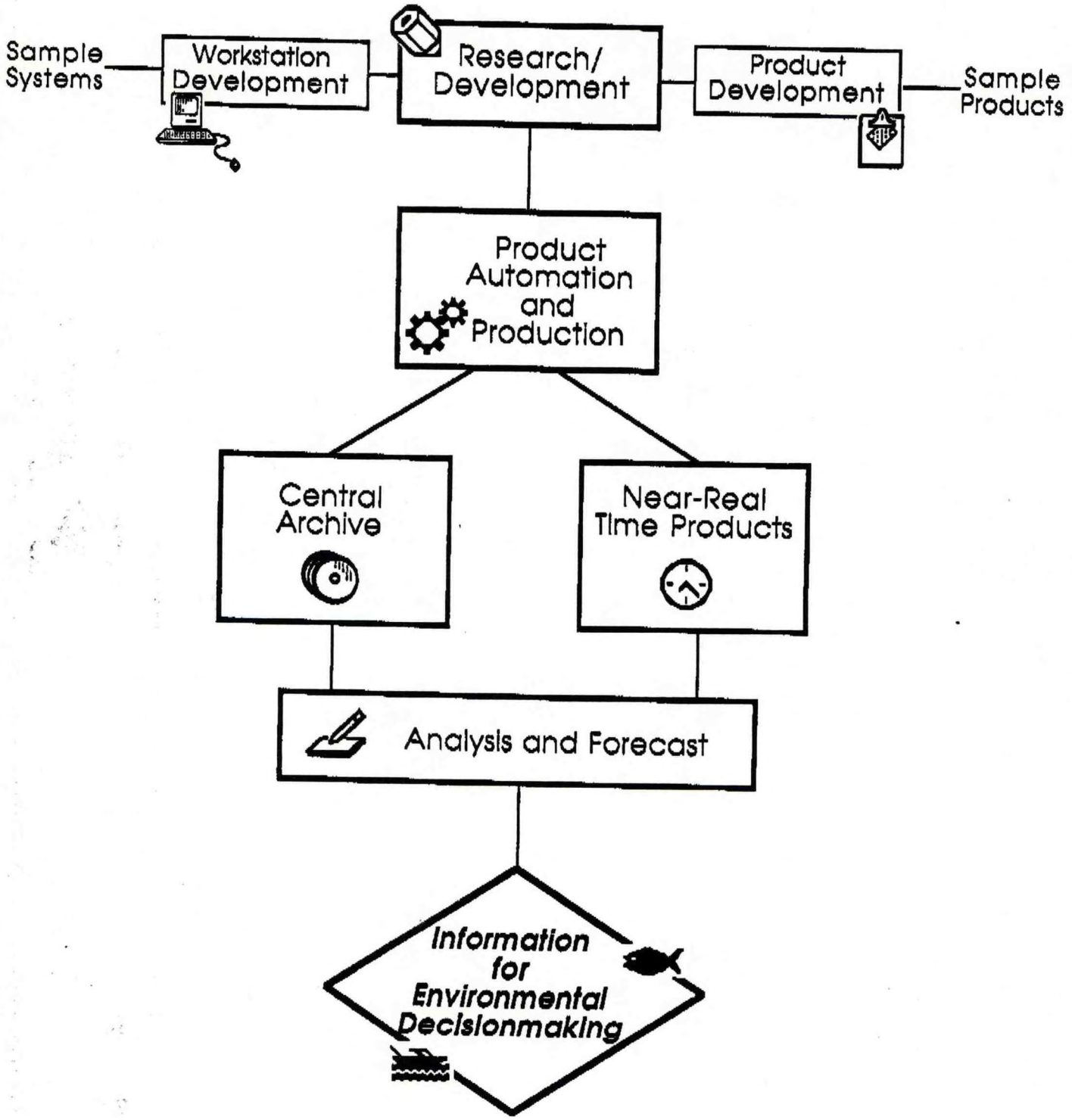

Figure 3

(1) Automated analyses of SST in the coastal regions of the U.S. at 3.5 km resolution produced thrice weekly to be used as guidance products.

(2) Full-resolution mapped images of AVHRR data available in near real-time.

(3) Physical variables such as SST, extent of estuarine algal blooms, turbidity, derived from the mapped AVHRR images.

(4) In-situ physical, chemical, and biological data.
(5) Archived satellite image data and derived products.

(6) Ekman transport and surface wind drift charts.

(7) Surface current information.

(8) Meteorological and oceanographic model output.

(9) Ocean frontal analyses.

Land Use, Habitat Change and Fish

Quantifying changes in land use and land/habitat cover in the coastal zone is critical to the linking of land-based human activities to the productivity of the coastal ocean. Change in the coastal zone due to human population growth and attendant impacts on the physical habitat, water quality and living marine resources is occurring faster and more pervasively than we have been able to monitor. On time scales appropriate for national and regional decisionmaking no appropriate monitoring of land use and land/habitat cover (i.e., coastal wetlands and adjacent uplands, and sea grass beds) exists for the coastal zone of the U.S. Therefore, a program is proposed to monitor land/habitat cover and change in the coastal zone of the U.S. in order to provide information needed to link coastal uplands, wetlands and sea grass beds to the distribution, abundance and health of living marine resources (Figure). This program directly supports NOAA's legislated responsibilities in estuarine and marine science, monitoring and management contained in the Fish and Wildlife Coordination Act, the Magnuson Fisheries Conservation and Management Act, and the Coastal Zone Management Act.

Land/habitat cover and change in the coastal zone of the U.S. will be mapped every two to five years and monitored annually in regions of significant change. The activity will emphasize the use of remotely sensed data from the Thematic Mapper (TM) or the SPOT (HRV) instrument as well as supplemental aerial photography and the Landsat Multispectral Scanner (MSS) for retrospective analyses. As newer, more technologically advanced instruments (i.e., better spatial, temporal and spectral resolution) and processing/analysis techniques

become available they will be evaluated for incorporation into the program. Data from wetland and estuarine ecologists, and from biologists will be used. While aerial photography is best for simple vegetation inventories of small test sites, use of MSS, TM or SPOT is better suited for rapid analyses with considerable cost savings for repetitive observations of vegetative changes and biomass of areas larger than 10,000 hectares (24,700 acres). Thus, this approach will build on that of the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) by allowing greater synopticity and more frequent updates, while making use of the NWI and other sources where possible to reduce ground truthing/field verification costs.

Relationship to Other Programs

Although several land cover mapping programs for the coastal zone are underway in various agencies, time scales for their completion and repetitive cycle make them less useful to NOAA for effective habitat management on a broad regional, or national scale. For purposes of comparison these other programs are briefly described.

The National Wetlands Inventory (NWI) is a major effort by the U.S. Fish and Wildlife Service (FWS) to map coastal and interior wetlands by type of land cover. Resolution ranges from 0.5 to several acres depending on location. To produce the NWI maps, the FWS makes use of high altitude photography. Interpretation of the photography is subjective and depends on individuals with considerable experience and natural faculties for pattern recognition. Much of the information is not digitized, making analysis of the data difficult. Because the aerial photography is spread out over a number of years, even within a single estuary, trend analysis is awkward due to potential biases caused by gains and losses of adjacent wetland areas. Under the Emergency Wetlands Resources Act of 1986 (Public Law 99-645) the FWS is to produce by September 30, 1988, NWI maps for the entire coastal zone of the U.S. Additionally, the FWS is to produce by September 30, 1990, and at ten-year intervals thereafter, reports to update and improve the information contained in the 1982 report "Status and Trends of Wetlands and Deepwater Habitat in the U.S., 1950's to 1970's". This report, however, does not contain change analysis maps showing where and what kind of changes have taken place over time. Such maps would be valuable to managers and researchers who need specific information on location and kind of change in order to make decisions regarding significance.

The Land Use Data Analysis (LUDA) Program of the U.S. Geological Survey (USGS) is an effort to map all land use for the entire U.S. The program makes use of aerial photography. The data are mapped to only a 10 acre resolution. Again the data base, begun in the 1970's for the U.S., is not yet complete, and subsequent surveys can not be repeated on a frequent basis.

County Soil Survey Reports (maps and text) are produced by the U.S. Soil Conservation Service (SCS). The reports generally cover all

non-federal lands and report on soil type for the top 5 feet of soil. The data are collected on foot with a hand auger. Samples are taken approximately every 5 to 10 acres. The scale on the maps produced ranges from 1: 15,840 to 1: 250,000. Additionally the SCS is conducting a wetlands mapping project on the nation's farmlands for the Swampbuster provision of the Food and Securities Act. An overlay of wetland coverage is being placed on the soil survey maps. The data are recorded by farm number at the field level and fed to state and national computers. With the computerized soils/wetland map, the SCS will work with the landowner to develop a conservation plan.

Additionally, most coastal states inventory their wetlands. Historically, however, wetlands have been defined differently from state to state making regional and national analyses impossible. The state surveys, while detailed, generally have been accomplished on foot or in some cases with aerial photography or more rarely with MSS or TM. Consequently, individual states have taken from 3 to 10 years to complete an initial survey. This has led to losses taking place faster than monitoring allowed for protective action.

In all cases, however, these other programs have the potential to provide valuable collateral information to assist in ground truthing/verification of the digital satellite data.

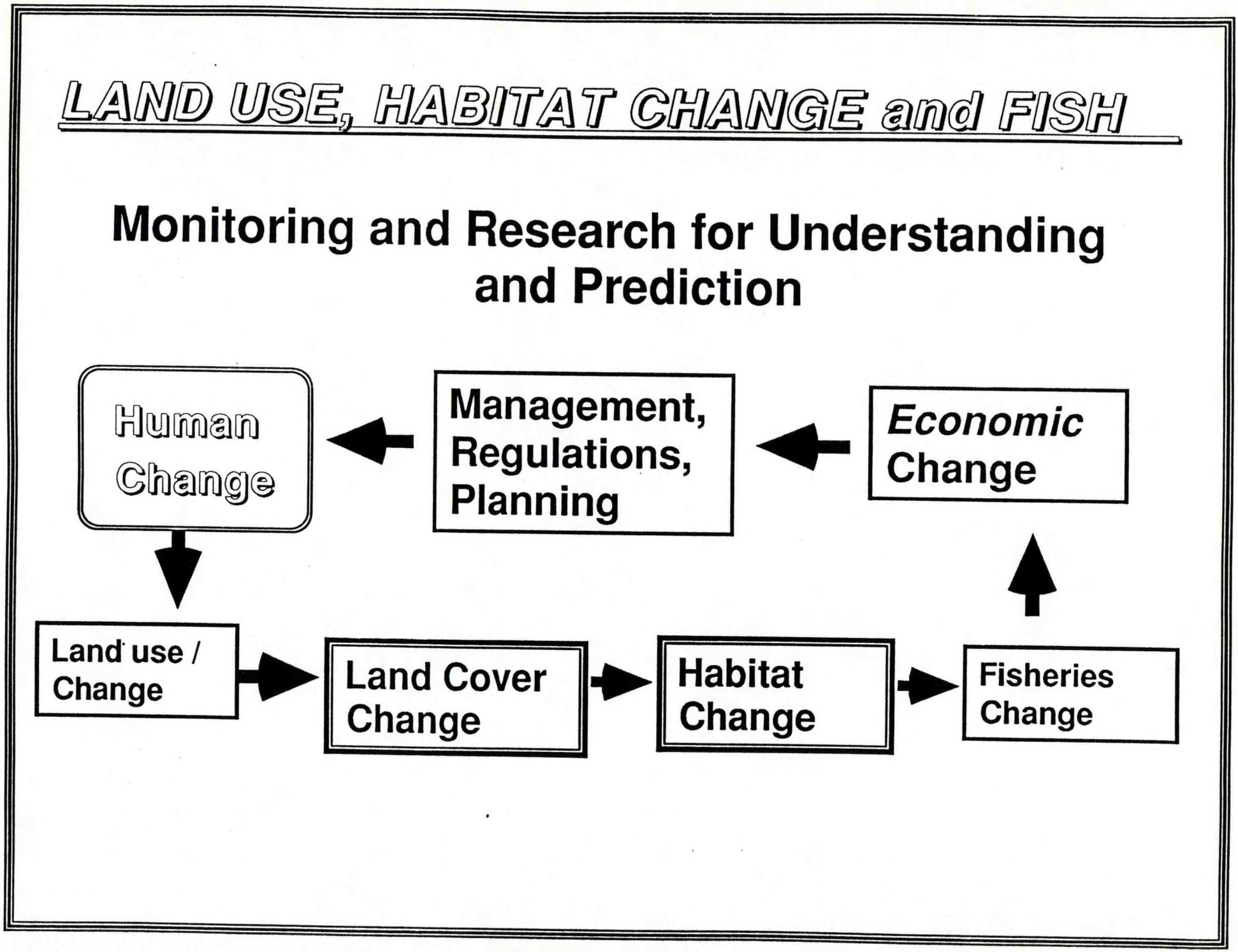
LAND USE, HABITAT CHANGE and FISH
Monitoring and Research for Understanding and Prediction
Human Change
Management, Regulations, Planning
Economic Change
Land use / Change
Land Cover Change
Habitat Change
Fisheries Change

Figure 4

LAND USE, HABITAT CHANGE and FISH

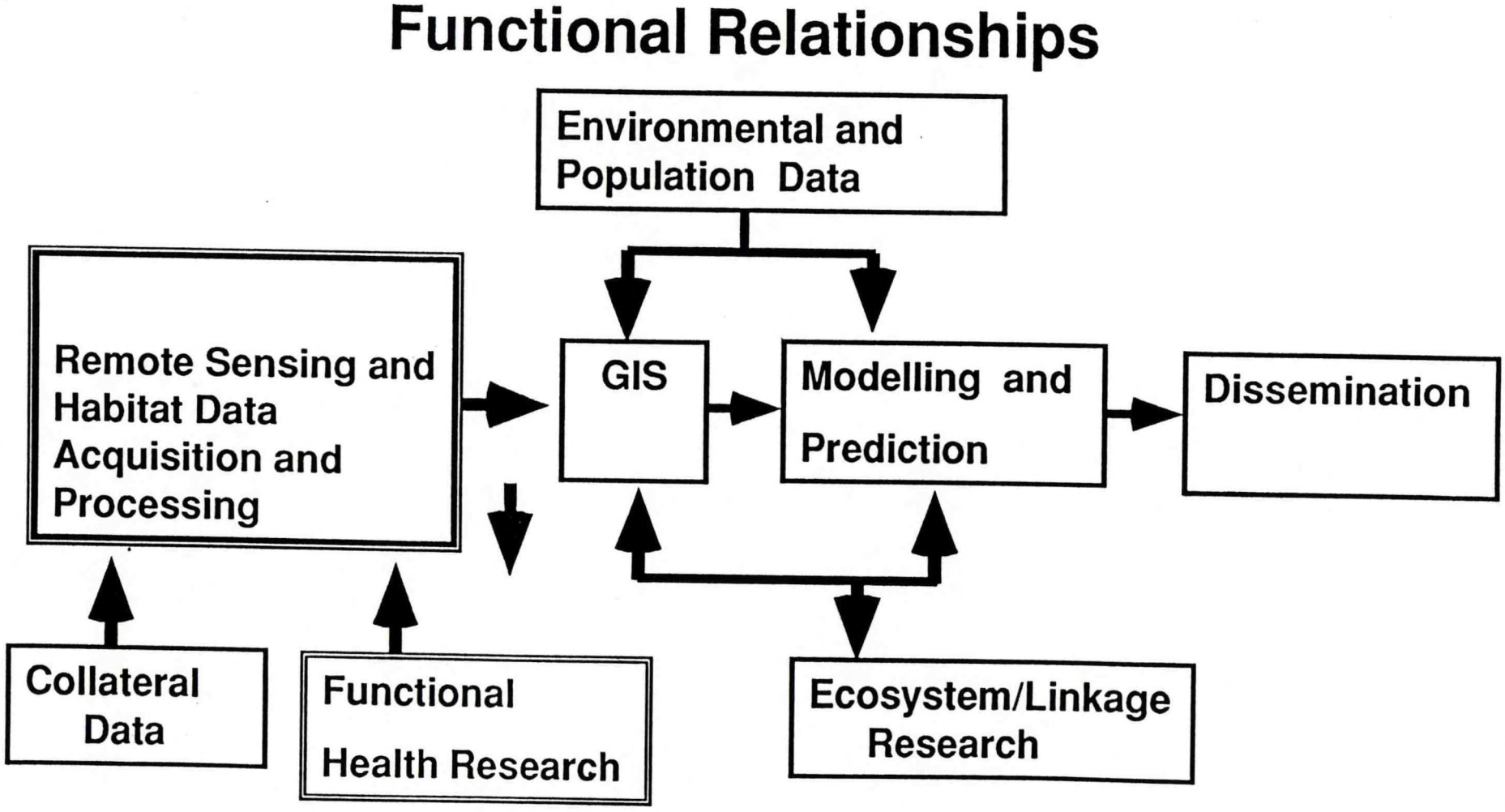

Figure 5

FUNCTIONAL COMPONENTS OF NOAA COASTWATCH

Functional components of NOAA CoastWatch are identified as well as NOAA Line Offices which have indicated a willingness to participate in development and operations. Other LO involvement will be encouraged. More detailed task plans are being developed which identify schedules, responsibilities and funding requirements.

Research and Applications Development

Research and applications development activities supporting NOAA CoastWatch will be coordinated by the NESDIS, NMFS and NOS. These efforts will help to assure the availability of new and improved products and systems, validation techniques, and coastal circulation models. Proposed tasks include:

(1) Assessing NMFS and regulatory agency data and product requirements,
(2) Development of algorithms, testing, and/or validation for full-resolution AVHRR mapping, remote sensing of SST turbidity, and estuarine algal blooms, navigation improvement, high resolution field analysis, cloud and aerosol detection, wind transport, wave height, circulation modeling, ocean color, phytoplankton biomass, total suspended matter, and transparency,
(3) Development of techniques for integration of satellite, aircraft, in-situ, climatological, meteorological, and modeling data for environmental decision making (see also other parts of the Coastal Ocean Program implementation plans),
(4) Development and trial production of sample products to better define user requirements,
(5) Validation of regional CoastWatch products, including the analysis and tracking of time-series records of comparisons of satellite and in-situ measurements and climatological anomalies,
(6) Development of a Marine Optical Buoy System for calibration/validation of ocean color measurements (see also other parts of the Coastal Ocean Program implementation plans, and
(7) Development of cooperative activities with appropriate universities and state and federal agencies to allow electronic sharing of innovations in satellite data navigation, validation, data storage using optical disk technology, electronic data distribution, and product processing.

Automated Product Production

NOAA CoastWatch automated product development and operations will be coordinated by the NESDIS, NMFS, NOS and NWS. Proposed activities are:

(1) Development of software to download, display, overlay, manipulate, and analyze the data and products for each CoastWatch area,

(2) Implementation of algorithms developed by researchers,
(3) Provision of training on the PC based CoastWatch workstation to field personnel,
(4) Update CoastWatch workstation software at all CoastWatch sites to make the latest techniques available to all,
(5) Conduct prototype operations with field sites to better determine suitability of PC analysis techniques for environmental decision making,
(6) Development, implementation, and maintenance of automated production of 2 km SST observations and 3.5 km SST objective analysis fields for the U.S. coasts,
(7) Development and operational production of full-resolution mapping of AVHRR data for the CoastWatch regions,
(8) Operational implementation and maintenance of derived products such as SST, turbidity, estuarine algal blooms, etc. using mapped AVHRR data,
(9) Development of a high-resolution (500 m) land/sea tag data base and a high-resolution (300-600 m) coastpoint file for the U.S. coastal zone for use in high-resolution AVHRR mapping and SST objective analysis production,
(10) Establishment and maintenance of the on-line rotating magnetic disk data bases of data and products for on-line access,
(11) Implementation and maintenance of surface wind and other meteorological data bases,
(12) Automate wind drift, Ekman and ship drift charts, and
(13) Develop improved methods of navigating satellite data with a goal of achieving 1-2 km navigation accuracy.

NOAA Ocean Communications Network

Development of the NOCN for use by NOAA CoastWatch will be undertaken by: NESDIS, NMFS and NOS. These organizations will coordinate the use of NOCN by NOAA CoastWatch. Funding for NOCN and a more complete discussion of the network will be found in the Coastal Ocean Program - Data and Information Transfer.

NOCN will provide dedicated communication lines operating at 9.6 to 56 Kbps to the on-line data bases, using Ethernet technology with the TCP/IP protocol. In most cases, a Time Sharing Option (TSO) connection will also be necessary using normal telephone lines operating at 1200 bps. This latter connection will be used for catalog queries and for initiating data transfers via the Ethernet.

Data and data products will be electronically routed to CoastWatch field sites via the proposed NOAA Ocean Communications Network (NOCN) (see Figure 6). This network will provide the wide-area communications network to interconnect the NMFS regional telecommunications network(s) with other components of NOAA. The integrated data networking of NOCN facilitates the near real-time acquisition and redistribution of marine weather observations and physical oceanographic measurements, as well as access to analyses, forecasts, and image products. The use of industry standard DECnet-Ethernet-TCP/IP communications protocols allows exchange among disparate computer types and database systems, such as the Climate Analysis Center's (CAC) Apollo computers, the OPC/COAP microVAX's and PC computers, the NCCF and the NESDIS Central Environmental Satellite Computer System (CESCS) IBM mainframe computers, and the NWS National Data Buoy Center's (NDBC) Data General superminicomputer. High-speed Ethernet communications links are also provided through OPC and CAC for access into the NASA Space Physics Applications Network (SPAN), which is interconnected with NSF-Net and allows NOCN users to exchange data sets with universities and other government scientists around the world in near real-time.

OCEAN SYSTEMS DATA CONNECTIVITY

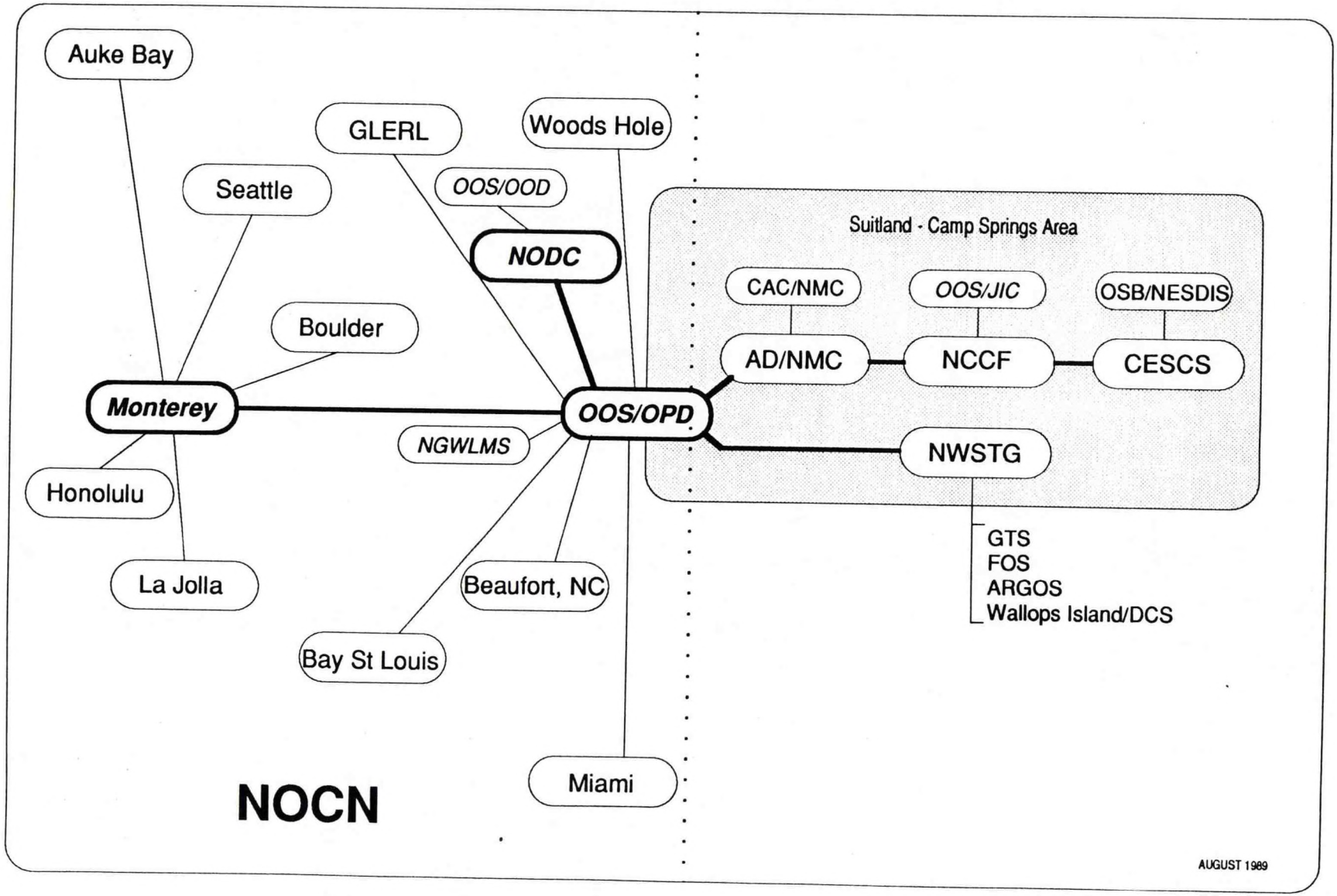

Figure 6

Archive System

Development of the NOAA CoastWatch Archive System will be achieved through the coordinated efforts of NESDIS, NOS and NMFS. Local archive systems for data and products from the Coastal Ocean Program will be the responsibility of investigators undertaking the observations and analyses.

Two major tasks are proposed comprising the Archive System:

1. **Online retrospective archive.** The system will be available to NOAA CoastWatch participants and will contain CoastWatch imagery, meteorological data/products, and in situ data.

2. **Management of in situ data.** In situ data generated by other components of the NOAA Coastal Ocean Program will be accessible locally by the responsible investigator, or centrally through NODC. Procedures, hardware and software will be developed to track program data and assure its availability.

Land Use, Habitat Change and Fish

Development of the Land Use, Habitat Change and Coastal Resources component of NOAA CoastWatch will be undertaken by NMFS, OAR, NOS and NESDIS. At least five steps are involved in developing the Land Use, Habitat Change and Coastal Resources functional area:

1. **Establish an operational protocol.** Methods will be selected which will be valid for all regions and be able to handle the various types of land remote sensing data. The protocol will establish a uniform basis for classification from scene to scene, and thereby allow intercomparison of two or more different scenes or regions. The protocol will also include ground truth procedures. The establishment of an operational protocol (including software development) will be a one-time cost, involving representatives from each region, and once established the protocol will be shared by all.

2. **Provide methodologically uniform documentation of habitat vegetation cover, land cover or coastal water type.** The derived products will consist of tables listing areal coverage (hectares) by state, county and hydrologic unit for each classified land/habitat cover type. Color enhanced, geocorrected and registered imagery will be used to produce maps denoting each classified type along with state, county or hydrologic boundaries. These maps will be at a 1:250,000 scale. Data, however, for all areas will be retained at full pixel resolution. Thus, finer scale maps (1:24,000) could be produced for selected areas.

3. **Determine change in areal coverage of each classified type.** The derived products will consist of tables listing change (hectares) for each classified (identified) type by state, county and hydrologic unit. Additionally, pixel by pixel intercomparison of the same path,

row scene (geocorrected and registered) from two different times will be accomplished to delineate specific changes. These changes will be presented as geocorrected and registered maps (1:250,000 scale). Data for all areas will be retained at full pixel resolution. Thus, finer scale maps (1:24,000) could be produced for selected areas.

4. **Determine biomass, productivity and health status and change.** Step 3 above determines whether a land/habitat cover type is present or absent. Step 4 provides the data base that will allow determination of biomass, productivity, and health (i.e. functional status) of wetlands habitat using remote sensing. In this way large areas could be evaluated and assessments made more quickly and easily. The step requires ground based research to relate remotely sensed spectral radiances to biomass, productivity and functional health. This work is particularly related to the Estuarine Habitat Studies Section of the Coastal Ocean Program in which the functional values of critical fisheries habitats are considered. It is anticipated that research will be conducted in each region of the country to establish the relationships.

5. **Determine the impact of land/habitat cover change on coastal resources.** This is a difficult task requiring the cooperative research and interaction of personnel engaged in the processing of the remotely sensed imagery, geographical information and analysis systems (GIS), and modeling, as well as wetland and estuarine ecologists and fishery biologists. The results feed directly into conceptual and predictive models, and for assisting habitat conservation and Federal and state decision making, particularly for long-range regional planning.

NOAA CoastWatch Enhancements (FY 91 and beyond)

Enhancements to NOAA CoastWatch include the development of new observational methodologies (e.g., satellite ocean color and SAR) as well as new geographic areas. These additions are subject not only to successful budget initiatives presently submitted for consideration in the FY 91 budget cycle, but also on negotiations between NASA and the private sector for development and launch of an ocean color instrument and with the European Space Agency for access and use of SAR and Low Bit Rate data from ERS-1.

Ocean Color

An ocean color instrument (originally Sea Wide Field Sensor (Sea-WiFS) is planned for launch in the early 1990s to provide direct-readout observations of ocean color at approximately 1 km resolution and global observations at 4.5 km resolution. It is proposed in FY 91 to begin development of the direct read out capability by providing a data acquisition capability for U.S. coastal regions. This data acquisition system will have broad application throughout the Coastal Ocean Program, including CoastWatch.

Using a combination of visible and near-IR data acquired from the ocean color instrument and in-situ data from a network of optical buoy systems, apparent optical properties, phytoplankton biomass, and total suspended matter, will be derived. These parameters, when appropriately analyzed, can be useful to CoastWatch as indicators of:

(1) fronts, eddies, coastal currents, and other mesoscale oceanographic features
(2) ocean dumping activities
(3) oil spill locations
(4) the presence of red tide
(5) optimum ship routes
(6) hazards to oil drilling operations
(7) productivity
(8) water quality (optical)

Data will be gathered by direct readout stations on both U.S. coasts, processed regionally and then centrally into products, and made available to CoastWatch workstations. Two options can be pursued: (1) HRPT data would be received at three NOAA sites, the NOAA Command and Data Acquisition (CDA) station in Fairbanks, Alaska, the Center for Ocean Analysis and Prediction (COAP) in Monterey, California, and at the NOAA CDA at Wallops, Virginia (Figure 7). A second option in cooperation with NASA would add additional ground stations, perhaps at the University of Miami, the Scripps Institution of Oceanography, and in Canada at Dalhousie University, Halifax, NS. For both options, NOAA will furnish the data communications system using the NOAA Ocean Communications Network (NOCN) and portions of the TIROS-N DOMSAT communications system. Raw data and locally processed

Ocean Color: Satellite Data Acquisition

NOAA option

Figure 7

products will be transmitted to Suitland, Maryland for further central processing and forwarding to the CoastWatch network.

Eventually, as operational capabilities are developed, ocean color products will be available within hours of readout from the satellite. Initially, however, satellite derived ocean color will likely be available only after approximately ten days after readout and only supporting research applications. The development of products, prototype operations, image workstation display development, operational implementation of products and communication will follow the procedures set up for CoastWatch water products.

A key aspect of the CoastWatch ocean color systems is the availability of data from a Marine Optical Buoy System. Consistently accurate conversion of ocean color raw data into biological parameters requires the near real-time availability of optical measurements from an in situ system. Development will be completed for the prototype of a buoy system capable of measuring, among other things, optical properties of the ocean and telemetering them via the GOES Data Collection System to the NESDIS central processing facility. The buoys will be untended; however, periodic servicing is required to maintain the accuracy of the optical measurement system. See also other Coastal Ocean Program for further details of coordination and development.

Synthetic Aperture Radar

The FY 91 launch of the European Remote Sensing (ERS-1) satellite will make routine Synthetic Aperture Radar (SAR) data available for the first time since SEASAT in 1978. One of the most important applications of SAR data is the monitoring of sea ice. With the SAR's 30m resolution, ice-edge, lead, concentration, and iceberg locations will be much more accurate than can be obtained with the 1.1km AVHRR. The SAR can also view ice through clouds and allow discrimination between first year and multi year ice. The ERS-1 SAR will be followed by a Japanese SAR in 1992 and a Canadian SAR in approximately 1994. Data from these three satellites will be read out and processed at a new Alaska SAR Facility (ASF) being built by NASA at the University of Alaska in Fairbanks. In addition, Canada will produce analyses from data received from its Gatineau ground station, with coverage including the Great Lakes. Because of the utility of these data for ice analyses, the NOAA - Navy Joint Ice Center proposes to conduct an operational demonstration of the utility of SAR data from these various sources to U.S. ice analysis and forecasting activities.

Specific applications include:

- Provide SAR data and analyses to the JIC for improving operational ice products, for directing ship operations, for calculation of ice motion vectors, and to guide oceanographic data gathering activities along the ice edge for the Arctic and Great Lakes,

- Study the role of the Bering and Chuckchi Sea ice in controlling Arctic ecosystems,

- Make SAR data available to NOAA and the Navy to assess other applications of SAR data, such as monitoring swell height and direction and detecting the presence of internal waves.

NOAA has agreed to share with the Navy the cost of augmenting the NASA ASF to allow near real time access by NOAA to SAR data for ice analyses in Alaskan and Arctic waters. Hardware will be installed at the ASF to capture, compress, and store high resolution (30m) and low (240m) resolution SAR data. Communications will be established between the ASF and the NOAA Fairbanks Command and Data Acquisition (CDA) station. The existing NOAA TIROS-N DOMSAT link will be used to forward the data to the Joint Ice Center in Suitland, MD. A image workstation will be installed at the JIC to analyze the SAR data and generate products for NOAA/Navy and other applications demonstrations.

In addition, the JIC and its Canadian counterpart will share the cost of installing and maintaining a communications link to exchange ice data and products derived from data sources that the Center is not capable of receiving. This will allow the JIC to access analyses and products derived from space-borne SAR data not received by the

Fairbanks ground station (e.g., Great Lakes coverage), as well as aircraft-borne SAR and SLAR flights conducted by Canada (e.g., Great Lakes and eastern U.S. seaboard). This access requires equipment and software to connect work stations to the current JIC interactive display equipment (DIFAS), as well as outyear software and training support.

Additional NOAA CoastWatch Regions

Work for each CoastWatch region will concentrate on establishing capabilities for monitoring and evaluating the impacts of unusual environmental events on west coast fisheries. The most notable example of an anomalous environmental event that affects west coast ocean waters is the El Nino. This large-scale event occurs at varying time intervals and with varying intensities and impacts on west coast fisheries. Red tide outbreaks also take place occasionally at diverse locations along coastal areas of the United States.

Support will be provided to Federal and state regulatory agencies offering information they need to make environmental systems management decisions. There will also be a heavy research component to the activity. Efforts in this area will capitalize on capabilities and experience of NOAA Fisheries available on the west coast and take advantage of the lines of communication that exist among NOAA Fisheries and other Federal and state regulatory agencies.

Satellite remote sensing data will be emphasized, along with in situ data, in research efforts and in environmental information disseminated to agency users. Near real-time NOAA satellite AVHRR temperature data and ocean color data, will be employed in research and in monitoring and generation of information for users. Archived AVHRR, Coastal Zone Color Scanner (CZCS) ocean color, and scatterometer (SASS) ocean data will be utilized in research activities.

Research will center on applying satellite remote sensing technology to understand the affects of varying ocean conditions on west coast fishery resources. Case studies will be conducted on selected groundfish and coastal pelagic species and will emphasize quantitative evaluation of environmental change on fishery resources. Research will develop uses of both current and archived, historical fishery and environmental data. Field studies will help test findings. Satellite data will play an important role in planning and guiding field study operations on vessels at sea.

Geographic areas under active consideration for becoming CoastWatch sites in FY 91 and beyond are on the West Coast, the Northeastern US, the Great Lakes, Alaska, and Hawaii (Figure 2).

Land Use, Habitat Change and Fish

During FY 91 protocol development and testing will be completed. Supporting research relating the functional health (biomass, productivity) of wetlands to the spectral radiances observed via satellites will be continued. Areas for enhancement include:

1. Funding to accelerate land cover/habitat change analyses through the purchase of data tapes for two time periods for the Gulf and Atlantic Coasts of the U.S. The Wetlands Policy Forum recommends that change analysis be accomplished every 1 - 2 years. In order to meet our proposed schedule of every 2 - 5 years (5 years initially) we must be able to purchase the data for two time periods in one year rather than several. After the first cycle of change analysis the program will purchase data for only one time period to compare with the previous data sets. A cost savings to the program will occur in out years.

2. Addition of aerial photography to determine change in area of seagrass beds in coastal waters (initially North Carolina). Seagrass beds not only are critical fisheries habitats, but also they are changing rapidly in many coastal areas. Low altitude aerial photography from aircraft appears to be the best way to track these beds. We propose this approach on a graduated scale beginning with North Carolina. Tests between satellite and low-altitude aircraft collected data will be accomplished to determine the best method (including costs) for our interests.

3. Start-up for data integration and analysis required to link human development in the coastal zone to fisheries resources in the coastal ocean. What has not been accomplished is the integration or linking of demographic patterns and human activities in the coastal zone through fisheries habitat to estuarine and coastal ocean fisheries and resultant economics. To do so requires the cooperative efforts of wetland ecologists, fisheries biologists and others, both within and outside NOAA, to integrate diverse data sets (i.e., from demographic patterns, land use, waste loads and physical habitat modifications; to fish biology, growth, reproduction and recruitment; to estuarine and coastal ocean fisheries and their economics). These data sets must be entered into an interactive analysis and/or geographical information and analysis system. The output will be used to develop models to assess present status and predict future trends in fisheries resources based on changing demographics, land use and fisheries habitats. Regional Fisheries Management Councils, land use planners, economists, and environmental managers will use of this information.

PROGRAM MANAGEMENT AND REVIEW

A. Program Management

Specific technical and scientific guidance for NOAA CoastWatch should be provided by the NOAA Coastal Council through a Steering Group comprised of LO representatives selected by the NOAA Assistant Administrators. The Coastal Council should provide general program direction, i.e., allocation of funds, and responsiveness to Coastal Ocean Program and agency requirements, but it should be the task of the Steering Group to assure a technically coordinated, and scientifically sound NOAA CoastWatch.

A Program Manager is required for day-to-day operations of NOAA CoastWatch including program development. He/she should be an employee of one of the participating Line Offices and involved in one of the functional components of CoastWatch. The Program Manager ultimately should be responsible to the Coastal Council for development and operations of NOAA CoastWatch, but with specific oversight provided by the proposed Steering Group.

Subject to Council approval, responsibility for development and operations of CoastWatch functions will be assigned to designated NOAA Line Offices.

B. Program Evaluation and Review

Program tasks supporting functional areas described above will be approved and funded on the basis of written proposals of a quality to withstand peer review. Tasks will generally describe activities expected to be of one to two years in duration and can be undertaken by NOAA, other governmental, academic, or private activities. Review of selected NOAA CoastWatch components will be undertaken at least annually; external program reviews of the complete program should be conducted regularly.

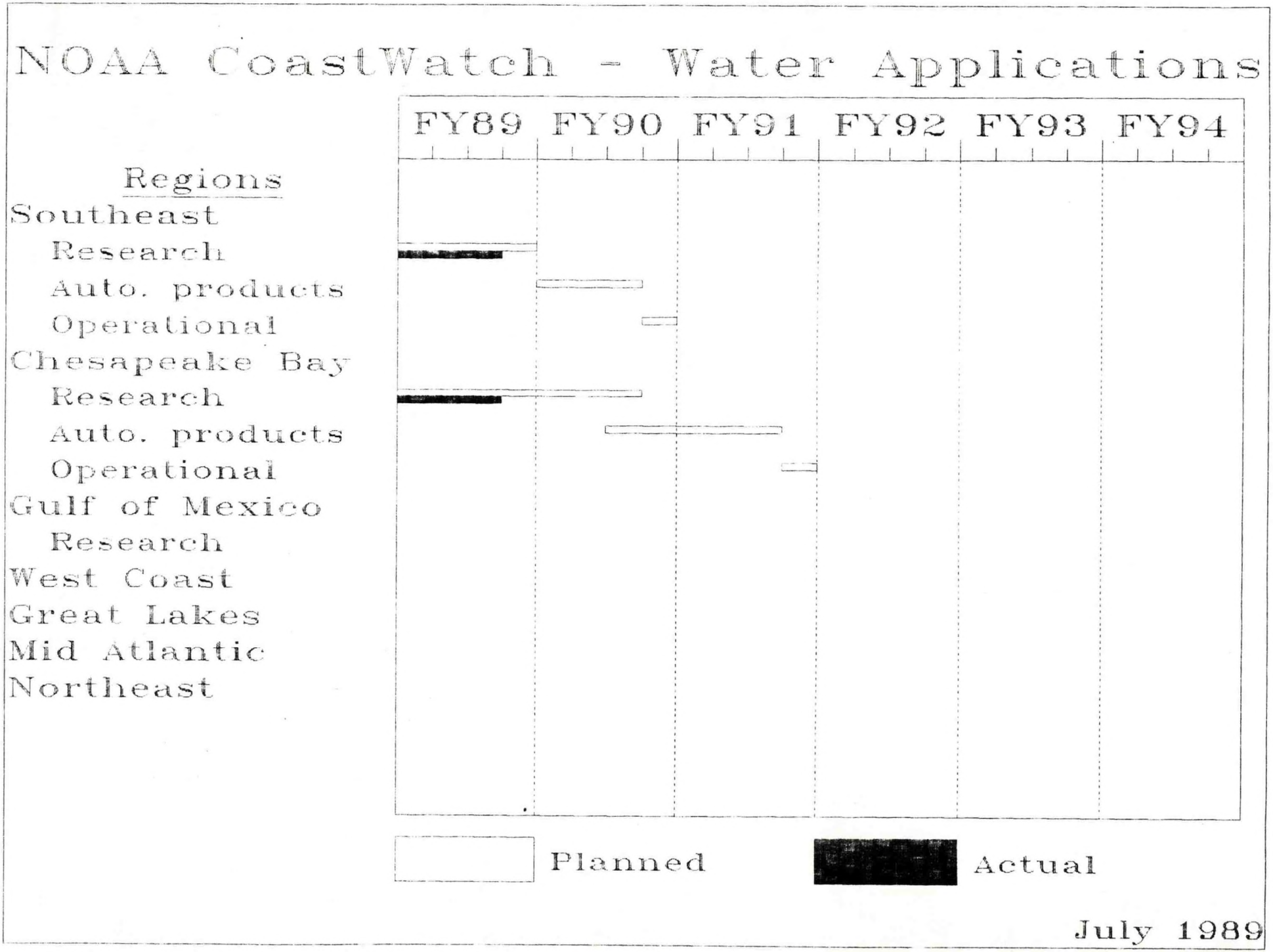
NOAA CoastWatch - Water Applications
FY89
FY90
FY91
FY92
FY93
FY94
Regions
Southeast
Research
Auto. products
Operational
Chesapeake Bay
Research
Auto. products
Operational
Gulf of Mexico
Research
West Coast
Great Lakes
Mid Atlantic
Northeast
Planned
Actual
July 1989

Figure 8

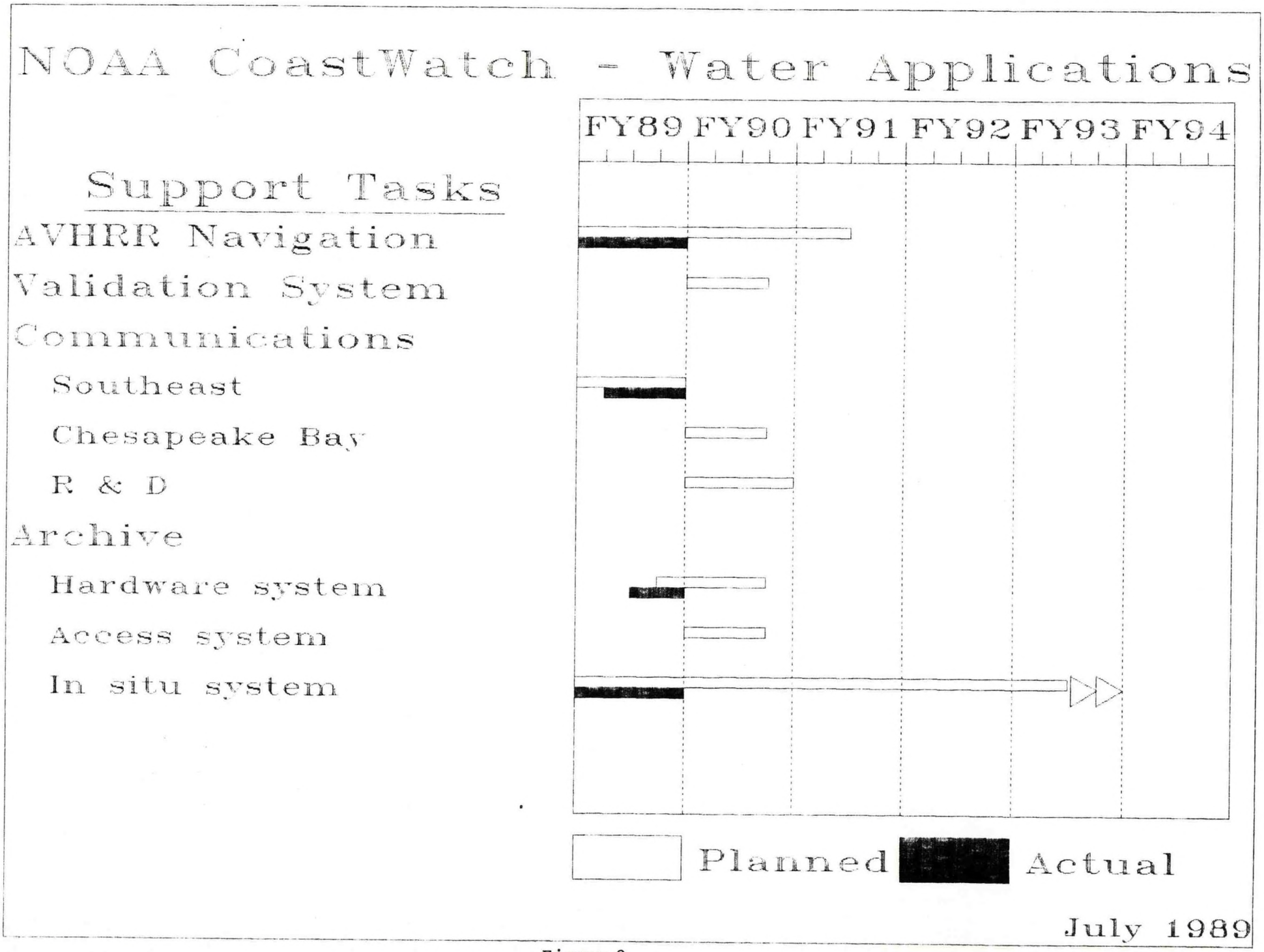
NOAA CoastWatch - Water Applications
FY89 FY90 FY91 FY92 FY93 FY94
Support Tasks
AVHRR Navigation
Validation System
Communications
Southeast
Chesapeake Bay
R & D
Archive
Hardware system
Access system
In situ system
Planned
Actual
July 1989

Figure 9

Land Use, Habitat Change and Fish

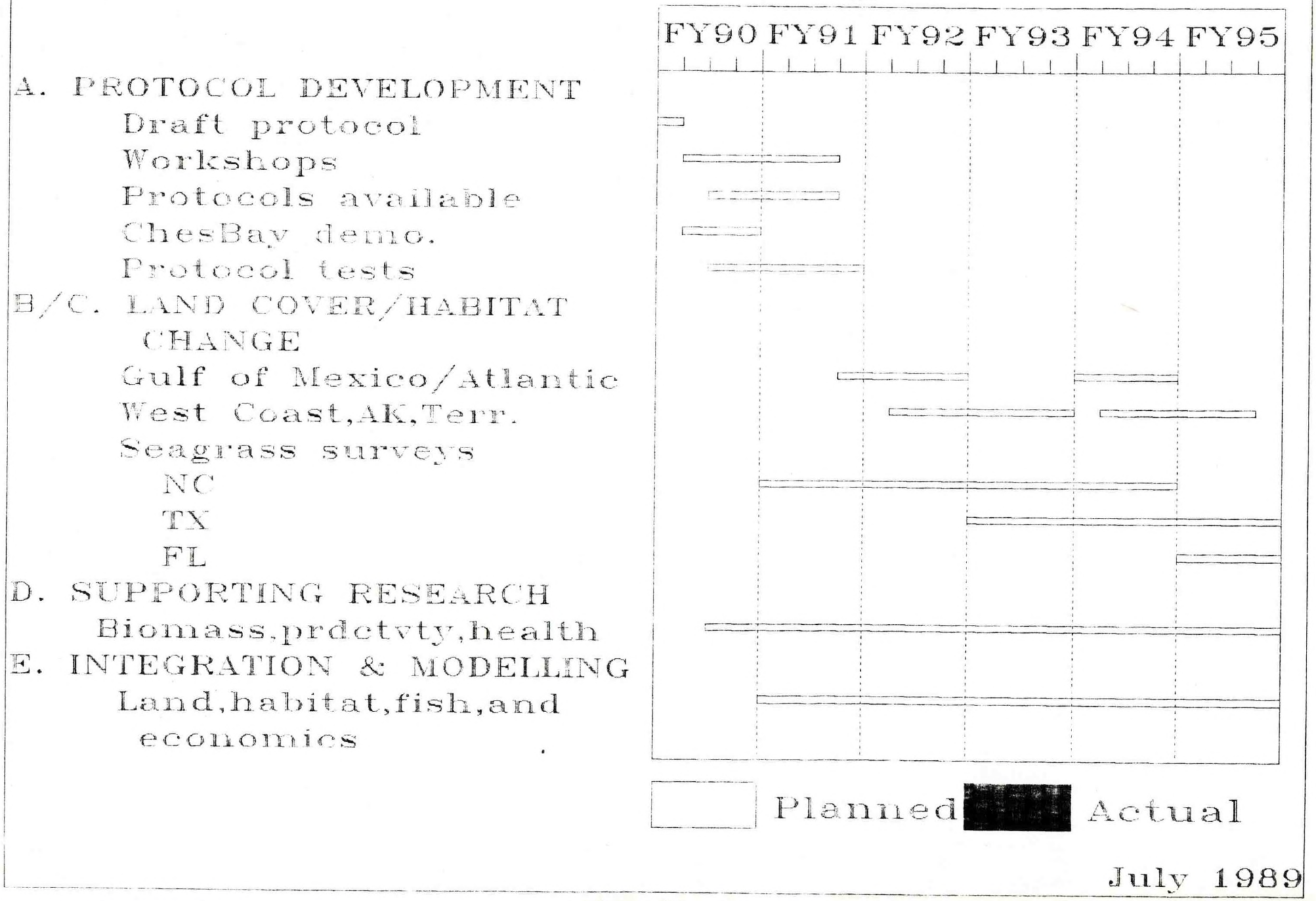

Figure 10