



Earth System MONITOR



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A Guide to NOAA's Data and Information Services

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Global Climate Perspectives System to Monitor Climate Change

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Global greenhouse warming has been a steadily growing issue during the 1980s and 1990s. The drought of 1988 brought the subject of climatic change painfully into focus in the United States, while statements by world leaders at the 1989 Paris Economic Summit drew international attention to the need for global monitoring. NOAA's response to these issues, articulated by NOAA Under Secretary John Knauss' call for a system of "leading environmental indicators", emphasized the need for an organized and coordinated monitoring and assessment mechanism using timely, reliable, and consistent information on the state of change in the environment. The Global Climate Perspectives System (GCPS) is being developed to meet these needs.

Supported by the NOAA Climate and Global Change Program, the GCPS is a coordinated project involving groups within three major NOAA components: the National Environmental Satellite, Data, and Information Service (NESDIS),

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the National Weather Service (NWS), and the Environmental Research Laboratories (ERL) of the Office of Oceanic and Atmospheric Research. The Global Climate Laboratory at the NESDIS National Climatic Data Center (NCDC) in Asheville, N.C., is the lead center and will manage the data base and develop long-term datasets. The NWS Climate Analysis Center (CAC), in Suitland, Md., will provide current monthly station data from the GTS collective to update the GCPS in a near-real-time mode, while the

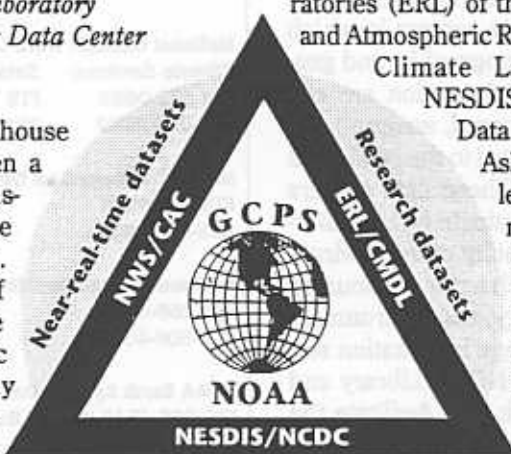
Climate Research Division within the ERL Climate Monitoring and Diagnostics Laboratory (CMDL), in Boulder, Colo., will develop some of the research datasets from the GCPS data base.

Global Historical Climate Network

The GCPS data base will initially consist of a global surface-based research-quality baseline dataset called the Global Historical Climate Network (GHCN). The GHCN, being developed by NCDC with financial support from the Department of Energy, is an integrated station data base containing all existing monthly data available at NCDC, research collections provided by other investigators, and several national datasets (including previously unavailable data from the USSR, China, and Mexico).

Since there will be some duplication between source datasets, a data quality

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NOAA's New Deputy Assistant Administrator for Environmental Information Services

Gregory W. Withee is NOAA's new Deputy Assistant Administrator for Environmental Information Services. NOAA established this position within the National Environmental Satellite, Data, and Information Service (NESDIS) on July 20, 1991, to provide a NOAA-wide focus for data and information management, make more efficient use of existing resources, and address changing mission requirements imposed by new NOAA-wide initiatives, including the Climate and Global Change, Coastal Ocean, and Data and Information Management Programs. Greg formerly served as the Director of the NESDIS National Oceanographic Data Center.

The new Deputy Assistant Administrator will support the Assistant Administrator for Satellite and Information Services—Thomas N. Pyke, Jr.—in planning, developing, coordinating, and managing NOAA's diverse system of data and infor-

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and
Atmospheric Administration

NEW NODC TELEPHONE NUMBERS



New telephone numbers are now in service at the main offices of the National Oceanographic Data Center located in the Universal South Building, 1825 Connecticut Avenue, NW, Washington, DC 20235. Please note that the 3-digit exchange for commercial calls (606) is now different from the exchange used for FTS (266).

All customer requests for NODC data services should be directed to the User Services Branch listed below.

Office of the Director

..... 202-606-4594
..... FTS 266-4594

Deputy Director

..... 202-606-4596
..... FTS 266-4596

User Services Branch

..... 202-606-4549
..... FTS 266-4549

World Data Center A for Oceanography

..... 202-606-4571
..... FTS 266-4571

Ocean Pollution Data and Information Network

..... 202-606-4539
..... FTS 266-4539

Data Acquisition and Management Branch

..... 202-606-4643
..... FTS 266-4643

NODC Fax

..... 202-606-4586
..... FTS 266-4586



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mation centers. He also will be responsible for developing and managing the NOAA-wide data and information management program that builds on the activities of all NOAA line offices and programs, and has strong links to other agencies and international organizations. In this capacity, the Deputy Assistant Administrator for Environmental Information Services will advise and assist the Under Secretary/Administrator on NOAA-wide matters related to data and information management.

Greg will coordinate the operation of NOAA's national data centers in which climatological, oceanographic, and geophysical data and information are collected, processed, stored, analyzed, applied, and disseminated to the public and specialized users. These data centers assemble and disseminate NOAA information on the variability of the environment as it affects such natural resources as agriculture, energy, and environmental quality, and manage information services, including the NOAA Library and Information Network, that facilitate the dissemination of scientific and technical information.

Recognizing the need for agency-wide coordination of NOAA's data and information services, Greg leads a team of representatives from all NOAA's line offices and cross-cutting program offices. This team is developing and implementing plans to rescue endangered environmental data and make all of NOAA's data and information easily and readily accessible.

In the next issue of the *Earth System Monitor* we will present a more extensive article on plans and activities of the new Deputy Assistant Administrator's office.

- Capt. Carl W. Fisher
Office of Environmental
Information Services
NOAA/NESDIS Ex2

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Office of Environmental Information Services
NOAA/NESDIS Ex2
Universal South Building, Room 517
1825 Connecticut Avenue, NW
Washington, DC 20235

HELPLINE:

National Climatic Data Center (NCDC)

Climate Services: *Satellite Services:*
FTS 672-0682 FTS 763-8399
704-259-0682 301-763-8399

National Geophysical Data Center (NGDC)

FTS 320-6958
303-497-6958

National Oceanographic Data Center (NODC)

FTS 266-4549
202-606-4549

NOAA Earth System Data Directory

FTS 266-4548 (Gerald Barton)
202-606-4548

FTS 266-4636 (Douglas Hamilton)
202-606-4636

NOAA Central Library

Reference Services:
FTS 443-8330
301-443-8330

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U.S. DEPARTMENT OF COMMERCE

Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration

John A. Knauss, Under Secretary
and Administrator

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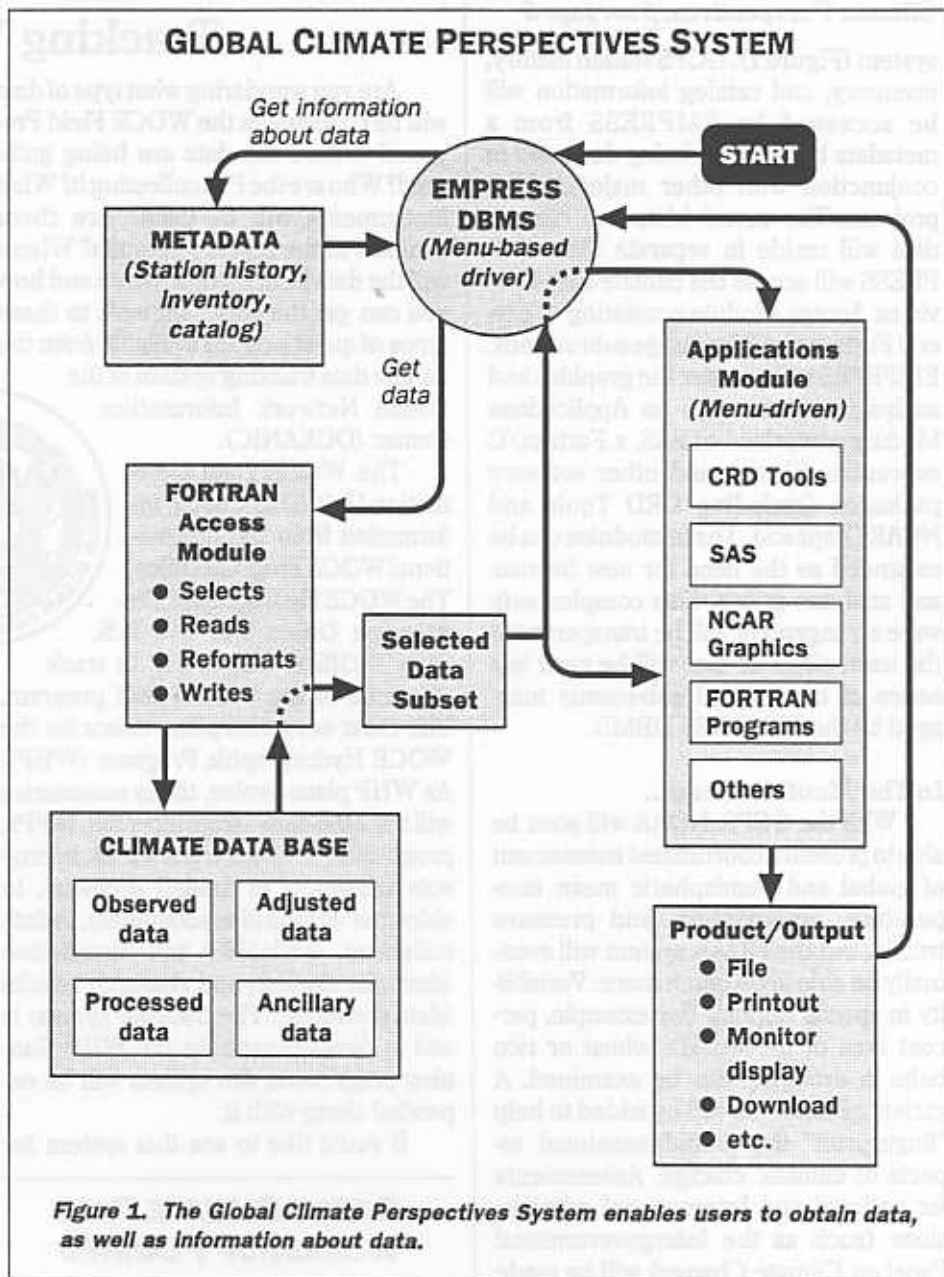
assessment algorithm is being used to select the "best" value from the duplicate stations for those year/months where multiple values exist. The duplicate elimination algorithm uses robust statistics and the spatial analysis of scalar fields, as well as an *a priori* assessment of the data quality of each source dataset. Nearest neighbor multiple regression (NNMR) estimates are calculated for each observed value. These NNMR estimates and the 95% confidence interval are used to express our confidence in the observed value, with the NNMR equation's explained variance being used to assess our confidence in the estimated value.

The GHCN data consist of year-monthly mean temperature, total precipitation, station pressure, and sea level pressure. Historical monthly COADS (Comprehensive Ocean-Atmosphere Data Set) gridded marine data will eventually be loaded into the GCPS data base. The system is being designed to incorporate additional parameters (e.g., snow data, ice cover, and upper-air data) and source datasets as they become available.

Bias Removal

Station history metadata and nearest neighbor comparisons will be used to identify data inhomogeneities. Adjustment algorithms developed by NCDC and ERL researchers and others will be used to remove biases caused by station relocations, changes in instrumentation, changes in observation practices, and changes in the surrounding environment (i.e., urban warming).

The station data will form the basis for several derived datasets. Monthly temperature, precipitation, and moisture anomaly index values will be calculated for a network of global climate divisions. A gridded dataset will be calculated from the station data, as well as values for special (e.g., agricultural, hydrological, ecological) regions. Several derived quantities (such as normalized temperature and precipitation, percent area of selected regions experiencing extreme temperature or moisture conditions) will be calculated.



GCPS Will Be User-Friendly and Functional

The GCPS will operate in a user-friendly menu-based environment on state-of-the-art SUN SPARC II workstations. A master menu will allow the user to perform one of five functions: display spatial information on maps, generate a time series graph, extract data for display or downloading to diskette, generate a climatological summary or perform some other statistical analysis, and update a dataset. Pull-down sub-menus will appear listing the choices allowed at each step of the process, with the choices depending

on the function being performed.

The user will decide how the data are to appear on the map or time series graph, and will also be able to use the map interactively to define special regions. Long-term mean lines, filters, and trend lines of various types will be available for time series plots, along with the appropriate regression statistics.

What The User Won't See

Beneath the menu overcoat, the entire system will be driven by EMPRESS, a commercial data base management

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Climate Perspectives, from page 3

system (Figure 1). GCPS station history, inventory, and catalog information will be accessed by EMPRESS from a metadata base that is being designed in conjunction with other major NCDC projects. The actual historical climate data will reside in separate files. EMPRESS will access the climate data base via an Access Module consisting of several Fortran and C language subroutines. EMPRESS will transfer the graphics and analysis operations to an Applications Module comprised of SAS, a Fortran/C subroutine library, and other software packages (including CRD Tools and NCAR Graphics). These modules can be expanded as the need for new formats and analyses arises. This complex software arrangement will be transparent to the user, since all that will be seen is a series of menus and sub-menus managed by the EMPRESS DBMS.

In The Months Ahead...

With the GCPS, NOAA will soon be able to present a coordinated assessment of global and hemispheric mean temperature, precipitation, and pressure trends. But the NOAA system will eventually be able to do much more. Variability in special regions (for example, percent area of the world's wheat or rice belts in drought) can be examined. A variety of elements will be added to help "fingerprint" the multidimensional aspects of climatic change. Assessments for national and international commissions (such as the Intergovernmental Panel on Climate Change) will be made more efficiently and conveniently. New climate reference datasets can be generated for the research community through the GCPS system and data base. And NOAA will be able to provide a more complete response to questions asked by national and international policy makers and the news media.

Development of the GHCN data base is nearing completion, while work on the software continues. It is anticipated that early in January 1992 we will be able to present a preliminary NOAA assessment of the 1991 annual global mean temperature. ■

Tracking WOCE Data

Are you wondering what type of data will be collected in the WOCE Field Program? Where the data are being gathered? Who are the PI's collecting it? What instruments will be used? Are there samples of the research results? Where will the data be archived? When and how you can get the data? Answers to these types of questions are available from the on-line data tracking system of the Ocean Network Information Center (OCEANIC).

The WOCE Data Information Unit (DIU), using information from the International WOCE Program Office, The WOCE Hydrographic Programme Office and the U.S. WOCE Office, has begun to track elements of the WOCE field program. The most advanced plans exist for the WOCE Hydrographic Program (WHP). As WHP plans evolve, these summaries will track the data—from inception (RFPs, proposals, proposed track lines), to projects (abstracts of funded projects), to ship time (ship cruise schedules), to data collection, availability and distribution (data directories), and research results (data products). The tracking system is still in development. As the WHP planning progresses, the system will be expanded along with it.

If you'd like to see this system for

yourself, you can easily access OCEANIC over several major networks or through direct dial. OCEANIC is available via:

- NSI-DECnet (formerly SPAN) (set host DELOCN/username: INFO),
- INTERNET (telnet delocn.udel.edu/username: INFO),
- OMNET (GOTO SONIC), or
- direct dial (up to 9600 baud) (302) 645-4204/username: INFO).

No password is required.

To view the tracking system maps on your terminal, your communication software must be able to emulate a Tektronics 4010 terminal.

The DIU is happy to provide public domain emulation software for MS-DOS machines to WOCE investigators who request it.

The WOCE field program plans are going through many revisions as the program reaches its final form. If you see errors or omissions on OCEANIC, or simply have questions or comments please contact Katherine Bouton at K.BOUTON/Omnet or call her at 302-645-4278.

- Katherine Bouton
WOCE Data Information Unit
College of Marine Studies
University of Delaware
700 Pilottown Road
Lewes, DE 19958 ■



OCEAN CLIMATE DATA WORKSHOP PLANNED

An international Ocean Climate Data Workshop is being planned for early 1992. The workshop will be held February 18-21, 1992 at the NASA Goddard Space Flight Center, Greenbelt, Md. The main purpose of the workshop is to begin discussions that may lead to the improved data delivery systems needed by scientists studying the ocean's role in climate change. The organizing sponsor is the Intergovernmental Oceanographic Commission, with support from other international scientific organizations.

The discussions will be structured around three main topics:

- The Past is Prologue to the Future (Convener: Sydney Levitus, USA)
- Monitoring Changes in the Ocean and Atmosphere (Convener: Ronald Wilson, Canada)
- Measuring the Effect of Change in the Ocean and on the Life Cycle (Convener: Mierion Jones, UK)

The workshop is intended primarily for those who are working on and planning ocean related climate projects.

For a copy of the preliminary conference brochure or for additional information, contact the National Oceanographic Data Center at 202-606-4571. ■

Media Mania: Workshop Ponders New Data Storage Alternatives

John Kinsfather
National Geophysical Data Center
NOAA/NESDIS

For many years archival data storage was synonymous with magnetic tape libraries. The quest for data media with greater data densities and longer lifetimes, however, has produced a host of new data storage alternatives. Although data managers have long recognized the

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shortcomings of magnetic tape for long-term data storage, the recent proliferation of competing media choices has complicated the search for a new standard.

To address this problem, on March 7, 1991, NOAA sponsored a workshop on data media alternatives that was organized by William Callicott of the NESDIS Office of Systems Development and hosted by the National Geophysical Data Center (NGDC), Boulder, Colo. The object of the workshop was to discuss alternative data storage media available now and to begin planning for new data storage media in the future. Among the 29

participants were representatives from the National Media Laboratory, the National Archives and Records Administration, the National Institute of Standards and Technology, the National Center for Atmospheric Research, NOAA's Environmental Research Laboratories, the Department of Commerce/Information Resources Management, the National Snow and Ice Data Center, and various elements of NOAA's National Environmental Satellite, Data and Information Service (NESDIS).

At the workshop, Bill Mularie,
—continued on page 8

MASS DATA STORAGE MEDIA COMPARED^(A)

MEDIUM	DRIVE COST	PRACTICAL MEDIUM CAPACITY (MB)	UNIT MEDIUM COST	PRACTICAL DATA FILE ACCESS TIME ^(B)	DATA THROUGHPUT RATE ^(B) (MB/min)	UNIT DUPLICATION TIME
MAGNETIC TAPE - 1/2" 1600 bpl	\$5 - 10K ^(C)	35 ^(D)	\$15	1 - 5 min	1 - 5	8 - 20 min
MAGNETIC TAPE - 1/2" 6250 bpl	\$10 - 20K ^(C)	120 ^(D)	\$15	1 - 5 min	1 - 5	20 - 50 min
IBM-3480 "SQUARE TAPE"	\$25K (2 drives + controller)	120 - 200 ^(D)	\$5	0.5 - 2 min	20 - 40	3 - 10 min
EXABYTE HELICAL SCAN 8 mm	\$3.5K	2,000	\$25 - 40 (certified)	10 min	1 - 15	7 - 12 hours
DIGITAL AUDIO TAPE (DAT) 4 mm	\$4.5K	1,000	\$20	2 min	1 - 5	3 - 6 hours
WORM OPTICAL - 5.25"	\$3K	200 - 300	\$120 (2-sided)	0.25 sec	2	1.5 - 3 hours
WORM OPTICAL - 12"	\$10K	2,000	\$345 (2-sided)	2 sec	4	<8 hours
BERNOULLI BOX - 8"	\$2.2K	10	\$89	0.5 sec	4.4	2.2 min
BERNOULLI BOX - 5.25"	\$2.8K	44	\$126	0.5 sec	4.4 - 6.3	7 - 10 min
ERASABLE OPTICAL - 5.25"	\$4 - 5K	580 - 620	\$190 (2-sided)	0.04 sec	6.6	2.2 hours
CD-ROM - 12 cm	\$0.4 - 0.8K	680	\$4.50 ^(E) (\$1.3K master, \$1.80/copy)	0.5 - 0.7 sec	3.5	None, copies made at mastering

(A) Manufacturer's specifications of system performance are often optimistic; values 20-50% lower are typical of actual operations.

(B) Access times and throughput rates vary depending on computers, system saturation, and make, model, and driver software for mass storage device.

(C) More expensive, higher speed 1/2-inch tape drives are available.

(D) Data storage capacity on both 9-track magnetic tape and IBM-3480 type tape depends on data file blocking size and number of inter-record gaps.

(E) Based on a run of 500 copies.

J. Allen © NOAA/NGDC

SEA's Colonial Seabird Desktop Information System

*Strategic Environmental Assessments (SEA) Division
Office of Ocean Resources
Conservation and Assessment
NOAA/NOS*



Colonial seabirds present the most visible evidence of the productivity of marine waters, and the status of their populations can provide valuable insights into the effects of natural and man-made changes on the marine environment. Seabirds are also useful in assessing overall environmental conditions, as their populations often indicate the presence of other marine species.

Over the past two decades, the Federal government has invested considerable resources in taking censuses of seabird populations throughout the coastal areas of the United States. The resulting data base, though rich with detailed information, has not been accessible to most research scientists and managers, and has not been in a form that can be combined easily with other coastal and marine data for planning, hazardous materials spill response, or scientific inquiry.

A Desktop System

To fill this information need, NOAA and the U.S. Fish and Wildlife Service began assembling a colonial seabird desktop system in 1989. The goal of this system was to give scientists, resource managers, and educators significantly greater access to an extensive and regularly updated data base. The desktop system, completed in March 1991, is part of the Strategic Environmental Assessments (SEA) Division's Computer Mapping and Analysis (*Cmas*) System (see box), and contains information on 45 seabird species in approximately 2,600 colonies along the west coast of North America and the northeastern Pacific coast of the USSR.

The West Coast of North America

Colonial Seabird Desktop Information System is a compact, easy-to-use product that operates on Apple Macintosh microcomputers. Within its simple selection environment, users can: 1) define analysis areas for designated species; 2) develop schematic maps and simple summations by species, month, and area; 3) select combinations of species and attributes for time-series histograms or tabular summaries; and 4) compute ratios and other comparisons for specified sub-areas of previously stored maps.

Seabird Information

Data sources are provided within the system, as is information on species' life history and breeding characteristics. Each life history file contains species-specific information including adult weight, clutch size, fledging success, and feeding methods. Time periods for specific breeding activities (laying, hatching, and fledging) are included for 11 biogeographic regions.

The inclusion of temporal information allows users to determine the presence of a specific life stage of any species at a given colony during a certain time period. It also allows the data base to be

NOAA's Strategic Environmental Assessments Division

The Strategic Environmental Assessments (SEA) Division of NOAA's Office of Ocean Resources Conservation and Assessment (ORCA) was created in response to the need for comprehensive information on the effects of human activities on the nation's estuarine and coastal ocean regions, including the U.S. Exclusive Economic Zone. SEA performs its strategic assessments to quantify the environmental impacts on these vital resources over space and time. The purpose is to identify strategies for balancing resource development and conservation for maximum benefit to the nation with minimum environmental damage and conflict among users.

As the volume of information on such resource uses and environmental impacts increases, decisionmaking becomes more complex, and more sophisticated methods are required for data management and analysis. The SEA Division is meeting this need through the continued development of data base information systems. These systems, which combine commercially available software with custom-designed applications, collect and organize information from diverse sources, and run on both mainframe and microcomputers. They range from simple spreadsheets to complex mapping and analysis systems.

The SEA Division's information systems have been developed and applied in three major areas:

- **The Computer Mapping and Analysis System (*Cmas*)** is a compact, user-friendly desktop information product designed to examine the spatial and temporal distribution of marine species. To date, information systems have been completed for Gulf of Mexico shrimp harvest data and west coast of North America colonial seabird populations.
- **The Coastal Ocean Management, Planning, and Assessment System (*COMPAS*)** is designed to make a wide range of data and information easily available to coastal resource managers.
- **GeoCOAST** is a state-of-the-art geographic information system developed to address environmental issues concerning the management and protection of coastal areas.

SEA/ORCA is currently the Strategic Assessment Branch of NOAA's Ocean Assessments Division. Following the formal implementation of a reorganization on September 22, the SEA Division will contain five branches focusing on the physical and biogeographic characteristics of the Nation's coastal and ocean zones and examining pollutant discharges and general human uses within these areas.

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Rockville, MD 20852

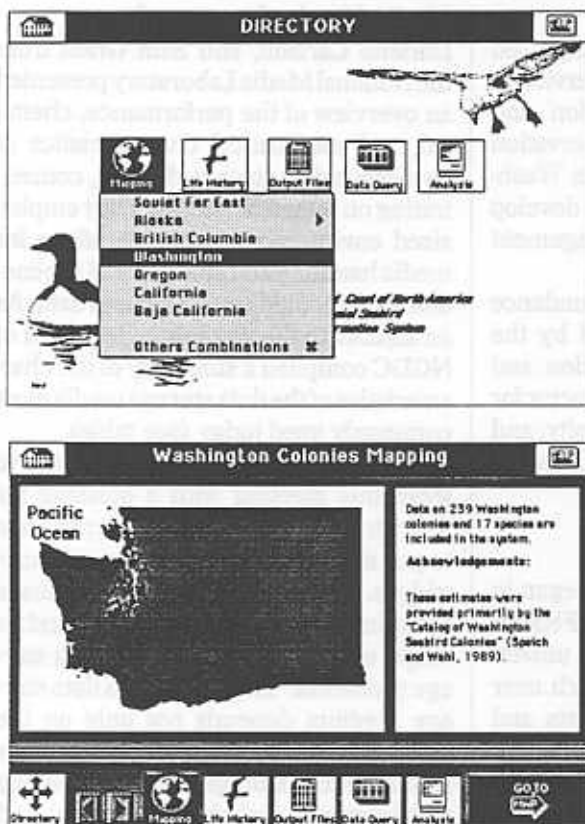


Figure 1. From the directory, users may select information on life histories, output files, specific data, and may view maps or conduct data analyses.

examined by functional rather than taxonomic unit. For example, in determining the vulnerability of a colony or region to an oil spill, a manager can divide the data base into diving vs. surface-feeding birds. Information on fledgling success can be used to estimate the number of chicks fledging from a colony, or a biogeographic analysis of the number of nocturnal zooplankton feeders can be produced to examine distribution patterns.

The seabird desktop system is designed to provide information at a wide range or scales, from site-specific data which is needed for state-level decision-making, to large-scale, regional analyses of distribution patterns useful in biogeographic investigations. The system has three major components: 1) simple data management and query; 2) maps and mapping; and 3) spatial data analysis.

Data Management and Query

Data management is the principle component of the system. The data have been organized by individual state (and

province) and structured as a series of individual records (or cards). Three basic types of files (or stacks) have been created: 1) "best estimate" colony population data; 2) bibliographic sources with documentation; and 3) life history information. A simple browse environment with data links allows quick movement within and among any of the data sets, for example, moving from colony data to bibliographic sources, or to species life history information by biogeographic region. Users also typically access this component to query data and extract a subset of colonies for mapping or report writing. Figure 1 shows the introductory screen for the Washington State data base, and for the data management module.

Maps and Mapping

The overall mapping component features maps at a 1:250,000 scale for each state in the study area, and several combined maps that include more than one state. Figure 2 shows seabird colony maps for Prince William Sound and the San Francisco Bay area. The system uses a "runtime" version of Atlas*MapMaker which users can purchase for a nominal cost, and which provides a rich set of mapping and display features. Some maps have been "pre-loaded" with seabird colony information, with several hundred colonies and about 30 individual species per map. Although the main purpose of the maps is to allow the user to portray collections of colo-

nies extracted from the data base, they may also be used for other point information the user may have. For example, a single map can allow the examination of the relationship between a set of colonies and pollution sources, or the relationship between point sources and monitoring sites. Any map created during a session can be saved in the user's own map files. These "user maps" can be recalled and modified at any time. The mapping component also allows users to zoom into maps for higher resolution, and provides a full legend, shading, display and labeling tools, as well as distance measurement capabilities.

—continued on page 8

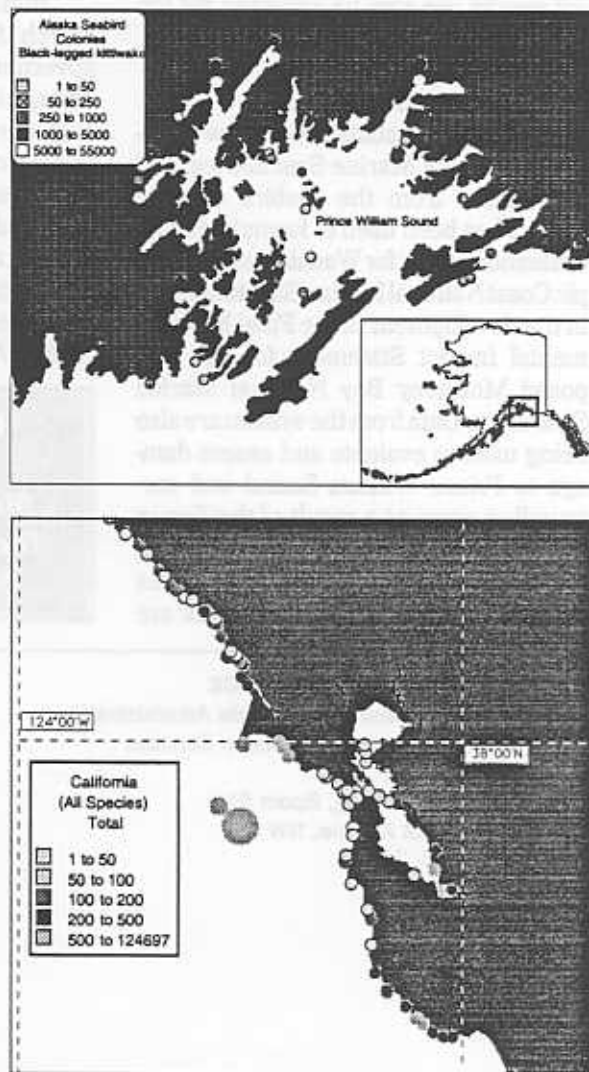


Figure 2. A variety of maps have been loaded into the Cmas Colonial Seabird Desktop Information System, and users may also create their own using information from the data base.

Seabird System, from page 7

Spatial Data Analysis

The system also allows rapid analyses of the entire data base, together with examinations of the spatial and temporal distributions of seabird species throughout the study area. The principal features of this component are: 1) analysis of species groups; and 2) comparisons of species distributions in user-defined areas. Users can define any region within the study area for analysis by drawing the area on a base map, and this defined area may be saved for later use. Outputs from this component include schematic maps, simple histograms, tabular summaries, colony listings, and ASCII files. Analytical results can also be exported for formal mapping.

System Uses and Users

NOAA is mandated under law to develop National Marine Sanctuaries, and information from the seabird desktop system has been used to formulate a site evaluation report for Washington's Olympic Coast National Marine Sanctuary, and in the development of the Final Environmental Impact Statement for the proposed Monterey Bay National Marine Sanctuary. Data from the system are also being used to evaluate and assess damage to Prince William Sound and surrounding areas as a result of the Exxon Valdez oil spill in 1989, and to examine the environmental sensitivity of areas where refined petroleum products are

produced in Washington State.

The system is currently being used by the U.S. Fish and Wildlife Service in Alaska and the Great Lakes region, and by the Department of Land Conservation and Development in Oregon. In Washington, data are being used to develop the state's Coastal Zone Management Program.

Seabird distribution and abundance information is also being used by the Arctic Environmental Information and Data Center in Alaska, by a contractor for Exxon at Colorado State University, and by the California State Lands Commission.

System Distribution

Initial system distribution began in March 1991 to selected State and Federal government agencies, as well as universities, within the study area. Each user receives: 1) system requirements and steps for installation; 2) simple tutorial exercises; 3) a reference list for the colony data; and 4) "on-line" help.

For more information on the system and its capabilities, please contact Tom LaPointe at the SEA Division (NOAA/NOS N/OMA31) at (301) 443-0453. ■

In the next issue:
**Media Mania, Part 2 -
The Past and Future of
Mass Data Storage**

Media Mania, from page 5

Darlene Carlson, and Sam Grant from the National Media Laboratory presented an overview of the performance, chemical, and mechanical characteristics of numerous data storage devices, concentrating on magnetic media. They emphasized environmental considerations for media handling and storage, and the conditions that could result in loss of data. As an adjunct to the workshop, Joe Allen of NGDC compiled a summary of the characteristics of the data storage media most commonly used today (see table).

The NESDIS contingent hoped to leave this meeting with a blessing for their already-started conversion program to put all the data archives on 3480 cartridges. As expected, there are pluses and minuses for all types of media, and no single one is the answer to all data storage problems. The choice of a data storage medium depends not only on the medium's lifetime, but also on factors including cost, storage capacity, handling requirements, available technology, and automation systems. The future holds great promise for very stable media that can hold data at much higher densities than at present. The IBM 3480 cartridge and follow-on generations (IBM 3490), however, do appear to be the best alternative currently available. With proper environmental storage and handling conditions and a migration plan for transferring data to newer media as they become available, the 3480 tape is an acceptable choice to meet present needs. ■

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