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EARTH SYSTEM MONITOR

A guide to NOAA's data and information services

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Live Access Server visualizes, subsets and extracts oceanographic data

Analyzing the effects of environmental variability on fisheries

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The Pacific Fisheries Environmental Laboratory (PFEL) is a component of the National Marine Fisheries Service Southwest Fisheries Science Center specializing in analyzing the effects of environmental variability on fisheries. Due to its original co-location at, and continuing cooperation with the Navy's Fleet Numerical Meteorology and Oceanography Center (FNMOC), PFEL has a wide variety of oceanographic and atmospheric datasets which are relevant to many areas of fisheries science, marine resource management, and climate change in the ocean.

For many years, PFEL has supplied extracts from these datasets to users around the world, and has also developed a number of derived products from these datasets, such as the Bakun upwelling index. These have been used in many areas of research. In the past, PFEL's data were only available by mailings of standard products or by special request, and in recent years distribution over the internet has increased. PFEL has implemented a version of PMEL's Live Access Server (March 1999 *Earth System Monitor*) which allows users to visualize, subset, and extract from PFEL's traditional data products, as well as some new and improved products, over the Internet.

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What differentiates PFEL's version of the LAS from other implementations is the wide variety of datasets available, allowing the researcher to access at one location a wide variety of pressure, wind and temperature data relevant to oceanographic research. At the present time, the following datasets can be accessed through the LAS:

Monthly Mean Products on 1-Degree Grid

1. Sea surface temperature and anomaly from Global Telecommunications System (GTS) observations (Jan. 1997 to present)
2. FNMOC sea level pressure (Nov. 1996 to present)
3. FNMOC surface winds (winds, wind stress and curl, July 1998 to present)
4. FNMOC geopotential height at 500 mb (July 1998 to present).

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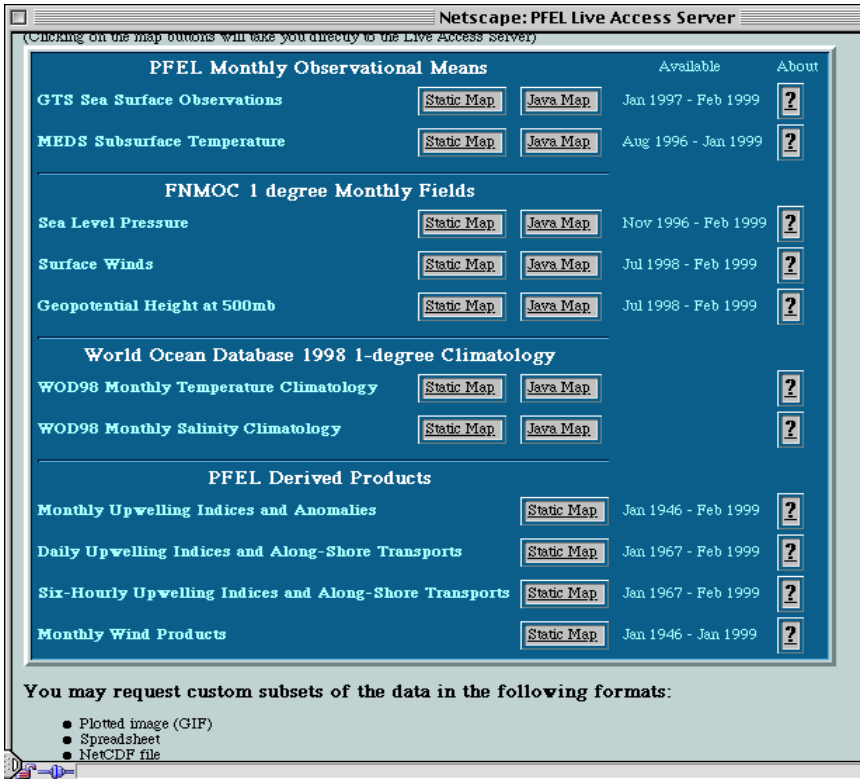

▲ **Figure 1**. The frontpage to PFEL's Live Access server provides information about each dataset available to the user, and will take the user to the LAS with the chosen dataset and selected map (static or java).

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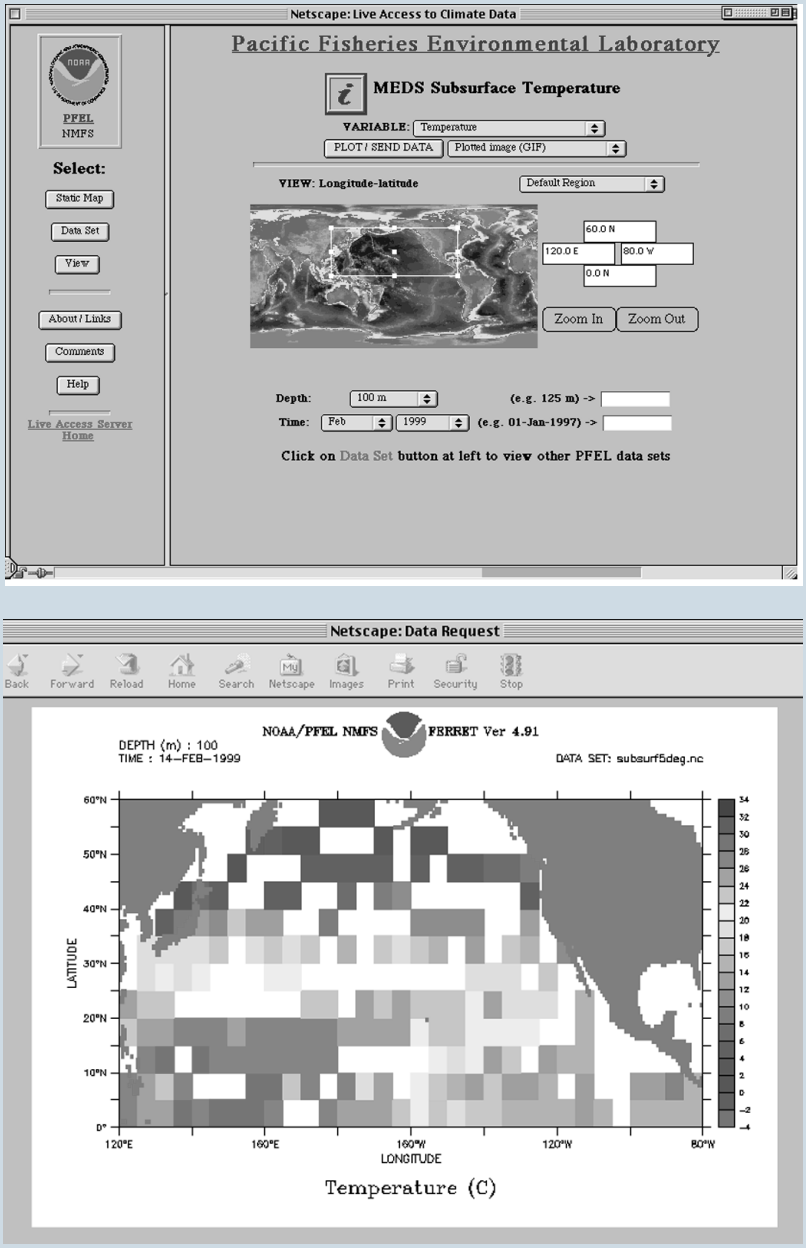

▲ **Figures 2.** (a) At top, the Java Map page of the LAS for the subsurface data. Subsurface data in the North Pacific for February 1999 at 100m depth is selected. (b) Below is the image plotted to screen from the selections above.

Live Access Server, *from page 1*

Subsurface Data

1. Monthly Climatologies (1-degree grid) from WODB98
2. Monthly 5-degree averages at 33 standard depths from MEDS/NODC
3. 10°C and 14°C monthly mean isotherm depths from MEDS/NODC

Derived Products at Standard Locations
(15 locations off the west coast of North America)

1. Monthly Upwelling Index (1946-present) calculated from FNMOC Pressure Fields
2. Derived Monthly Air/Ocean Indices (1946-present) calculated from FNMOC Pressure Fields
3. Daily Upwelling Indices (1967-present) calculated from FNMOC Pressure Fields
4. 6-Hourly Upwelling Indices (1967-present) calculated from FNMOC Pressure Fields

— *continued on page 4*

EARTH SYSTEM MONITOR

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U.S. Geological Survey assists South Pacific island nation

The United States Geological Survey (USGS) is providing land resource management assistance to the Federated States of Micronesia, an island chain in the South Pacific Ocean. These islands experienced severe drought conditions during the El Niño winter of 1998, and geologists are investigating enhanced methods for land and natural resource management during times of extreme climatic conditions. The USGS has obtained climatological data from the National Climatic Data Center's new Climate Data Online (CDO) system to assist in this project. Meteorological data from three South Pacific cooperative climate stations in an electronic format were obtained for a 40-50 year period, to better ascertain the climatic trends of the region.

Daily temperature/precipitation covering 1951-1990

The National Climatic Data Center (NCDC), Natural Resources Conservation Service (NRCS), and the Climate Diagnostic Center (CDC) are co-sponsoring a project to produce a serially complete data set of daily temperatures and precipitation for the United States. The data set covers the period 1951-1990. The source file is the NCDC archive of data from cooperative and National Weather Service sites. The NRCS has completed work on stations west of the Mississippi River and will begin analysis of data for stations in the eastern half of the country. NCDC is revising its software to operate on a UNIX platform and query the Oracle database to identify and inventory sites to be included in the project.

Antarctic Mapping Advisory Group

The Antarctic Mapping Advisory Group (AMAG) convened to discuss data processing, distribution, and preliminary research findings from the RADARSAT Antarctic Mapping Project (RAMP). Staff from the National Snow and Ice Data Center participated in the AMAG meeting. Comparative images of the Antarctic Peninsula were presented, which were derived from RADARSAT synthetic aperture radar and Advanced Very High Resolution Radiometers, showing the advantage of procuring both types of imagery to optimize research efforts.

News briefs

GODAR review meeting

The National Oceonographic Data Center/World Data Center-A for Oceanography in Silver Spring, Maryland, hosted the Global Oceanogaphic Data Archaeology and Rescue (GODAR) International Review Meeting, July 12-15. GODAR's mission is to locate (archaeology) and rescue (digitize) oceanographic data which are at risk of being lost due to media decay or neglect; identify priorities and ways of assisting Member States of the Intergovernmental Oceanographic Commission (IOC) in oceanographic data archaeology and rescue operations; and establish implementation plans for data rescue operations and recommend possible sources of funding based on agreed upon priorities.

The meeting was intended to review the progress to date of the GODAR project and to furnish guidance for future GODAR activities. Of note during the review was a move to include data other than the original, physical oceanographic scope of GODAR including chemical oceanographic and fisheries data. In the coming years, the IOC can be expected to begin focusing on archaeology and rescue of marine geological and geophysical data as part of a broader GODAR effort.

BioData Working Group

The third meeting of the NOAA BioData Working Group was held via videoconference on July 27. NGDC's John Kineman gave a presentation of biological data activities at NGDC, followed by presentations from Dave Anderson and Chris Elvidge. The Working Group is composed of representatives from all the line offices and is investigating the needs for data management for NOAA biological data in response to a request made by NESDIS (National Environmental Satellite Data and Information Service) Deputy Assistant Administrator Dr. Susan Zevin. Dr. Zevin's memo states that the National Environmental Data Access and Archive System proposed by NESDIS "must include plans for the widely distributed sources of small biological data sets, as well as the high volume, large array remote sensing data which will define our storage needs."

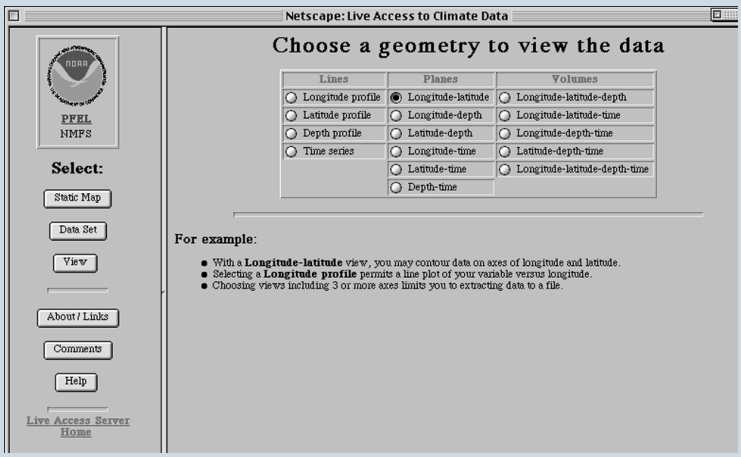
Lake Erie water level history noted

A full-page article written by reporter Gareth W. Dodd appeared in the August 1999 edition of U.S. Water News, entitled "Evidence shows Lake Erie flood created Niagara Falls—ancient Lake Erie flood a boon to newlyweds." The article summarizes results of a paper presented by Troy L. Holcombe of NGDC and CIRES/University of Colorado, at the 1999 meeting of the International Association of Great Lakes Research, held in Cleveland, Ohio. Co-authors are Lisa Taylor of NGDC, Peter Vincent and David Redid of NOAA's Great Lakes Environmental Research Laboratory, John Warren of the Canadian Hydrographic Service, and C.E. Herdendorf of Ohio State University.

The study, growing out of a compilation of new bathymetry for Lake Erie, found prehistoric shoreline features on the lakefloor, which can only be explained by low water levels in the lake five to ten thousand years before the present. Low water levels during this time, when upper Great Lakes drainage bypassed Lake Erie and the climate was warmer and drier, are postulated to have resulted in a closed basin. The study also speculates that water levels rose quickly once upper Great Lakes water was diverted into Lake Erie via the Detroit/Saint Clair River about 5400 years ago.

NGDC hazards information featured

The online version of the NGDC Natural Hazards Data Resources Directory was featured in the May 1999 issue of the Multidisciplinary Center for Earthquake Engineering Research (MCEER) Information Service News. The MCEER Information Service News is a monthly publication sent to hundreds of researchers and practitioners around the world. The Natural Hazards Data Resources Directory is a resource for the disaster and natural hazard management community as well as the general public. It includes descriptions of over 250 organizations that provide data and information on geological hazards, meteorological hazards, and societal response. The descriptions, contact information, e-mail addresses, and web links for all of these organizations were updated during the last year. The Directory was also released as a WebBook for ease of reading and chapter-based searching.



▲ **Figure 3.** The "View" page for the subsurface data. This shows the wide variety of geometries possible to use in subsetting the data.

Once logged in, you can access the front-end of our LAS (Figure 1) at:

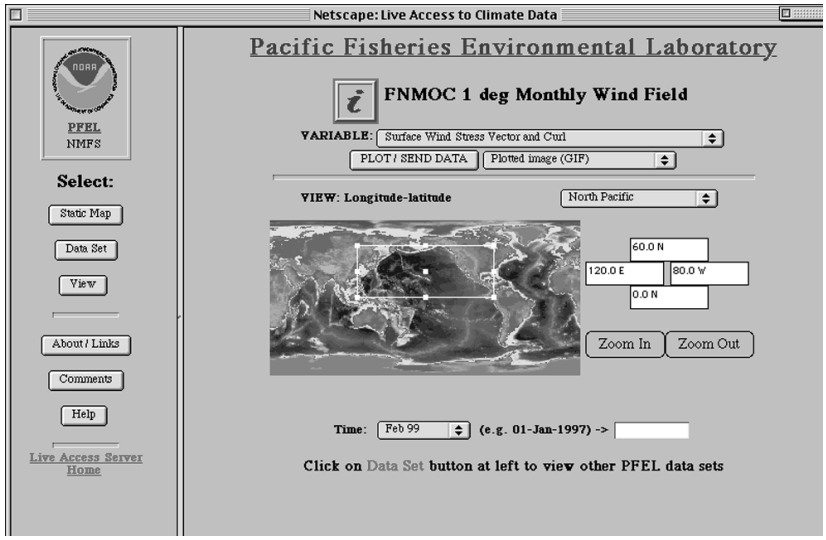
http://www.pfeg.noaa.gov/data_for_users/las.html

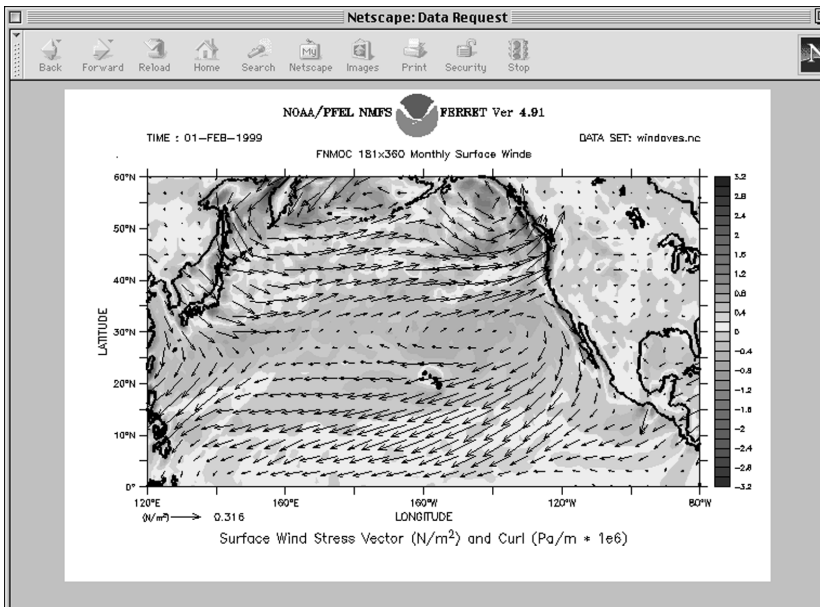
This allows the user to obtain information about the datasets, choose a static or java version of the map to select an area of extract, and access the LAS directly for the variable chosen. Once in the LAS (Figure 2a shows the java map for the subsurface data), a new dataset can be selected by selecting the "Data Set" button. Custom subsets of the data may be requested in the following formats: Plotted image (GIF), spreadsheet, NetCDF file, Tab-delimited file, Comma-delimited file, and Generic ASCII file (3- and 4-dimensional data

Live Access Server, *from page 2*

The GTS data contain 1-degree means, number of observations, anomalies and climatologies by month. The FNMOC surface winds are not calculated from the pressure fields but instead are from FNMOC's 1-degree wind model. Besides the wind components, estimates of the stress components as well as wind stress curl are available, which are mean values calculated from each six-hourly field. The subsurface climatologies were calculated from the World Ocean Database 98 (see *http://www.nodc.noaa.gov/OC5/indwod98.html*), while the averages are from the monthly MEDS/NODC compilation. The isotherm depths are interpolated from the temperature fields. The other datasets are PFEL's traditional upwelling indices at 15 locations off the coast of North America, plus a series of Air/Ocean flow indices calculated from FNMOC's pressure fields.

Information about PFEL's LAS, as well as plots of the current month's data, can be obtained from our homepage at *http://www.pfeg.noaa.gov/whats_new/las_whats_new.html* but to actually access the LAS you must as a first time user register at PFEL's data gate (*http://www.pfeg.noaa.gov/data_gate/pfeg_data_avenue.html*) or login at the same URL if previously registered. The registration and login is mainly for PFEL to track the usage of its data services, and at registration we request information about expected uses of our data products. This helps us keep a record of the impact our data services are having.





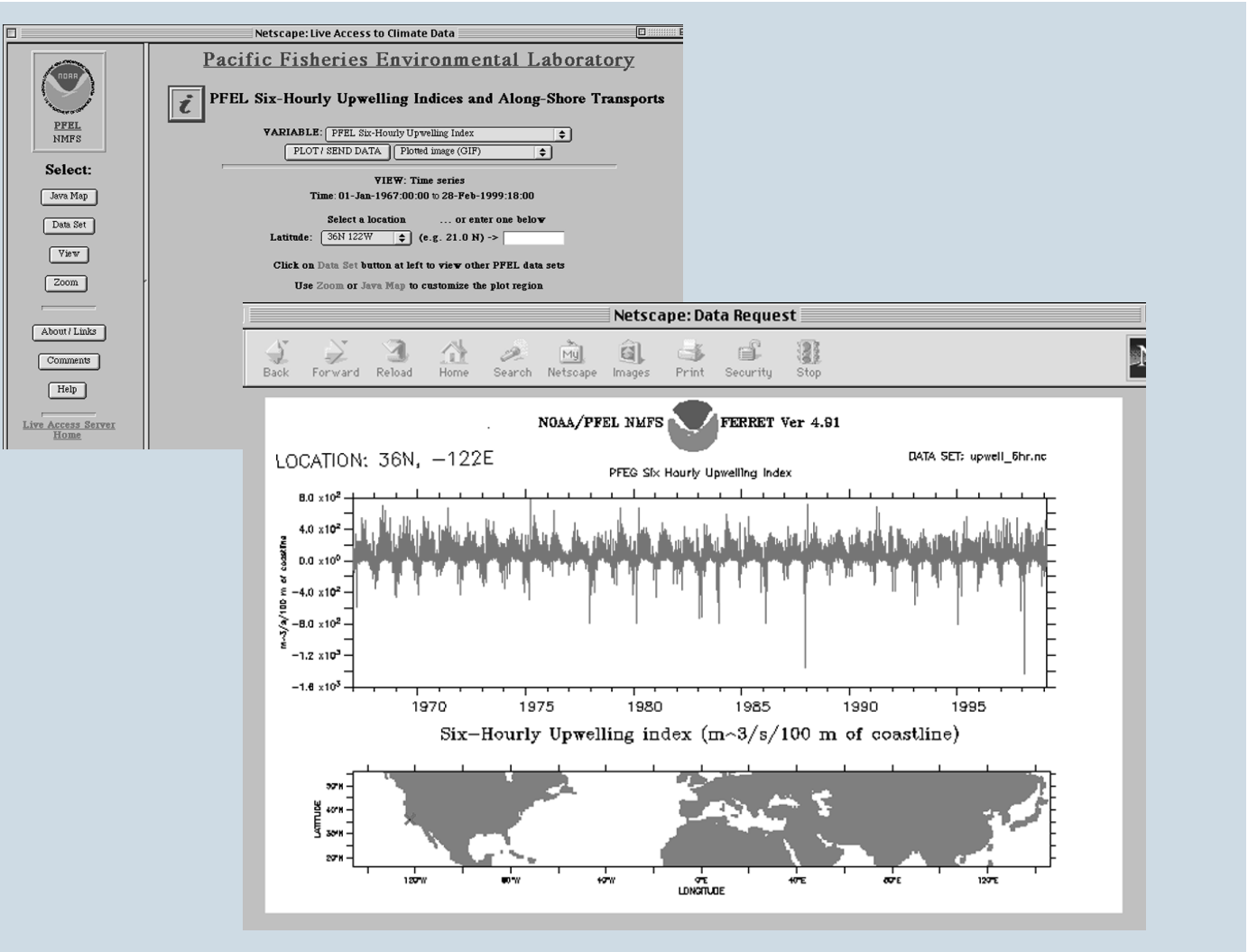
▲ **Figures 4.** (a) At top, the Java Map page for the surface wind data. Wind stress vectors plotted on wind stress curl for the North Pacific in February 1999 has been selected. (b) Below is the image plotted to the screen from the selection.

can only be downloaded). Subsets for plots and downloads may be obtained in various geometries by selecting the "View" button such as latitude-longitude, time series, profiles along latitude or longitude lines, and time series along latitude or longitude lines (the view selection for the subsurface data (Figure 3) shows the myriad of ways that the data can be subsetted).

Choosing the view to be a 2-dimensional latitude-longitude view, selecting February 1999 as the month, 100m depth, North Pacific as the predefined region and selecting "Plotted image" (Figure 2a) produces a new window with a color map showing the 5-degree mean temperatures (Figure 2b). If desired the data can be downloaded by making a different selection from the drop-down menu where "Plot image (GIF)" is now selected.

The surface wind data allows the plotting of the wind stress vectors on the wind stress curl (Figure 4a shows the Java Map page selecting the North Pacific for February 1999 and Figure 4b shows the resulting graphic), but to download the wind stress vectors, each component must be done separately. Because the 15 standard locations for the upwelling indices and the Air/Ocean flow indices are not truly on a grid, they can only be accessed in the "Static Map" mode. An error results if access is tried through the "Java Map" mode. Monthly, daily and six-hourly upwelling indices are available, and can be subsetted on a combination of location and time. The "Air/Ocean Indices" are various measures of monthly average transport and also can be subsetted on a combination of location and time for the 15 standard locations. These are the traditional PFEL products that until a few years ago were only available in graphic form by mail, or on tape by special request. Selecting 36°N as the location and January 1967 - January 1999 as the time selection (Figure 5a) produces a time series plot of the six-hourly upwelling index (Figure 5b). For any given geometry selected from the "View" button, subsets of the data can be selected by clicking on the "Zoom" button. For example, in "Time Series" mode, the "Zoom" button will bring up a screen for subsetting in time the selected series.

The datasets used in the LAS are updated monthly, with most of the datasets being updated by the first week of the month. We hope in the future to both improve and expand our coverage. Comments and suggestions on how our services can be improved are always welcome. ■



▲ **Figures 5.** (a) At top, the Static Map page for the six-hourly upwelling index. The index at 36 N for Jan. 1967 - Jan. 1999 has been selected. (b) Below is the time series plot produced by the selected extract as well as a map of the location of the time series.

Global Ocean Observing System next steps

Argo to provide real-time profile measurements

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Office of the Deputy Chief Scientist
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In oceanography today we have the capability—both scientific and technical—to consider implementing an operational observing system for the global ocean.

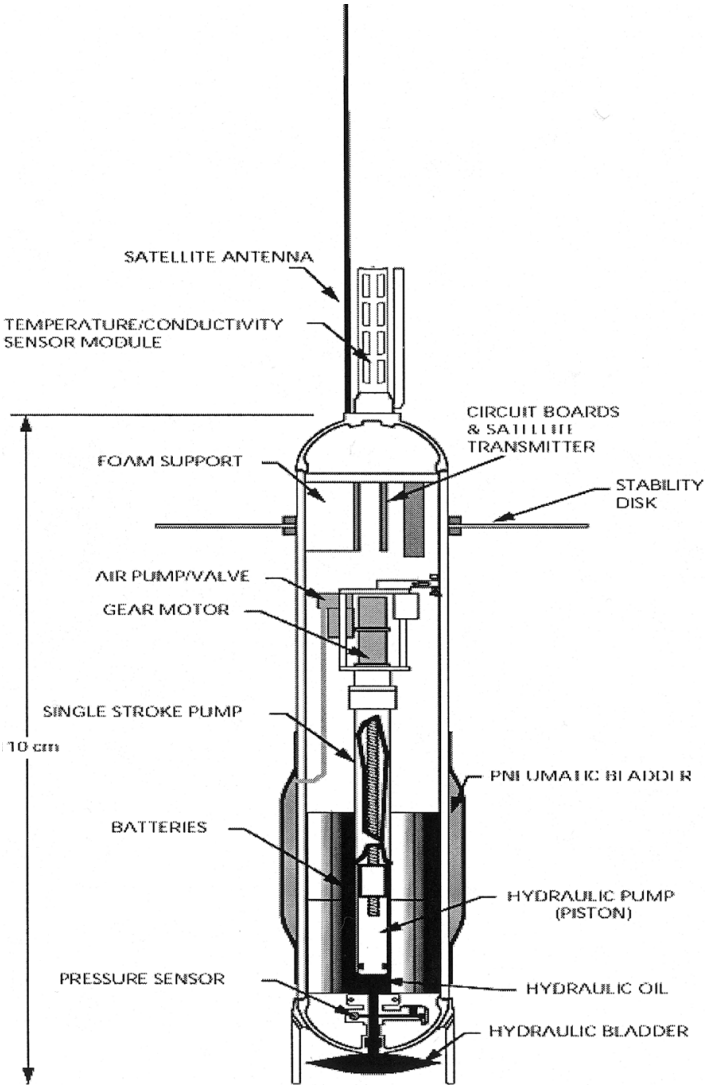
We have satellite systems, either flying or in development, to globally observe sea levels, surface winds, and surface temperature. We have a variety of *in situ* systems to observe upper-ocean temperature, salinity, and currents, but neither in sufficient quantity to cover an ocean basin nor of sufficient duration to address decadal time scales. We have the communications capability to collect these observations in near real-time, but most is done well after the fact. We have the models and the computing capability to utilize these data.

We are at a point in time when we can put it all together, collecting satellite and *in situ* observations; assimilating them into models; estimating the oceanic temperature, salinity, and current structure; producing forecasts for the ocean; and initializing atmospheric models—globally, in near real-time, and long-term. This is key to understanding the circulation of the ocean, what drives it, and how the ocean and atmosphere interact as a coupled system, as well as producing climate forecasts which of necessity involve the coupled ocean-atmosphere system. This will also provide the context for addressing chemical and biological variability in the ocean such as is associated with phytoplankton productivity and fisheries applications.

We have, in effect, put it all together for the Equatorial Pacific where real-time ocean observations are fed into climate models to produce El Niño-based seasonal atmospheric forecasts. The next logical steps are to build on this operational system by extending coverage to span the entire North Pacific and North Atlantic, where there is significant thermal variability at decadal time scales associated with the Pacific Decadal Oscillation and the North Atlantic Oscillation, respectively. The critical missing element is the *in-situ* observing system; we only have piecemeal coverage of those basins at present.

To address this need, a new program called Argo has been introduced. Argo is the result of over two decades of development and utilization of float technology sponsored by the National Science Foundation and the Office of Naval Research. One of the major Administration initiatives announced at the National Ocean Conference was an expanded ocean monitoring system, this comprised of profiling autonomous floats; that will help us get started. Argo will provide real-time, basin-wide measurements of temperature and salinity profiles, and will estimate current velocities at depth. These data will be used with existing satellite and other in situ ocean observations and weather analyses to produce weather maps of the upper ocean. The seasonal patterns of ocean anomalies in these maps are key to understanding and predicting the climate phenomena that affect U.S. interests at home and abroad.

This proposed array will consist of 3,000 floats to be deployed globally, spaced about 300 kilometers (186 miles) apart. When deployed at the surface, each float (Figure 1) will sink to a typical depth of 2,000 meters. After drifting with the ocean current at that



▲ **Figure 1.** Schematic of an Argo float.

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depth for ten days, it will rise to the surface, measuring the temperature and salinity of the layers through which it rises. On the surface, the float will radio its data and position to an orbiting satellite before returning to depth and continuing another cycle. Floats will continue cycling throughout their design life of four to five years.

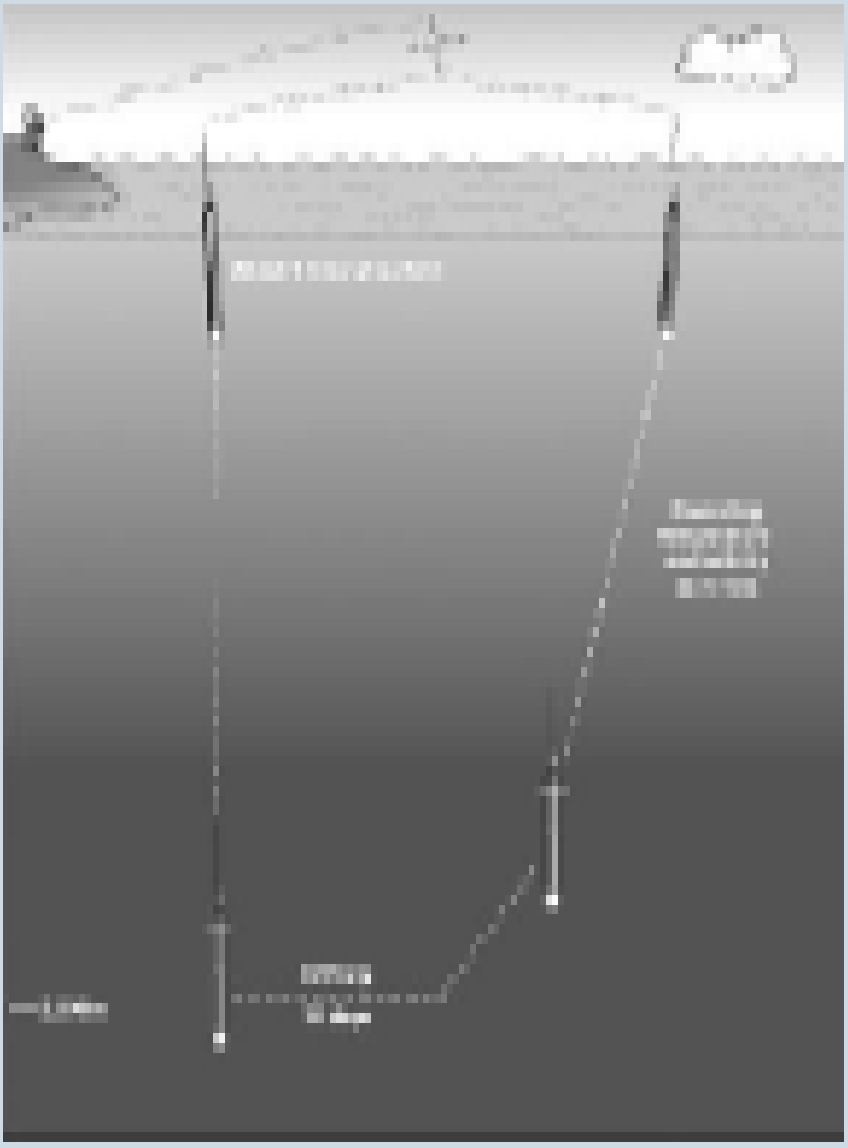
Satellites will relay the data they receive from Argo floats to land-based receiving stations (Figure 2). From there, the data will go to a number of scientific teams around the world, who will carry out initial quality control. They will then make the data available for operational forecast centers and scientists in near real time, via the Global Telecommunications System. All data will be openly available, without proprietary restrictions.

Argo floats will be deployed from a variety of ships and aircraft. Hundreds of commercial vessels that ply trading routes across the globe can deploy floats, just as they now make meteorological observations and drop instruments that give a single ocean profile. The remotest regions of the ocean can be seeded by air. The great advantage of the floats is that, after deployment, they will continue to operate unattended. Once fully implemented, Argo will constitute an oceanic equivalent of the worldwide network of balloon-borne radiosondes. Just as the radiosondes contribute to accurate three to five day weather forecasts, Argo will contribute to accurate climate predictions.

The oceanographic community is moving in this direction working via the Global Climate and the Global Ocean Observing Systems (GCOS/GOOS), of which this is a component. Two complementary international programs will help rationalize, design, and implement a system to collect such basin-scale *in situ* observations: the Climate Variability and Predictability Program (CLIVAR) and the Global Ocean Data Assimilation Experiment (GODAE). CLIVAR is focused more on understanding the role of the ocean in climate and GODAE more on demonstrating practical benefits.

Argo will contribute greatly to the work of such organization as CLIVAR and GODAE. In 1999, the World Meteorological Organization Congress and the Assembly of the Intergovernmental Oceanographic Commission both accepted Argo as an important contribution to global ocean observing activities. Argo will require substantial international collaboration.

The Administration is proposing to provide one-third of the array over a three-year period at a total cost of $12 million. NOAA is soliciting partnerships with Japan, Europe, Canada, Australia, and others. No nation can afford to cover the ocean on its own. ■



▲ **Figure 2.** This diagram shows the Argo float cycle, with communications and position reporting by satellite.

Oregon's Dynamic Estuary Management Information System

Providing geo-spatial information for estuaries and their watersheds

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Department of Land Conservation and Development

The physical setting of estuaries and the wide array of human activities they attract pose some unique coastal management challenges. Analyses which tackle these challenges often require a wide array of geo-spatial data to resolve. Many branches of NOAA, and a variety of other federal and state agencies with jurisdiction in the coastal zone generate geo-spatial data relevant to such analyses, but often in file formats, scales and geographic projections which render them unusable to the lay-public or even sister agencies without considerable effort.

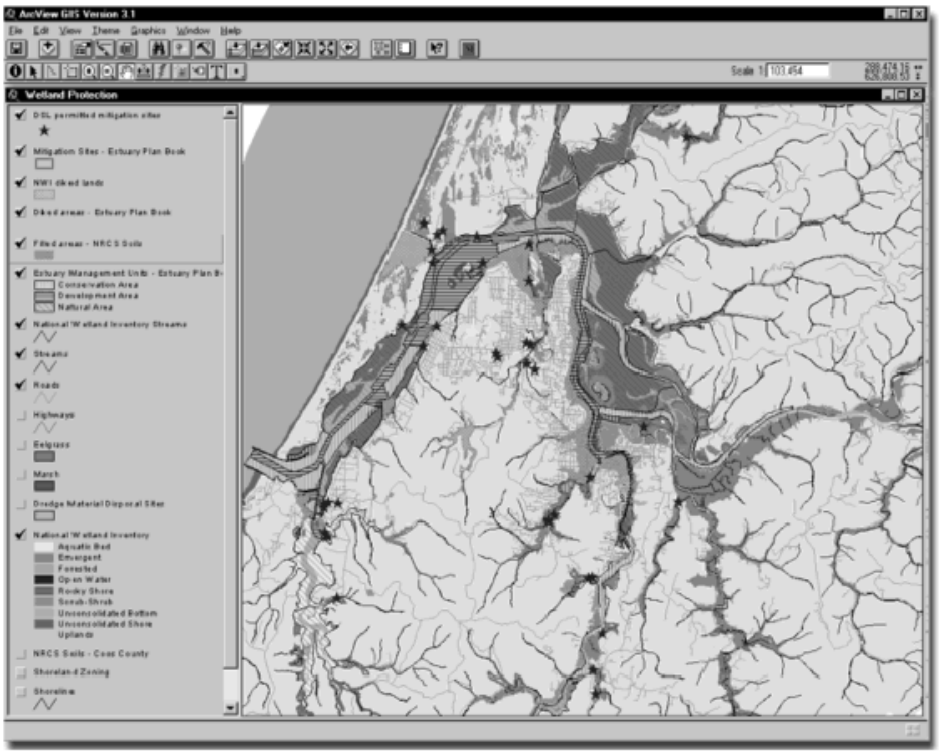
This article details a program through which the Oregon Ocean Coastal Management Program (OCMP) works to make a variety of federal, state, and other geo-spatial data widely available in common format to interested public users who are often stakeholders in estuarine and coastal management issues. The project aims to provide a central information depot for traditional and digital information relating to estuaries in Oregon in order to focus attention on frequently ignored estuarine systems and facilitate use of the best available information in state and local estuarine resource management decisions, non-regulatory conservation and restoration efforts, science, and education.

Introduction

Oregon's system for managing its 22 major estuaries and their estuarine shorelands has a history of successfully reducing use conflicts. It is based on estuary-specific resource inventories that form the foundation of estuarine management plans, which in turn dictate the types of development that can occur in specific areas. Unfortunately, the mapped habitat data upon which these use-decisions are based are increasingly dated: a situation which if left unaddressed, implies that the effectiveness of the resource management system will decline. To prevent this eventuality, the Oregon OCMP initiated a project in 1996 to define and launch a coast-wide estuary GIS that would be centered on each of the 22 major Oregon estuaries. The effort was further motivated by fragmentation of information related to Oregon estuaries that had evolved since estuary management plans were developed in the 1980's. Important resource information was housed in a variety of federal and state agency and county offices located around the state, and newly available information was not sufficiently integrated into decision-making processes. An estuary-centered GIS had the potential to integrate the array of digital data generated by ssorted local, state, federal, private and non-profit entities with emerging new estuarine information, and to subsequently share this information amongst the various potential users and decision makers.

Pilot project

A two-year pilot effort was undertaken to fully develop the Dynamic Estuary Management Information System (DEMIS) for Oregon estuaries. In mid-1996 OCMP successfully applied to host a NOAA Coastal Management Fellow to implement the pilot phase of the



▲ **Figure 1.** Pre-configured Arcview Project Files are available on the DEMIS pilot CD-ROM which group related data themes into "issue modules" and display them with easily interpreted legends and map colors.

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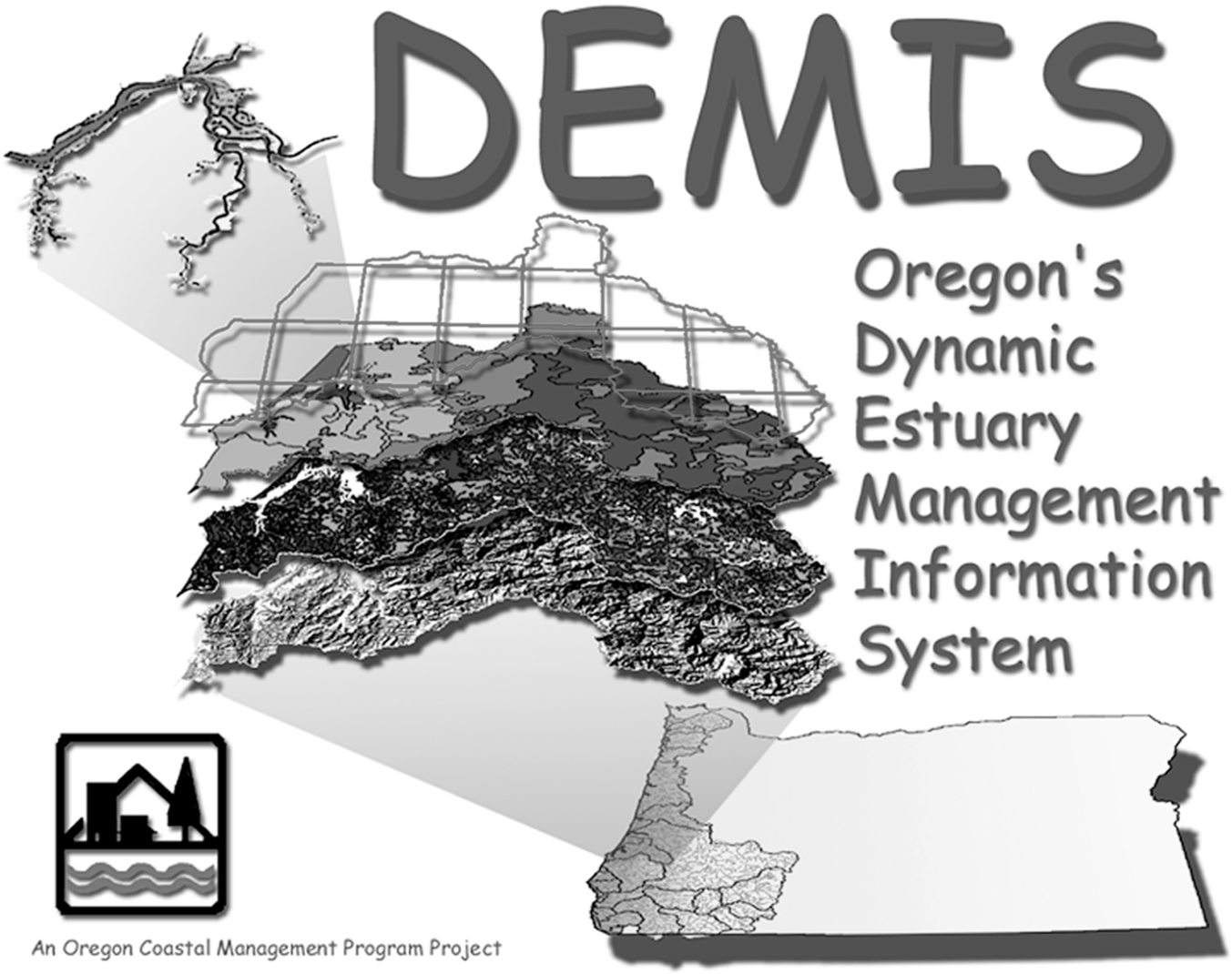


▲ **Figure 2.** The DEMIS logo shows the focus on data layers that are pertinent to estuarine wetland restoration.

DEMIS project.

The pilot was centered in the Coos Bay estuary and watershed, and explored a variety of management and data-related issues. The intent was to create a framework for data collection, storage, and use that was:
a) transferable to local users such as citizen-based watershed councils,
b) flexible and specific enough to address particular local management needs,
c) based on an information system structure that would remain compatible when expanded along the coast.

The main products of the pilot effort included data management processes and standards for an estuary GIS, a compact disc (Table 1) with over 140 accumulated data layers which had been geographically standardized and clipped to the Coos Bay estuary's watershed boundaries, and an informational internet web site. The CD-ROM includes both shapefiles and ArcInfo Export (e00) files (Figure 1), as well as user-friendly ArcExplorer and ArcView project files which integrate related datasets into easily interpreted "issue modules". It was envisioned that while the initial data collections in the estuary would be published on CD, any additional data layers developed for the region would be shared via an expanded version of the web site.

Phase 2: expansion estuaries

Building on the pilot effort, a second phase of DEMIS was begun in late 1998 to expand the system to other Oregon estuaries. OCMP was once again successful in obtaining a NOAA Coastal Management Fellow for carrying out this expansion. Phase 2 will:
a) refine the framework, capacity and standards developed by the DEMIS-Coos Bay pilot,
b) focus data collection on layers (Figure 2) deemed pertinent to estuarine wetland restoration, and
c) inventory and analyze potential estuarine wetland restoration sites for each DEMIS estuary.

Phase 2 began by selecting priority estuaries for the DEMIS based on a number of management-related estuary characteristics, including:

—continued on page 10

Table 1. Geo-Spatial data theme types collected on the DEMIS pilot CD-ROM

Biology
Habitat maps by species groups, wildlife distribution, fish occurrences etc.

Environmental Quality
Data layers having to do with environmental quality such as mapped CERCLA and TRI sites, dredge material disposal sites, mitigation sites, and locations of permitted wastewater outfalls.

Geomorphology
Various soil and geologic data layers.

Hydrology
Any layers concerned with the various hydrologic features of the estuary and the surrounding watershed: Aquifers, rivers, streams, lakes, sub-basins, wetland inventories, etc.

Infrastructure
Layers depicting the locations of major infrastructure: highways, roads. railroads,dams, culverts etc.

Miscellaneous Covers
Data layers which do not easily fit into any of the other more specific categories. Quad grids, basemap footprints, Oregon state outline, etc.

Political
Boundaries that exist in the estuary for various political or legal reasons. Urban growth boundaries, zoning, estuary management unit designations, congressional districts, oyster lease locations etc.

Population
Various census data layers regarding population distribution, density etc.

Terrain
DEMs, shaded relief images etc.

Vegetation
Assorted vegetation coverage maps including a Landsat TM image.

Oregon's DEMIS, *from page 9*

a) the geographic distribution of estuaries in the DEMIS up and down the Oregon coast,
B) the physical variability amongst selected estuaries,
c) the Oregon Estuary Planning classification of the estuary,
d) connectivity to Core Salmon Restoration Initiative (CSRI) streams and Aquatic Diversity Areas (ADA's).
e) presence of Oregon Department of Fish and Wildlife salmon index sites,
f) progress of the local watershed council in the watershed assessment process, and
g) the presence or absence of any existing GIS efforts relating to the estuary.

The overall intent was to expand the DEMIS system in such a way as to maximize the contribution that the program made to the state's total knowledge base, while maintaining a diversity in physical location and estuarine characteristics. Estuaries with connectivity to CSRI stream and ADA's were considered a high priority, as were those where a local watershed council was advanced in the watershed assessment process and might be well-positioned to make immediate use of the DEMIS products. Estuaries with a potential to maximize corridors of beneficial salmonid habitat were given a higher ranking. Finally, estuaries with substantial non-DEMIS GIS programs (such as the Columbia River and Tillamook Bay estuaries) were essentially not considered.

As a result of these priorities, four DEMIS expansion estuaries and their associated watersheds were chosen for Phase 2: the Nehalem River, Siletz Bay, Siuslaw River, and Coquille River. Data collection and potential estuarine wetland restoration inventories are expected to be complete for these systems by late 2000.

Envisioning restoration possibilities

An additional goal of DEMIS-Phase 2 is to demonstrate how the analytical capabilities of a GIS can be used to synthesize these data into viable community action plans. The focus on identification of potential estuarine wetland restoration areas was introduced as a priority for the Phase 2 expansion of the DEMIS program because the issue of loss of estuarine wetland habitat is a resource management concern common to all the Oregon estuaries, and because baseline GIS layers collected for this purpose also constitue an excellent starting GIS base from which to launch other estuary-related analyses. In addition, with the 1998 and 1999 listings of several coastal Oregon salmonid populations as threatened under the Endangered Species Act, an inventory of areas with ecological potential for estuarine habitat restoration is seen as a valuable starting point for non-regulatory restoration initiatives.

An inventory of potential wetland restoration sites within each DEMIS estuary will be created by combinig the digital data assembled by DEMIS with site visits and extensive review of aerial photos and county cadastral maps for each DEMIS estuary. The inventory will be made available to watershed councils, and managers/decision makers at all levels. No attempt will be made to prioritize the sites identified in each inventory. Instead, an attempt will be made to make the database associated with the inventory as management-comprehensive as possible, incorporating as many ecological and social site parameters as can realististically be assembled in order to create a tool that can be readily queried to created action plans based on the specific priorities of the user-group in question.

Groups that utilize the DEMIS-based inventory for selecting and prioritizing restoration sites may use the inventory to construct watershed "visions" of the alternative landscape outcomes of their actions. It is hoped that the proliferation of such tools will facilitate more informed decision-making regarding non-regulatory estuarine wetland restoration efforts in both the public and private/non-profit sectors, and that as a result increases in estuarine wetland acreage will occur in such a way as to maximize both social and ecological benefits.

Targeting users: working with local groups

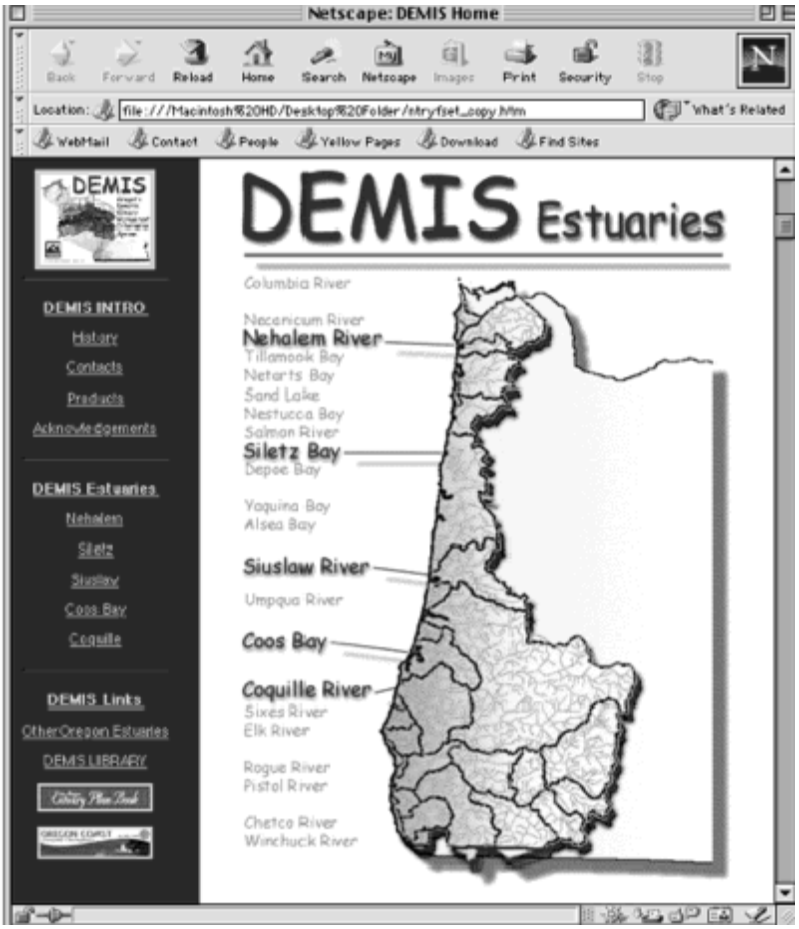
An integral aspect of the DEMIS program is working with citizen-based watershed councils, Native American tribes, and other groups relevant to

each of the selected priority estuaries to assure that the products that emerge from the effort meet local needs in addition to conforming to the technical standards desired by the state. The local watershed council structure in particular is a valuable connection for the program to make. These citizen-based volunteer groups are the footprint of the *Oregon Plan for Salmon and Watersheds*, a Governor's initiative to encourage grassroots non-regulatory restoration efforts in response to the salmon crisis, and are in place with the specific goal of sustaining natural resource and watershed protection and enhancement within a watershed.

The estuary-focus of the dEMIS program complements the councils' watershed assessment process well, as the importance of estuarine systems is often somewhat under-emphasized in those assessments. In addition, the technical skill-level of watershed council members is also an important benchmark against which to gauge the "usability" of DEMIS products. With this is mind, DEMIS expansion "scope" meetings have been held with groups in the Coos, Coquille, and Nehalem estuarine watersheds, in order to determine the local community's priority issues relative to overall DEMIS goals. At each meeting, specific local issues were framed in terms of the GIS analyses that might be done to address them. Through this process, a list of estuary-specific priority data layers was obtained which were than pursued for inclusion in the DEMIS. Data collection and standardization has commenced in the Coquille and Nehalem estuaries following the framework and standards laid out in the DEMIS-Coos Bay pilot project.

DEMIS on the Web

Finally, an expanded DEMIS web site has been developed to reflect the coast-wide nature of the DEMIS project objectives, and to enhance accessibility for the public (Figure 3). A deliberate effort was made to ensure that the "look and feel" of the entire site is compatible with the organizational layout of the pilot DEMIS CD-ROM, and allowances were made for logical, parallel navigation paths to the data and



▲ **Figure 3.** The Coast-wide DEMIS portal features easily interpreted graphics and highlights watershed council boundaries and estuaries where data collection is ongoing.

metadata collection for any Oregon estuary in Phase 2 and beyond. This design is meant to ensure ease-of-use for DEMIS users who regularly navigation both the web site and the CD-ROM products. The site is also intended to act as a portal to dispersed internet information about private, non-profit, local, state, and federal estuary-related projects in both DEMIS and non-DEMIS estuaries, and establishes an on-line library to accommodate non-GIS information regarding Oregon estuaries.

Currently DEMIS web users may view the metadata for all the layers assembled for the targeted estuaries, download individual data layers of interest as zipped ESRI shape files, or order the CD-ROM produced in the DEMIS pilot effort. It is likely that as the DEMIS program and its site continue to grow, the program will take advantage of on-line mapping technologies to further simplify user access to data. The DEMIS web site is accessible from within the web site of its parent agency, the Department of Land Conservation and Development at: *http://www.lcd.state.or.us/coast/demis/core.htm*

About the NOAA Coastal Services Center Coastal Management Fellowship

This was established in 1996 to provide professional on-the-job education and training opportunities for post-graduate students in coastal resource management and policy and to provide specific technical assistance for state coastal resource management programs. The program matches recently graduated master's, professional, and doctoral degree students with state hosts around the U.S. in state coastal zone management programs. For two years, the recipients will work on substantive state-level coastal resource management issues that pertain to federal management policies and regulations. The recipients are designated NOAA CSC Coastal Management Fellows. All states with federally approved coastal zone management programs, and states developing such programs for approval, are eligible to apply for this program through the NOAA CSC. See the following website. *http://www.csc.noaa.gov/cms/fellows.html* ■

Quick action needed for world's declining coral reefs

Results of the International Conference on Scientific Aspects of Coral Reef Assessment, Monitoring, and Restoration

James D. Thomas and Richard E. Dodge
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More than 480 coral reef scientists, resource managers, technicians, and conservationists came from 34 countries, Guam, Puerto Rico, and the U.S. Virgin Islands to the recent International Conference on Scientific Aspects of Coral Reef Assessment, Monitoring, and Restoration in Ft. Lauderdale, Florida.

It was a unique opportunity for both scientists and resource managers to meet together on a global scale to:
a) discuss current aspects of reef assessment, monitoring, and restoration
b) identify common concerns
c) identify ways to work together more effectively

Despite the diversity of interests among participants, six major themes emerged from the Conference:
1. Persuasive evidence exists for systemic declines in corals and reef communities worldwide.
2. Reef systems are already showing distinct and measurable responses to global stresses, and it is probable that they will do so at an accelerating rate in the future.
3. Any attempts to protect the world's remaining healthy reefs from further degradation must include quick and decisive action at a variety of spatial scales, ranging from local to global.
4. Meso- and large-scale, time-dependent, integrated risk assessment and risk management protocols are needed which operate through a cooperative research-centered model.
5. A global network of coral reef marine protected areas (MPA) can ensure the long-term survival of high value communities, but an increased emphasis on scientific protocols to site and monitor effectiveness of MPA is urgently needed.
6. The science of coral reef restoration-rehabilitation is in its formative stages and has promise for expediting reef recovery. The development of reef restoration into an effective management tool will require approaches that encompass hypothesis-based measures of efficacy and outcome assessment.

In addition to these outcomes, a variety of emerging and new scientific techniques and approaches to address the above problem areas were identified by experts at the conference.

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Overview of coral reefs and conference rationale

Not just corals and fish live in coral reefs. The level of biodiversity in coral reefs is so great that they are often referred to as the Rain Forests of the Ocean. While the roles of coral reefs in nature are impressive, they also make a multi-billion dollar impact in the world's tourist economies. In some cases this aspect constitutes a large percentage of smaller local economies. Coral reefs provide critical habitat for numerous fish and shellfish species in addition to their recreational and commercial value.

Globally, it appears that coral reefs are experiencing large-scale ecological and physical changes. Both the amplitude and frequency of these events have no recent historical equivalents. Scientists and managers alike recognize that new and innovative programs are needed to understand and interpret theses changes so steps can be implemented to effectively promote more precise research and management programs. This Conference provided impetus toward those goals.

Globally, at least four major system variables are "out of range" from past geological levels and are continuing to increase rapidly. Even if current inputs are stabilized, these trends will continue at least for decades longer. These global systems are:
a) atmospheric CO_2 concentration
b) carbon cycle flux rates
c) nitrogen cycle flux rates
d) human population increases
Additionally, global temperature will likely join this list within a few decades; also, entirely new, bioreactive environmental components have been introduced and globally distributed (e.g., artificial biocides, endocrine disrupters).

The urgency to act in some capacity to protect reefs despite the level of knowledge of system process and response can lead to the scientist's dilemma: "Starting from a false premise cannot result in a correct conclusion, no matter how flawless the logic." Thus, two possible assumptions for actions pertaining to coral reefs could be the "firefighting" approach or the "triage" approach (Table 1). If the triage approach is adopted, then a triage classification scheme is needed (Table 2).

Additional priorities need to be evaluated (Table 3). Assessment, monitoring, and restoration issues are key concerns when considering coral reefs. These were also the three central themes of the conference.

Background

The conference was organized by the National Coral Reef Institute (NCRI), established in 1998. Based at Nova Southeastern University's Oceanographic Center near Ft. Lauderdale, Florida, NCRI's primary objective is the protection and preservation of coral reefs through basic and applied research on coral reef assessment, monitoring, and restoration programs coupled with specific training and education.

Held April 14-16, 1999, the scientific program of the Conference included four plenary speakers, one keynote speaker, eight special and 10

— continued on page 16

Table 1. Two Possible Assumptions for Actions

Assumption #1: "Fire-Fighting" Approach

"Fire-fighting:" Coping at an individual level with small numbers of casualties (coral reefs) under conditions of limited resources. Resources expended with little comprehensive assessment of overall reef value/risk.

Assume:
1. Stable, favorable global environment
2. Adequate funding and personnel resources
3. Response action is to address problems as they arise in order of perceived seriousness

If this assumption is wrong, risk is loss of all or most of system.

Procedure:
1. Programs implemented in data-scarce environment
2. Resource expended with little or no definable outcome measurement
3. Value lies in the process itself, not the outcome

Assumption #2: "Triage" Approach

"Triage:" Coping with large numbers of casualties (coral reefs) simultaneously under conditions of limited, resources (funding). Resources expended via a comprehensive assessment of reef value/risk.

Assume:
1. Deteriorating environment
2. Limited funding and personnel resources
3. Response action is to concentrate resources on saving the as-yet-undamaged, the particularly valuable, the hardy, and the salvageable

If this assumption is wrong, risk is unnecessary sacrifice of some marginal parts of the existing system.

Procedure:
1. Assess risk of injury
2. Assess vulnerability to injury
3. Assess value(s)

Table 2. Coral Reef Triage Classification Scheme

Coral Reef Triage Classification Scheme for Screening and Characterizing Reefs

1. Likely to recover with relatively minimal attention (Priority Level 1)
2. Eventual full recovery possible with extensive/prompt treatment (Priority Level 2)
3. Death or permanent disability probable (Priority Level 3)

Table 3. Priorities Involved

Assessment	Monitoring	Restoration
1. Environmental characterization (risk, present and future)	1. Provides the time dimension of assessment	1. Classify via triage model and reallocate resources
2. Coral Community characterization by: a) Vulnerability b) Value(s) c) Time trajectories	2. Tests/refines classification and process models	2. Improve scientific basis
3. Community condition	3. Tests effectiveness of intervention techniques	
4. Classification (triage category)		

Advanced Weather Interactive Processing System installed: NOAA looks to the future

A high-tech, interactive weather computer and communications system has been installed in 152 National Oceanic and Atmospheric Administration sites across the country, completing a decade-long effort to revamp weather services and significantly improve weather forecasting, Deputy Secretary of Commerce Robert Mallett announced.

"Today we celebrate the beginning of modernized operations for NOAA's National Weather Service," said Deputy Secretary Mallett. "The installation of Advanced Weather Interactive Processing System (AWIPS) units is a milestone in the revolution of weather services for our country.

AWIPS provides significant improvements in weather- and flood-related services. The system gives NWS forecasters access to other tools developed and installed under the modernization program such as satellite imagery, Doppler radar data, automated weather observations and computer-generated numerical forecasts, all at one workstation.

"The modernization process we've been engaged in for the past decade is not just a Weather Service success story, but a NOAA success story," said NOAA Administrator D. James Baker. "Many NOAA scientists have contributed research and development expertise to the systems the Weather Service uses, and NOAA's satellite and data management branches are critical elements in the weather services provided to the nation."

"Our vision is to be America's no-surprise weather service and we are well on our way," said National Weather Service Director John J. Kelly Jr.

Kelly cited examples demonstrating the modernization program's success: AWIPS and Doppler radar helped forecasters in Norman, Okla., detect tornadoes and rapidly issue severe weather warnings that alerted people to the deadly tornado outbreak in May and helped save lives; and in July 1998, the advanced graphic display capabilities of AWIPS helped forecasters in Salt Lake City see heavy rains in Zion National Park. A timely flash-flood warning resulted and at least 40 hikers avoided a flooding canyon.

For an investment that costs each American about $4 per year, the NWS issues more than 734,000 weather forecasts and 850,000 river and flood forecasts, in addition to between 45,000 and 50,000 potentially life-saving severe weather warnings annually. Statistics show overall improvements in forecast accuracy and in the timeliness of severe weather and flood warnings.

"We take great satisfaction in having reached this important milestone in the AWIPS program," said Len Pomata, Litton vice president and president of PRC, the primary AWIPS contractor. "But we are most proud to be an integral part of this important national program and look forward to continuing to work with the Weather Service to constantly improve the life-saving capabilities of the AWIPS system."

The AWIPS program has twice been recognized: in June, AWIPS earned a Computerworld/Smithsonian Award for using technology in an innovative way to benefit society, and in 1997 AWIPS earned a "Best of What's New" award from Popular Science magazine.

More information about AWIPS is available on the Internet at: *http://www.nws.noaa.gov/modernize/success.htm*.

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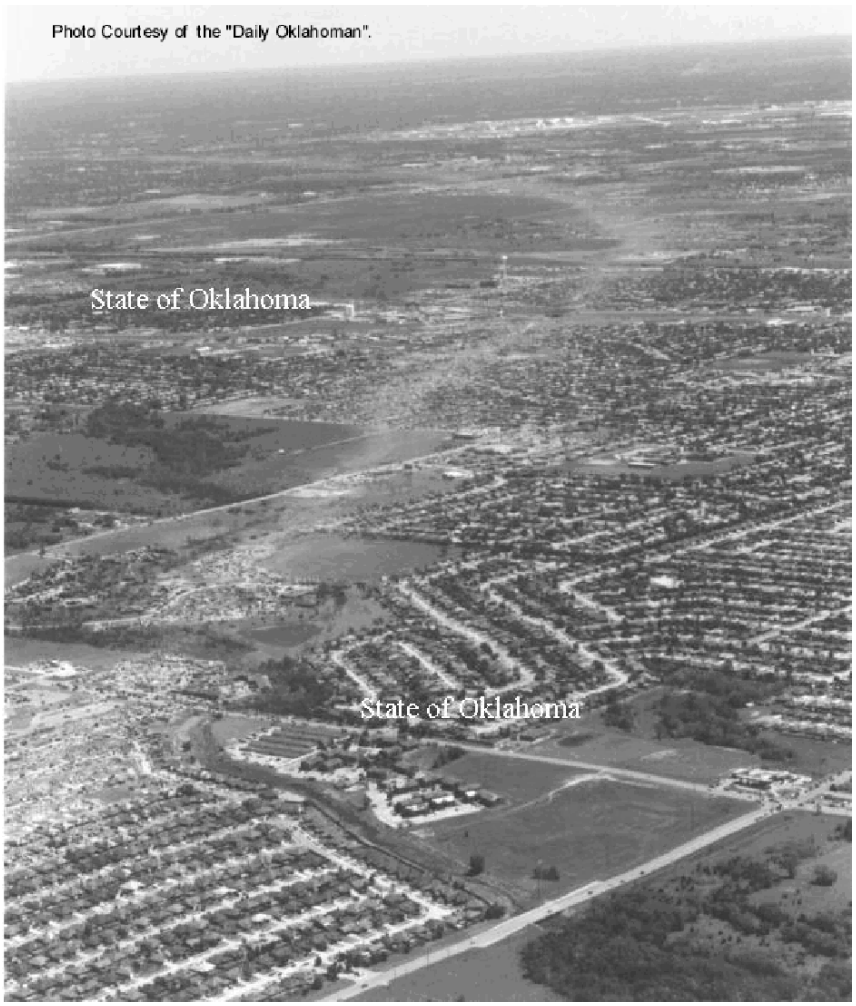

▲ **Figure 1**. A tornado's destructive swath is visible in this aerial view over Oklahoma, courtesy of the National Climatic Data Center.

Data products and services

Climate Data On-Line system

The National Climatic Data Center (NCDC) has placed its new Climate Data On-Line (CDO) system into full on-line operational mode containing 100 gigabytes of climate in-situ data, stored in an Oracle relational data base. Web users may now place orders through the system via the On-line Store, pay for the data with a credit card, and receive the data via ftp, all without any manual intervention by customer service personnel.

The CDO system now includes six full periods of record data sets: cooperative summary of day, first order summary of day, monthly summary, hourly precipitation, 15-minute precipitation, and monthly climatic data for the world. Data can be selected by various combinations of country, state, climate division, county, station, year, month, and day. The system is also used to process various applications requested off-line, such as the cooperative extremes tabulation. NCDC will advertise the system's availability to gradually increase system load. The next data sets being prepared for On-line access are U.S./global surface hourly and U.S./global upper air.
Contact: NCDC

Hurricane precipitation data

Dr. Libby Johns of the Atlantic Oceanographic and Meteorological Laboratory was supplied daily precipitation data by the National Climatic Data Center for cooperative locations in Florida Climate Divisions 4, 5, 6, and 7 via NCDC's anonymous ftp site. Dr. Johns intends to use the data in her research regarding precipitation expectations with land-falling hurricanes in the South Florida area.
Contact: NCDC

Geomagnetic data

The Niemegk magnetic observatory in Niemegk, Germany has sent NGDC, via Internet, the 1.0 minute and hourly value data for the year 1997. The use of the information highway has increased the timeliness and efficiency of receipt of geomagnetic data from various places around the world. Email is used to notify receipt and successful reading of the data files. Additionally, the 1997 magnetic yearbook was received. This publication contains annual and monthly mean data as well as the three hourly K indices. The total amount of data for this transfer was 14.7 megabytes. This new acquisition of data has been placed in the geomagnetic archive and the NGDC Space Physics Interactive Data Resource (SPIDR). This will enable the quick access and use of the data by the world's scientific community.
Contact: NGDC

Billion dollar weather disasters

The U.S. Billion Dollar Weather Disaster Report for 1980-1999 has been updated. The report is accessible from *http://www.ncdc.noaa.gov/extremes.html*; paper copies are also available. Two events have been added -- severe thunderstorms/hailstorms in Minnesota in May 1998 and the tornado outbreak in Oklahoma and Kansas in May 1999. Overall, 42 events occurred over the past 20 years, with 36 of these during 1988-99.
Contact: NCDC

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National Oceanographic Data Center (NODC)
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WWW: *http://www.nodc.noaa.gov*

NOAA Environmental Services Data Directory
301-713-0572
(Gerry Barton)
Fax: 301-713-1249
E-mail: barton@esdim.noaa.gov
WWW: *http://www.esdim.noaa.gov/#data-products*

NOAA Central Library
Reference Services:
301-713-2600
Fax: 301-713-4599
E-mail: *reference@nodc.noaa.gov*
WWW: *http://www.lib.noaa.gov/*

NCDC data used in balloon expedition

A European-based ballooning team contacted the National Climatic Data Center to obtain climatological data which will be used in a balloon flight over the Arctic Ocean. The balloonists' preliminary plans are to depart in late March 2000 near the city of Sredne, Russia, and terminate the flight somewhere over the United Kingdom in May. The NCDC provided the expedition team with the *Global Upper Air Climatic Atlas (GUACA)* CD-ROM. The team will extract the wind patterns at a flight level of 20,000 feet along with temperature and moisture characteristics before determining a final route.
Contact: NCDC

Prehistoric coral records

A report on paleoclimate records of the tropical ocean, including coral records, is now available. The report is titled "Annual Records of Tropical Systems" (ARTS), and presents recommendations for research. The report also highlights some recent successes that contribute to NOAA goals in assessing past climate. The NGDC/NOAA Paleoclimatology program supports the ARTS program by contributing data management expertise to ensure that data produced by ARTS are accessible to the broad scientific community. The report can be obtained from the Past Global Changes Project Office at *http://www.pages.unibe.ch/pages.html*
Contact: NGDC

World tour regatta

The Norfolk, VA, Chamber of Commerce requested the National Climatic Data Center publication *Local Climatological Data (LCD)* for the period January 1995 through May 1999. A global regatta, including some of the largest sailing ships in the world, will be sailing past Norfolk to celebrate the 2000 millenium. The race will start in Australia and travel eastward across the South Pacific around Cape Horn, South America. The regatta will continue northward where the participants will make their way to New York via Norfolk. The Chamber is expecting almost two million visitors for the regatta, and will use the LCDs to determine local climatological conditions.
Contact: NCDC

Declining coral reefs, *from page 12*

general sessions comprised of 140 oral presentations, and 130 scientific posters. Organizers reported that the conference met its goal of creating a scientific review and analysis, integrating the global body of knowledge available in the specific areas of coral reef assessment, monitoring, and restoration. In doing so, emerging concepts were identified, and innovative scientific and technological approaches were presented.

The keynote speaker for the event was Deputy Assistant Secretary for Oceans and Atmosphere of the U. S. Department of Commerce, Sally J. Yozell, who gave the Administration's views and contributions to coral reefs in "The U.S. Commitment to Coral Reefs, Both Physically and Fiscally."

She attributed current interest in coral reefs to the work of members of the assemblage and thanked them for their help. Last year President Clinton signed an Executive Order establishing both a federal policy regarding coral reef degradation and a Coral Reef Task Force. This task force is composed of 11 federal agencies, as well as the governors of the states and territories with responsibilities for coral reefs. (See the June issue of *Earth System Monitor* for more information about the CRTF.)

Ms. Yozell asked for the help and participation of everyone present at the conference to share their expertise and recommendations with the Task Force in order to reduce human impacts and better protect reef ecosystems—and the communities and economies that depend on them.

Appendix

Nine organizations co-sponsored the conference, including the International Society for Reef Studies; National Ocean Service and the National Marine Fisheries Science Center, both subsidiaries of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA); the Broward County (Florida) Department of Natural Resource Protection; the Ocean Research and Education Foundation Inc.; the National Center for Caribbean Coral Reef Research at the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences (RSMAS); Florida Sea Grant at the University of Florida; the Florida Institute of Oceanography; LAW Engineering & Environmental Services, Inc. The International Center for Living Aquatic Resources Management (ICLARM)'s ReefBase endorsed the scientific program of the conference.

The Conference was the brainchild of NCRI Executive Director (and Dean of Nova Southeastern University's Oceanographic Center) Dr. Richard E. Dodge and NCRI Research Director Dr. James D. Thomas. The effort was supported by NCRI Research Scientist Dr. David S. Gilliam. Dr. Dodge is a noted expert on corals and coral reefs, with considerable experience in the investigation and analysis of the growth rates of reef-building corals, coral reef structure, fossil coral reefs, the ecology of coral reefs, techniques of coral reef damage assessment (including the effects of ship groundings), and oil effects on corals and coral reefs. Dr. Thomas is a noted coral reef ecologist, focusing on biodiversity issues and taxonomy, but retaining a broad over-arching perspective.

More information about the Conference (including text of all abstracts and a Participants List) may be found on the web at *http://www.nova.edu/ocean/ncri/conf99.html*. More information about the National Coral Reef Institute may be found at *http://www.nova.edu/ocean/ncri/index.html*.

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