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Resource Ecology Data Analysis at the Northwest Fisheries Center (NWFC)

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INTRODUCTION

Although few people doubt that living marine organisms are affected by the marine environment, the enormous tasks associated with not only the initial measurement, but the subsequent analysis of the three-dimensional spatial fields have proved to be a major deterrent in acquiring the amount of environmental data required to provide insight into specific relationships. In the 1950's and 1960's the Bureau of Commercial Fisheries (BCF), the forerunner of the present National Marine Fisheries Service (NMFS), NOAA, conducted unprecedented year-round oceanographic surveys, still unequalled in scope and intensity, over wide expanses of the Pacific Ocean from below the Equator to the Bering Sea. Those surveys were largely in support of tuna research conducted by the La Jolla and Honolulu Biological Laboratories, and Pacific salmon research at the Seattle Biological Laboratory. Unavoidably, the results of many oceanographic studies were not forthcoming for months (and in some cases years) after termination of the cruises, whereas the data from fishing cruises were normally immediately available. As a result, interest and support for oceanographic studies waned.

However, modern technology—in the form of salinity-temperature-oxygen-depth systems, chemical autoanalysers, and other sampling equipment—has greatly simplified the acquisition of data. Recently simple, automated, analytical equipment has become available that permits not only rapid analysis of data but a renewed and increasing demand for additional data related to the ecology of living marine resources.

One oceanic area of particular concern to the Northwest Fisheries Center (NWFC) is the northern Gulf of Alaska and eastern Bering Sea where important stocks of crustaceans such as king and snow (Tanner) crab, shrimp, and groundfish such as Pacific halibut and walleye (Alaska) pollock are being heavily exploited or affected by foreign fishing activities. There is an extensive data base of routine serial oceanographic observations in this area, as shown by a dotplot (Fig. 1) constructed from a portion of an oceanographic data geofile available at the National Oceanographic Data Center (NODC).

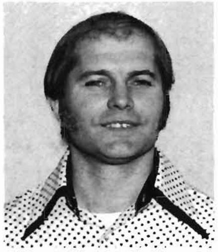
COMPUTER INFORMATION SYSTEM AND GRAPHICS SUITE

The Division of Resource Ecology and Fisheries Management of the NWFC has recently acquired data processing equipment composed of several components synthesized into a graphics-oriented remote computer suite, which is currently interfaced with the University of Washington CDC6400/CYBER73 computers via INTERCOM[1] (Control Data Corporation, 1975) at 30-120 characters per second transmission rate over regular telephone lines. The components—the CRT (cathode ray tube) terminal, the digitizer tablet, the disc memory unit, and printers (Figs. 2 and 3)—are used as an interactive computer cartography system for digitizing maps and displaying spatially and temporally distributed statistics computer from extensive environmental data bases. The suite provides improved access and analysis of not only extensive historical environmental data collected by countries contributing to World Data Centers and available at NODC (National Oceanographic Data Center, 1974) by geographic area of interest but also near real-time data from various agencies conducting field operations. All available station data have been implemented on an information storage and retrieval system, developed by L. Gales and D. J. Brown, called RIRS[2,3].

RIRS provides random-access, fast response (usually 1-5 minutes) retrieval of Boolean combinations of the keys or variables associated with the data base. Retrieved data are listed, summarized, or mapped onto a "live" atlas which can be interactively manipulated at the terminal. Any rectangular area of the map can be expanded to screen size (19-inch diagonal) by defining a


Favorite


Brown


Ingraham

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[1] Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

[2] Gales, L., and D. J. Brown, 1974. Setup procedure for RIRS: A randomized information retrieval system. Unpubl. manuscr., 12 p. Univ. Washington Sea Grant, NORFISH N133B.

[3] Gales, L., and D. J. Brown. 1974. Users guide for RIRS: A randomized information retrieval system. Unpubl. manuscr., 6 p. Univ. Washington Sea Grant, NORFISH N133A.

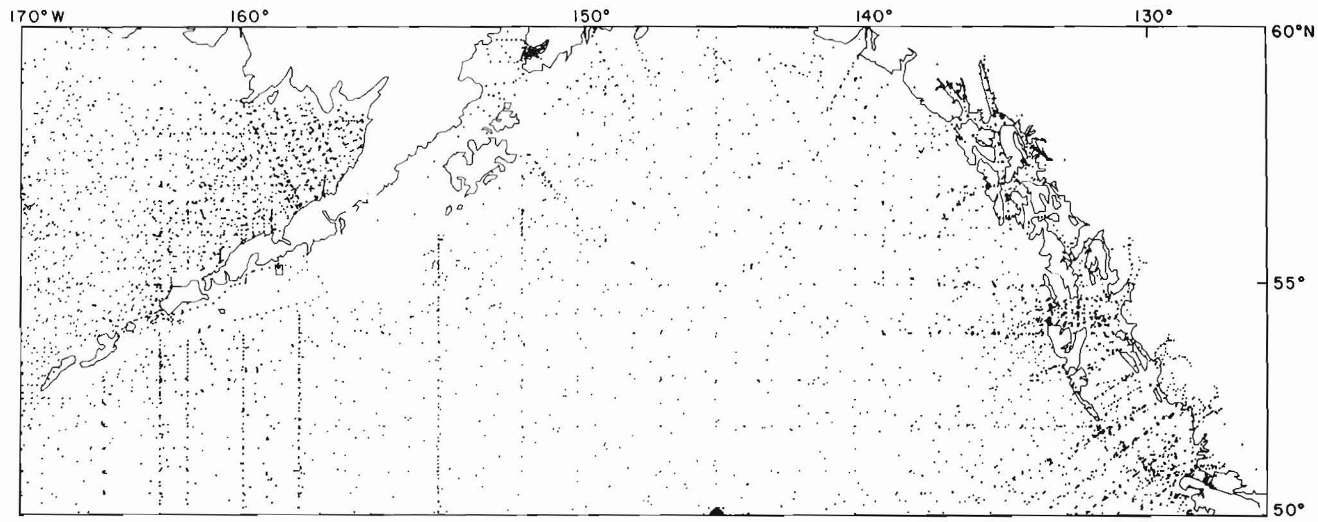

Figure 1.—Locations of all oceanographic stations within a portion of the NODC geofile acquired in June 1975.

rectangular block using adjustable x-y axis cross hairs. The tablet permits immediate on-screen digitizing of land contours, bathymetry, or any other form of x-y plots. Once created, a particular map can be stored remotely on the floppy disc and redisplayed,

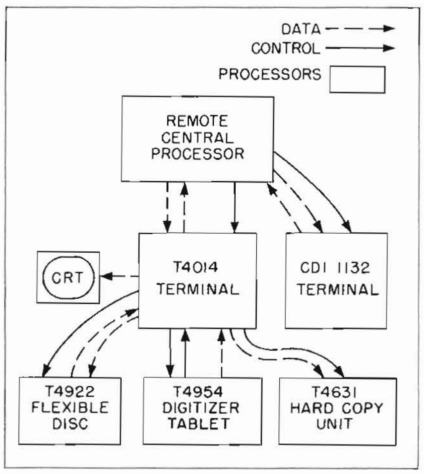

Figure 2.—Diagram of system components.

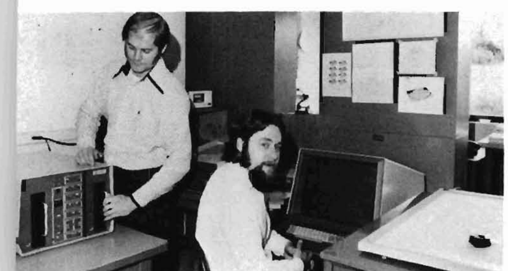

Figure 3.—W. James Ingraham, Jr. (left) and Daniel J. Brown (right), operating computer graphics components.

plotted for manuscript quality reproduction, or instantly printed on the hard copy unit.

The results of a sample conversational retrieval and mapping session follow. The keys, variables, retrieval request, and computer costs are also given. The original NODC data have been reformated, eliminating extraneous and redundant information; the remaining keys and variables are:

Keys

CNY	Country
CRU	Cruise
CONS	Consecutive number
TEN	Ten degree square
ONE	One degree square
FIVE	Five degree square
LATD	Latitude degrees
LATM	Latitude minutes
LOND	Longitude degrees
LONM	Longitude minutes
YEAR	Year
MO	Month
DAY	Day
SHIP	Ship
DBOT	Depth to bottom, meters

Variables

DEPTH	Depth of sample, meters
TEMP	Temperature, °C
SALIN	Salinity,‰
SIGT	Density, g/l
OXY	Oxygen, ml/l
DYD	Dynamic depth anomaly

Example 1—The following two statements,

IF ((TEN. EQ. 1417. OR TEN. EQ. 1418). AND. (MO. EQ. 6)) RETREVE =. TRUE.

IF ((FIVE. EQ. 3. OR FIVE. EQ. 4). AND. (DEPTH. EQ. 0)) RETREVE =. TRUE.

request the retrieval of all data at the sea surface from a 97,000 card image data base for the month of June in four 5° Marsden quadrants that encompass Bristol Bay and the western Gulf of Alaska. The retrieval cost was $4.59, and it took 8 minutes for the computer to respond after retrieving 488 card images from the master data file. Once the new data file is created, any of the variables or keys can be superimposed on a Mercator map projection of the area.

For example, LATD and LOND of station locations were selected and processed by a graphics program. This produced a dotplot superimposed on the appropriate portion of the map in 2 minutes (Fig. 4) that can be previewed on the terminal screen. The information is stored for re-use and a paper (hard) copy is made.

Example 2—The following two statements,

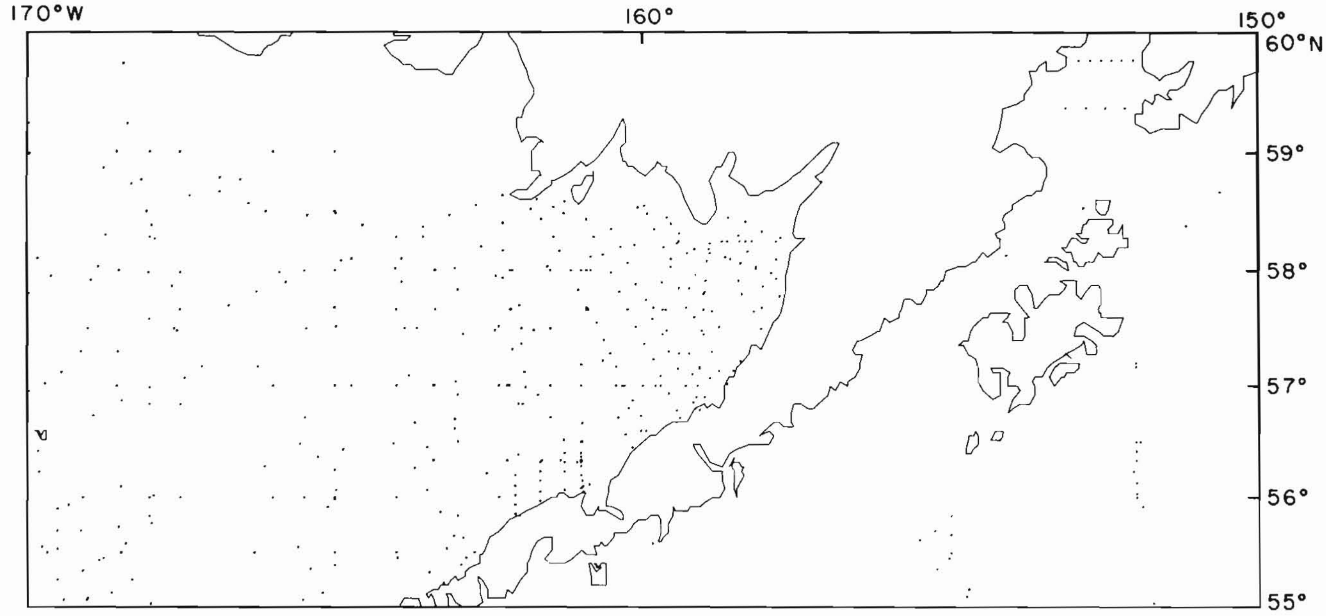

Figure 4.—Location of oceanographic stations available for the month of June.

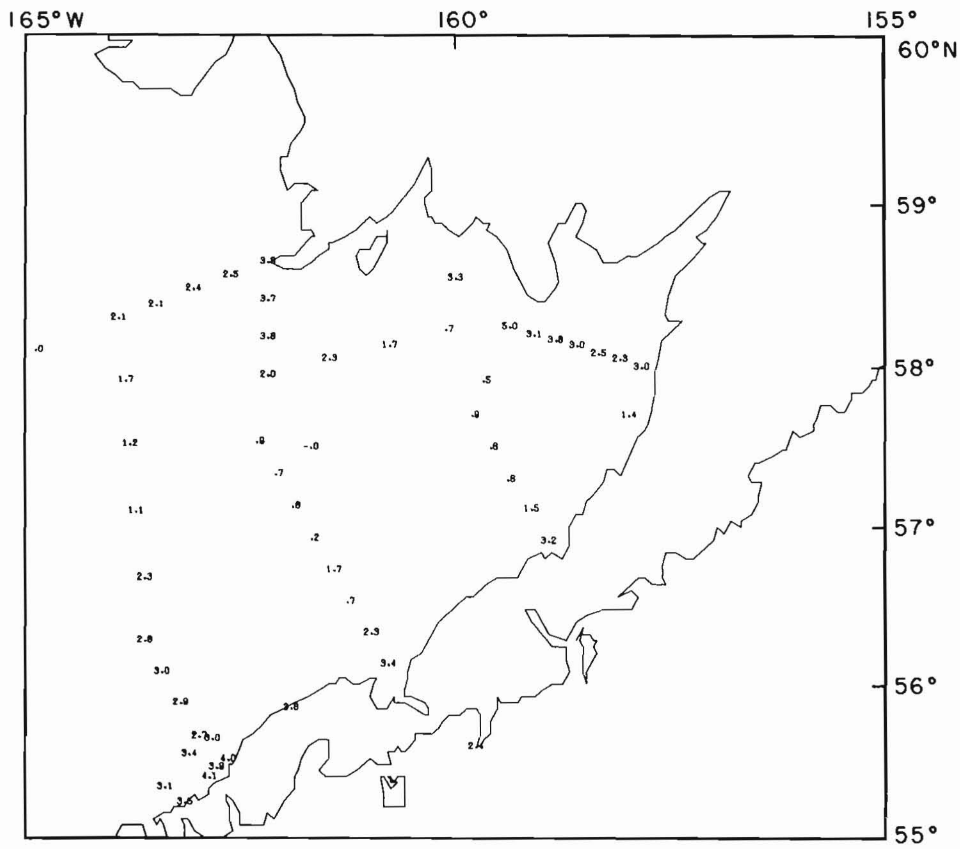

Figure 5.—Sea surface temperature (°C) data available for June 1971.

IF ((TEN. EQ. 1417. OR. TEN. EQ. 1418). AND. (MO. EQ. 6). AND. (YEAR. EQ. 1971)) RETREVE =. TRUE.

IF (FIVE. EQ. 3. OR. FIVE. EQ. 4). AND (DEPTH. EQ. 0)) RETREVE =. TRUE.

request the retrieval of all data at the sea surface for the specific month, June 1971. Retrieval cost was $1.60 and 4 minutes was required to select the 78 card images meeting the retrieval criteria. Instead of creating a dotplot of station locations, this time surface temperature values in the two 5° Marsden squares encompassing the eastern Bering Sea were selected, previewed, and printed (Fig. 5)—again, in a matter of seconds. These examples demonstrate two simple applications of data retrieval and the accompanying displays that assist in analyses of environmental conditions. Obviously the inherent versatility and capability of these new techniques provide convenient methods of studying various components of ecosystems. Maps with higher resolution of the coastline, and if desired with bathymetry, can be digitized interactively on the graphics tablet, and various horizontal physical, chemical, biological, and geological fields can be viewed sequentially or even superimposed on the CRT terminal.

FUTURE REQUIREMENTS AND PLANS

The ability to manipulate large amounts of data has clearly indicated the paucity of observations near the sea floor over the continental shelf and slope. Although early water sampling devices (e.g., Nansen bottles) were vulnerable to damage by dragging along the bottom because of the delays inherent in tripping devices, acoustic "pingers" (that accurately indicate the depth of the device off the bottom), acoustic tripping mechanisms (operable in conjunction with Nansen bottles), and salinity-temperature-depth sensors presently eliminate this problem. Nevertheless, although today an increasing number of marine scientists are interested in the total vertical field of mass, many will have to be encouraged to obtain observations of water properties down to the sea floor itself if we are to increase our understanding of the ecology of this area of the ocean.

This computer information system and graphics suite permits an interactive, iterative method of analysis of various environmental data, thus optimizing benefit of the speed of the conversational remote terminal and heuristic human capabilities. These are complementary roles, and computer graphics provides a high level language interface between man and machine. Further development of computer software is planned in conjunction with not only numerous "live" and historical environmental atlases of finite coastal areas, but also with hydrodynamical and ecosystem models, which will provide insight into multispecies and ecological interacting variables.

ACKNOWLEDGMENTS

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