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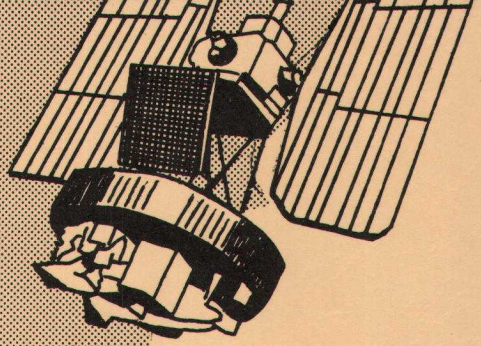
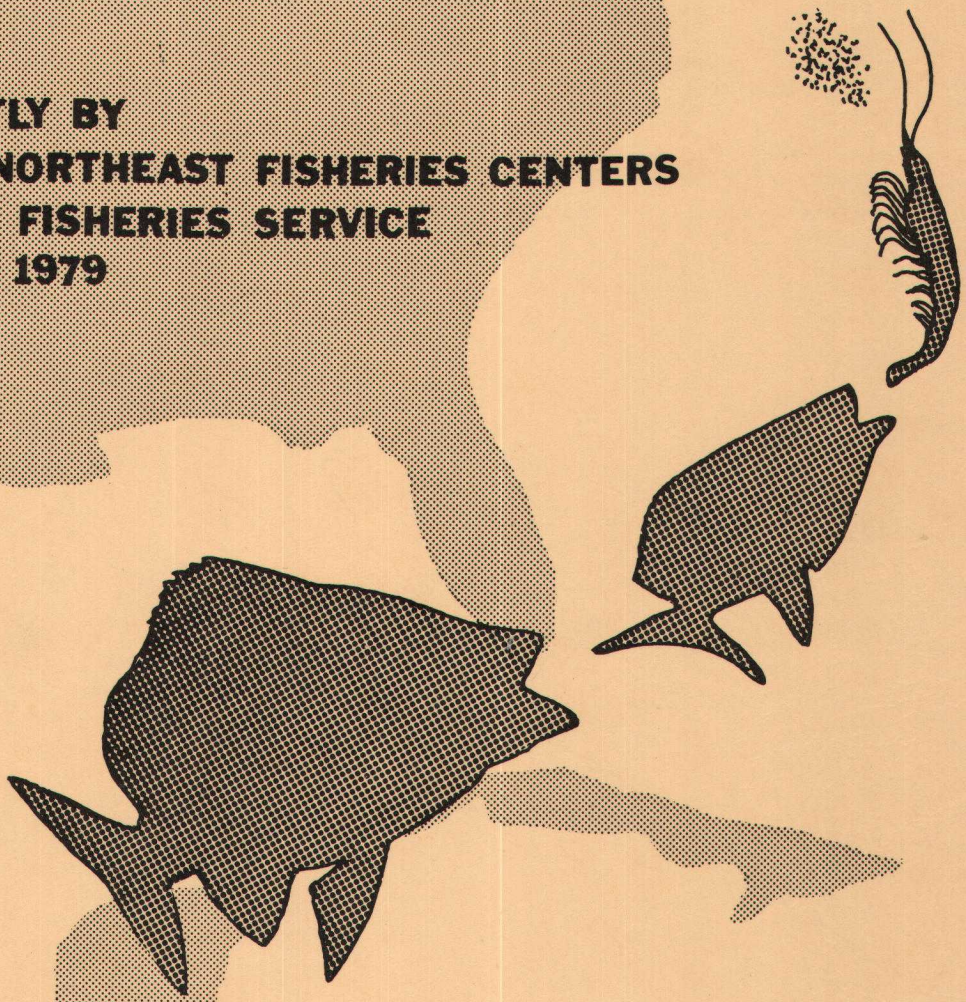


PROCEEDINGS OF COASTAL ZONE COLOR SCANNER WORKSHOP

SPONSORED JOINTLY BY
SOUTHEAST AND NORTHEAST FISHERIES CENTERS
NATIONAL MARINE FISHERIES SERVICE
OCTOBER 22-24, 1979



S. DEPARTMENT OF COMMERCE
ATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ATIONAL MARINE FISHERIES SERVICE
OUTHEAST FISHERIES CENTER
IAMI, FLORIDA
EBRUARY 1980

NOAA Technical Memorandum
NMFS-SEFC-9

PROCEEDINGS OF
COASTAL ZONE COLOR SCANNER WORKSHOP

Sponsored Jointly by
Southeast Fisheries Center and Northeast Fisheries Center
National Marine Fisheries Service
Miami, Florida
October 22-24, 1979

Edited by Joan A. Browder and Joseph E. Powers
Southeast Fisheries Center
February, 1980

U.S. Department of Commerce
Philip M. Klutznick, Secretary
National Oceanic and Atmospheric Administration
Richard R. Frank, Administrator
National Marine Fisheries Service
Terry L. Leitzell, Assistant Administrator of Fisheries

EXECUTIVE SUMMARY

A WORKSHOP WAS HELD IN MIAMI, FLORIDA ON OCTOBER 22-24, 1979, TO DISCUSS THE POTENTIAL FOR USING THE COASTAL ZONE COLOR SCANNER (CZCS) IN ECOLOGICAL FISHERIES RESEARCH. THE NORTHEAST AND SOUTHEAST FISHERIES CENTERS, WHO CO-HOSTED THE WORKSHOP, HAVE COMMON INTERESTS IN REMOTE SENSING AND ECOLOGICAL STUDIES. A RECENT SIGNIFICANT INCREASE IN INTEREST BY NOAA AGENCIES IN THE APPLICATION OF REMOTE SENSING TO MARINE STUDIES HAS BEEN SPURRED BY:

1) THE NEWLY RECOGNIZED NEED FOR SYNOPTIC DATA COVERING LARGE AREAS FOR FISHERY ECOSYSTEM STUDIES; AND

2) NEW BREAK-THROUGHS BY THE NATIONAL ENVIRONMENTAL SATELLITE SERVICE (NESS) ON THE INTERPRETATION OF CZCS DATA TO DETERMINE CONCENTRATIONS OF CHLOROPHYLL AND SUSPENDED PARTICULATE MATTER.

THE WORKSHOP RECOMMENDED A JOINT RESEARCH EFFORT ON THE PART OF THE NORTHEAST AND SOUTHEAST FISHERIES CENTERS AND OTHER INTERESTED AGENCIES, SUCH AS NESS AND THE ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY (AOML) OF THE NOAA ENVIRONMENTAL RESOURCE LABORATORIES (ERL), TO TAKE ADVANTAGE OF THE CZCS. THE WORKSHOP RECOMMENDED IMMEDIATE ACTION.

INTRODUCTION

For some time there has been interest within the National Oceanic and Atmospheric Administration (NOAA) to apply satellite-obtained remote sensing data to marine studies. This technology holds the potential for systematic measurement of several oceanographic variables which could be invaluable to research within NOAA. The National Aeronautics and Space Administration (NASA) has launched several satellites with ocean remote sensing capabilities, one of the more recent being the NIMBUS-7 spacecraft, which carries the Coastal Zone Color Scanner (CZCS), the first ocean color sensor ever operated from space for inferred measurements of chlorophyll and turbidity. The CZCS of the Nimbus-7 satellite has been monitoring, recording, and transmitting radiance data on the oceans of the world since October 29, 1978.

NOAA has fielded a small effort to develop algorithms for converting CZCS radiance data into inferred chlorophyll and turbidity measurements for approximately four years. However, considerable doubt has existed as to whether the relationship between space color measurements and chlorophyll could be quantified, i.e., if a successful algorithm could be developed. Recent results have indicated that indeed chlorophyll can be inferred with accuracies exceeding design goals. With these positive results, NASA is now capable of producing mappings of chlorophyll on a regular basis. Validity of the maps does, however, have to be verified by sea surface measurements.

Relatively little support has been provided by NOAA for the analysis of CZCS data. The Nimbus-7 Experiment Team, which cooperated with NASA in the development of analytical capability, was, however, chaired by a NOAA person -- Dr. Warren Hovis. Without NASA support, which exceeded that from NOAA, the advances made with the CZCS system never would have been possible.

There recently has been a significant increase in interest within NOAA concerning remote sensing applications to marine studies, primarily due to demonstrated potentials with satellite systems such as LANDSAT, SEASAT-A and NIMBUS-7.

Both the Southeast Fisheries Center (SEFC) and the Northeast Fisheries Center (NEFC) of NMFS have been interested in applying chlorophyll and turbidity data to the study of marine ecosystems and the fisheries they support. Chlorophyll data from the CZCS could provide a quantum jump in this area.

Additionally, cooperative efforts on the part of SEFC and NEFC could yield increased data on sea surface truth measurements for the particular ocean waters of concern to these organizations.

In order to develop such a cooperative effort, the SEFC and NEFC hosted a workshop October 22-24, 1979 at the SEFC Miami facility. The objectives of this workshop were fivefold:

1. to assess the present level of effort in sea surface truth measurements relative to the CZCS,

2. to assess the accuracy of satellite-derived chlorophyll measurements and their conversion algorithms,

3. to exchange information between the agencies and institutions involved in remote sensing or ecosystem studies of the oceans under NEFC and SEFC purview,

4. to establish a communications base to facilitate future cooperative work with the National Environmental Satellite Service (NESS), the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the Environmental Resources Laboratories (ERL), and other interested research groups,

5. to outline a proposal for an ecosystem study in which remote-sensing techniques could be applied to fisheries.

This report is a summary of the findings and conclusions of that workshop.

WORKSHOP SUMMARY

The Southeast Fisheries Center provided meeting facilities for the CZCS workshop with Dr. Joan Browder (SEFC) chairing the sessions. Dr. William Fox, SEFC Center Director, gave the opening address, and Dr. Robert Edwards, NEFC Center Director, made a brief orientation speech. Other NOAA agencies represented at the workshop were the Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami, Satellite Field Service Station (SFSS) of the National Environmental Satellite Service (NESS), the Washington, D.C. office of NESS, the Langley Research Center of the National Atmospheric and Space Administration (NASA), and the Marine Environmental Assessment Division (MEAD) of the Center for Environmental Assessment Services (CEAS) for the Environmental Data and Information Service (EDIS) in Washington, D.C. Additionally several other agencies and universities were represented.

The workshop was held to determine the potential for the coastal zone color scanner to provide urgently needed information for marine fishery ecological studies. The scope of the workshop broadened spontaneously to include discussion of the information opportunities offered to marine ecological studies by other currently operating remote sensor systems such as LANDSAT, TIROS-N, NOAA-6, and GOES-1,3. According to workshop participants dynamic and synoptic information on currents, fronts, patches, salinity wedges, freshwater lenses, and concentrations of chlorophyll and suspended particulate matter (SPM) can be obtained through the interpretation of gradients and discontinuities in the imagery from these satellite systems.

The capability to detect and quantify chlorophyll and SPM exists with the CZCS. Major breakthroughs in interpretation of CZCS data for these two variables have recently been made. Mr. Dennis Clark of NOAA/NESS/Washington presented results in which high correlations were achieved between surface pigment (chlorophyll and phaeophytin a) measurements ranging over three orders of magnitude in concentration and the log of ratios of upwelled radiance at three different wave lengths. Sea truth is necessary to the reliable interpretation of CZCS data and is required to provide adequate information for ecological studies. Sea truth should include: upwelled radiance in four spectral bands (443, 520, 550, and 670 m) at 1 m below the surface and several other depths, depending on turbidity; chlorophyll and phaeophytin concentrations in the surface meter; and ratio of chlorophyll to phaeophytin. So that surface chlorophyll concentrations can be extended to the entire euphotic zone and be used as an index of primary productivity, sea truth also should include integration of chlorophyll and phaeophytin through the entire euphotic zone and primary productivity per unit chlorophyll at various depths. A workshop presentation by Dr. Sayed El Sayed indicated a strong linear relationship between surface chlorophyll and the integration of chlorophyll with depth and an equally good linear relationship between chlorophyll and primary productivity, within specific locations and seasons. To estimate the potential food for fishes, the ratio of chlorophyll to biomass needs to be determined.

The extent to which sea truth is required in the application of remote sensing data was a major topic of discussion at the workshop. Participants who had extensive backgrounds in the development and application of information from remote sensors emphasized that adequate sea truth was essential to the development of quantitative

information from the sensors. The extent to which sea truth can be extrapolated space and time depends upon the parameter, specific problems and experience with the sensor.

Dr. Robert Edwards noted that the degree of accuracy required by NASA of remote sensors before making them operational may be unrealistic since obviously less th absolute values that are being achieved at this time can be extremely useful in ecological studies. The remark was in part related to the fact that NASA still considers CZCS to be an experimental sensor and apparently for that reason does n make available its processed data on a timely basis, and also because there has been a pervasive problem generally trying to develop a dialogue between the biologists and oceanographers and the engineers directly working with sensors.

A major impediment to the application of the CZCS to marine fisheries ecological studies is the slow turnaround time on processed CZCS images at the NASA/Goddard facility.

The Northeast and Southeast Fisheries Centers currently are developing a joint project on the comparison of energy flow in different types of marine ecosystems importance to fishery production. A study utilizing the coastal zone color scann to obtain synoptic and seasonal data on chlorophyll and suspended particulate matter in order to quantify the resource base of fisheries will be part of the first level of effort in the joint ecosystem study. A plan for this study, which will potentially involve other cooperators from NOAA and private institutions, wa a direct outgrowth of the CZCS Workshop.

RESEARCH PLAN FOR THE COMPARISON OF ENERGY FLOW IN MARINE FISHERIES ECOSYSTEMS
A JOINT PROJECT OF THE SOUTHEAST FISHERIES CENTER, THE NORTHEAST FISHERIES CENTER, AND THEIR COOPERATORS

The major focus in marine ecosystem studies has been in boreal-temperate areas such as the North Sea, the Norwegian Sea, the Baltic, and the Northwest Atlantic; and southern temperate and subtropical marine ecosystems have been neglected. Although comparisons of marine ecosystems from different temperature zones previously have been made they have primarily been based upon qualitative information and from extrapolations from tropical terrestrial systems.

The Northeast and Southeast Fisheries Centers of the National Marine Fisheries Service are initiating cooperative comparative studies on structure and energy flow in boreal-temperate, southern temperate, and subtropical marine systems. The overall objectives of these studies are to examine the functional relationships between primary production, secondary production, and the productivity of fish stocks. The area under study extends from the Gulf of Maine to the Gulf of Mexico and the Caribbean.

The comprehensive study will define and quantify the major physical forces acting on the systems, major inputs to the systems, major trophic levels represented, and significant prey-predator relationships. These will be diagrammed in the form of a set of compartments and interconnecting energy flows that will then be quantified. On the basis of the information, the systems will be compared for:

1. type and magnitude of significant physical forces;
2. sources of inputs of energy and materials;
3. number of significant trophic levels;
4. number of significant compartments at each trophic level;
5. relative magnitude of trophic types;
6. relative magnitude of analagous energy flows;
7. ecological efficiency at each trophic level; and
8. number of significant interactions.

Interactions where changes have a disproportionately high effect on system behavior will be identified as critical nodes, and the systems will be compared for locations of these nodes within the trophic web.

The study will determine the amplitudes and frequencies of fluctuations in major forcing functions such as the Loop Current, the Gulf Stream, and the Mississippi River discharge, as well as the amplitudes and frequencies of fluctuations in standing stocks of phytoplankton, zooplankton, and young and adults of major fish and shellfish species.

The study will quantify and compare seasonal variation in phytoplankton standing stock and horizontal patterns of distribution of phytoplankton. It will identify the principal sizes and types of food of larval fishes of the primary species and document the timing of phytoplankton peaks, zooplankton peaks, and spawning of fish and shellfish. The survival of early life history stages will be viewed with respect to the synchronization of these events.

The resiliency of the systems will be compared by measuring the changes in each system that occur under perturbation and the time required by each system to retu to "normality" after the event. System response to both predictable and unpredictable events will be examined.

Due to the complexity of these problems and the inadequacy of the current data base, it is expected that approximately 10 years will be required to meet the overall objectives. The study therefore will be approached at several levels wit discrete products.

The first level of effort will focus on factors affecting the early life history fishes and will take advantage of synoptic and dynamic information on chlorophyll and suspended particulate matter concentrations that can be obtained from the coastal zone color scanner (CZCS) in the NIMBUS-7 satellite. Other remote sensor systems such as LANDSAT and TIROS will be used to obtain information on other factors, such as currents, temperature fronts, patches, and salinity wedge-freshwater lenses, that are thought to influence larval survival. Results the first level of effort are expected to be particularly relevent to understandi fisheries in the context of their ecosystems, because fishery yield is known to b determined early in the development of a year class.

Sea truth for sensory calibration of the CZCS will concentrate on two highly productive ecosystems: Georges Bank, a boreal-temperate offshore system, and the Mississippi River discharge area, a subtropical system that is essentially estuarine. Mississippi and Georges Bank systems supply a large proportion of U.S fishery landings and economic yield. To the extent that resources are available, effort may be extended to New York Bight, the western Florida shelf, the Texas shelf and the coastal Carolinas.

The scheduled cruises on which sea truth data can be collected are listed by are in Table 1.

Table 1. Scheduled Cruises for Potential CZCS Sea Truth in Primary Target Area.

A. Mississippi Area

Cruise Date	Vessel	Agency	Area Covered by Cruise
Nov. 28-Dec. 9	ENDEAVOR	AOML	North Gulf, Pensacola Bay to Galveston
Dec. 11-21	OREGON II	NMFS/SEFC	North Gulf, Pensacola Bay to Galveston
Feb. 5-15	OREGON II	NMFS/SEFC	North Gulf, Pensacola Bay to Galveston
Feb. 27-Mar. 27	OREGON II	NMFS/SEFC	Gulf of Mexico (offshore waters)
Apr. 10-May 4	OREGON II	NMFS/SEFC	North Gulf, Mobile Bay to Texas coast

B. Georges Bank

Organization	Cruises Per Year
NMFS/NEFC	12 (Monthly)
Brookhaven	3 - 4
Bigelow Marine Lab	Several

In addition to the cruises one fixed sampling platform for continuous sampling at one location may be established in each primary target area. A possible location for the Georges Bank fixed site is the Nantucket Shoal lighthouse. Any one of several manned drilling platforms immediately west of the Mississippi discharge site are potential sites for fixed measuresments in that area.

The parameters to be measured in the development of sea truth are listed in Table 2. To the extent resources allow, these parameters will be measured both on cruises and at the fixed platform.

Table 2. Parameters to Be Measured for CZCS Sea Truth.

Sea state
Percent cloud cover
Nader upwelled radiance (in narrow spectral bands at 443, 520, 550, and 670)

* chlorophyll-a and phaeophytin-a
* phaeophytin-a/chlorophyll a ratios
  biomass/chlorophyll-a ratios
* suspended particulate matter
* particle size
* percent organic in suspended matter
* dissolved organic matter
* temperature
* salinity
  Secchi disc
  brown Secchi disc
* dissolved oxygen
* primary productivity/chlorophyll a
  taxonomic composition of phytoplankton

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* vertical distribution to be determined

Data collected specifically as sea truth for the CZCS will be augmented by data collected coincidentally by other workers in the target areas over the period of coverage by the satellite. An EDIS search has disclosed 32 studies in which chlorophyll and/or suspended particulate matter measurements have already been ma in the northern Gulf of Mexico.

Extension of satellite data outside of the two primary target areas will depend almost entirely on other workers. These are shown by area of coverage in Table 3

Table 3. Current studies for potential CZCS sea truth secondary target areas.

A. New York Bight

New Jersey Marine Science Consortium
U.S. Geological Service - Wood Hole
University of Connecticutt
Stoney Brook

B. Western Florida Shelf

Florida Department of Natural Resources
(5 day cruises every third week)

C. Northwestern Gulf (Bryan Mound Area)

Department of Energy Strategic Petroleum Reserve Studies (not presently making these particular measurements but might be persuaded to include them)

Some products of the initial level of effort are expected to be:

1. a description of the timing and duration of blooms in relationship to climate and hydragraphic events;

2. a description of seasonal changes in taxonomic composition and biomass of phytoplankton;

3. a description of the size and distribution of phytoplankton patches;

4. the high frequency detail of the annual cycle of chlorophyll in each area; and

5. an estimate of total biomass and annual primary productivity of each system.

Cost Estimate of Ground Truth Instrumentation
for F.R.V. OREGON II

Special equipment is needed by the Southeast Fisheries Center to collect sea truth data for the coastal zone color scanner. Listed are instrumentation and estimated costs to minimally equip the OREGON II research vessel for sea truth measurements of the variables considered most important for calibration of remote color measurements, namely:

1. Upwelling and downwelling radiance
2. Chlorophyll a and phaeophytes (continuous and discrete measurements)
3. Suspended particle (including % organic and size distribution)

Measurement	Suggested Instrument	Cost ($K)
Chlorophyll a	Turner Designs 10-005 continuous flow fluorometer + accessories	5.0
Chylorophyll a	Turner 111 Fluorometer (discrete samples)	3.0
Radiance	RSI 35-187 Underwater Radiometer	17.5
Suspended Particles, Nutrients	Water Sampling bottles, filters, etc.	1.5
	9 channel digital tape recorder	14.0
	Total	41.0

The radiometer estimate is for a new wavelength-tunable radiometer in which the filter wheel assembly will be replaced by a monochromator. The unit, which is being developed by RSI, is expected to sell for $15K to $20, assuming that the da are to be recorded digitally on magnetic tape. (Robert Crabb, RSI, pers. comm., Nov. 9, 1979). Analog recording would reduce the total cost by about $10K.

CONCLUSIONS

The Workshop concluded that current conditions appear particularly favorable for the application of remote sensing data to fishery studies for the following reasons:

1. Remote sensing techniques have been sufficiently developed to provide the degree of accuracy necessary for ecosystem studies.

2. Requirements for sea-truth data from field studies to obtain this accuracy are now within the practical range.

3. Fishery ecosystem techniques are now sufficiently developed to provide the structure to encorporate data obtained by remote sensing.

The direction that fishery research is taking suggests that we can expect increased reliance by fisheries researchers on data collected on a spatial and temporal scale obtainable only through remote sensing.

We need to act immediately to take advantage of the opportunities provided by the Coastal Zone Color Scanner.

Workshop Agenda
Southeast Fisheries Center
Miami, Florida
October 22-24, 1979

Monday Afternoon Session - 1:00-4:30 p.m.

Welcome	Dr. Joan Browder NMFS/SEFC, Miami
Introductory comments	Dr. William Fox NMFS/SEFC, Miami
Roles and interfaces	Dr. Robert Edwards NMFS/NEFC, Woods Hole
Background on the coastal zone scanner	Dr. Andrew Kemmerer NMFS/SEFC/NFEL, Bay St. Louis
MARMAP Fisheries Ecosystem Studies off the Northeast Coast of the U.S.	Dr. Kenneth Sherman NMFS/NEFC, Narragansett
State of technology in application of the coastal zone color scanner	Dr. Dennis Clark NESS, Washington
The use of remote sensing in biological effects monitoring (the Ocean Pulse Program)	Dr. Jack Pearce NMFS/NEFC, Sandy Hook
The LAMPEX program: application of the color scanner, IRI, and other remote sensing tools for monitoring	Dr. Jim Thomas NMFS/NEFC, Sandy Hook
Current remote sensing studies in the coastal zone and marine environment	Dr. Victor Klemas Center for Remote Sensing University of Delaware
Use of remote sensing data in bluefin tuna research	Dr. George Maul AOML, Miami and Mr. Mitch Roffer University of Miami
Present use of the coastal zone color scanner in red tide research in the eastern Gulf of Mexico	Mr. Kenneth Haddad Florida DNR

Tuesday Morning Session - 9:00-12:00 noon

The potential for remote sensing via the CZCS in marine ecological studies in the Southeast Region	Dr. Joseph Powers NMFS/SEFC, Miami
Ecosystem study of the North Central Gulf of Mexico	Dr. Joan Browder NMFS/SEFC, Miami
Data collection and development studies involving the Strategic Petroleum Reserve and other programs in the Gulf of Mexico	Mr. Dick Wheeler EDIS
Biological and chemical survey of two proposed brine disposal sites off West Hackberry and Weeks Island, La., and Buccaneer Oil Fields, Tx.	Dr. Charles Caillouet NMFS/SEFC, Galveston
Chlorophyll measurements in the Gulf of Mexico and consideration in remote sensing	Dr. S.Z. El-Sayed Texas A&M University
NMFS-AOML COOPERATIVE PROGRAM ON LARVAL HABITAT factors and role of organics in the marine environment	Dr. Ford A. Cross NMFS/SEFC, Beaufort and Dr. Peter Ortner AOML, Miami
Responses of potential users in research to a questionnaire on information needs from remote sensing	Dr. Don Ekberg NMFS/SERO, St. Petersburg
Remote sensing data available at the Miami Satellite Field Services Station (abstract included although no presentation was made)	Dr. Stephen Baig NESS/SFSS, Miami

Open Discussion

Tuesday Afternoon Session - 1:30-4:30 p.m.

Plan Development
Evaluation
Description
Comparison
Quantification
Modeling
- Recruitment Prediction
- MSY-OY Estimation
- Ecosystem Analysis

Wednesday Morning Session - 9:00-12:00 noon

Summary and Discussion

ABSTRACT

Presentation at Miami CZCS Workshop

Robert L. Edwards
Northeast Fisheries Center
National Marine Fisheries Service
Woods Hole, Massachusetts

The particular Workshop comes at a time when all of us need to consider the way in which we carry on our work. To do what we are proposing to do, that is to study the variations in primary production in a boreal and tropical regime, requires a great deal of coordination between Centers, between programs within Centers, between disciplines, between vessels, and most importantly in the present instances, all of these with the large number of people who are variously working in the field of remote sensing. The reward structure in research organizations is still, for the most part, based on individual effort. Here we are talking about an enormous number of different individuals with very different interests. We need to find a coherent basis for doing the work that needs to be done, preserving as much as possible of the existing reward structure by recognizing that goals will be achieved only if people are really working together. It wouldn't surprise me a bit if some of the documents which come out of our effort have as many as 20 different authors. There is also a need to develop a new paradigm for doing this work that coherently relates to individuals doing the process-oriented research and those doing the broad scale applied kind of research. Each kind of work has its proper role but these roles need to be blended in a sensitive manner to achieve the best results. The blending will take place providing we can identify objectives, however broad, that everyone can agree upon and providing each individual takes seriously the responsibility for communicating one with the other.

As far as I am concerned it is all too clear that we are now asking questions of the ocean environment that cannot be answered using vessels. Only a tool such as the remote sensing tool can provide both the synopticity required and the insights needed concerning the micro- and meso-scale structures that exist in the ocean. At this point in time it is less important that sensors cannot be absolutely quantified. What is important is that they see structures of real meaning to us in semi-quantitative or even useful qualitative terms. We have picked the CZCS as our basic tool simply because it seems to offer the most information at the present time.

ABSTRACT

Historical Review

Andrew Kemmerer
National Fisheries Engineering Laboratory

The proposal for a joint SEFC-NEFC ecological program that would emphasize data from the Nimbus-7 Coastal Zone Color Scanner (CZCS) was an outgrowth of many previous efforts related to this satellite system. The first of these was an Ocea Color Workshop co-hosted by NMFS/SEFC and ERL/AOML October 1976 in Miami, Florida. The purpose of the Workshop was to develop recommendations for NOAA's involvement in a CZCS program. The Workshop recommended a significant NOAA commitment, suggested an organizational structure similar to one used by the SEASAT-A program, and provided 45 separate proposals for ocean color research. Following the workshop, a CZCS issue paper and a program development plan were prepared which stressed research by NMFS organizations in cooperation with NESS, ERL, NOS, and NASA. Unfortunately, the program was not approved because of technical uncertainties about ocean color remote sensing potentials. A limited amount of reprogramming in NESS, however, was approved such that some basic ocean color research could be done.

Nimbus-7 was finally launched in October 1978 and CZCS data have been routinely collected from many areas of interest to marine scientists. While data processin problems have hindered distribution and analysis of the data, sufficient analyses have been completed to demonstrate that the CZCS meets and possibly exceeds its design goals for inferred measurements of ocean chlorophyll. Selected results fr these analyses were presented at a NOAA workshop on Oceanic Remote Sensing held i Estes Park, Colorado, August 1979. The results were so good that NMFS representatives at the workshop proposed a joint program between the SEFC and NEF which would capitalize on CZCS-derived information and rely intensively on assistance from remote sensing specialists and oceanographers from NOAA and NASA, to characterize and study specific fishery ecosystem unique to each region.

The proposal for a joint SEFC-NEFC program in remote sensing was reviewed by each Center and a suggested meeting between scientists from the two Centers to develop specific plans for a joint program was approved shortly after the NOAA Workshop. The SEFC was asked to host the meeting.

ABSTRACT

MARMAP Fisheries Ecosystem Studies off the

Northeast Coast of the United States

Kenneth Sherman
Narragansett Laboratory
National Marine Fisheries Service
Narragansett, Rhode Island

Under the Fisheries Conservation and Management Act of 1976[1] some 2.2 million square miles of contiguous ocean water falls under the jurisdiction of the United States as a Fisheries Management Zone. At present only 200,000 square miles of the zone, most of which is off the northeast coast, is being systematically monitored for seasonal, areal, and annual changes in plankton, fish benthos, and hydrography. There are no shortcuts to obtaining the comprehensive population and environmental information required to improve forecasts of fish abundance within the FMZ. A balanced approach is needed that allows for: (1) a time-series of ship observations in the form of routinized multispecies fish, plankton, benthos, and hydrographic monitoring surveys; (2) a systematic collection of fish-catch data; and (3) ancillary process oriented studies dealing with linkages among plankton production, benthos production, and the influence of the environment on the productivity of fish resources to ensure that the most critical spatial and temporal processes are, in fact, being monitored adequately for forecasting purposes. This kind of fisheries ecosystem program, called MARMAP for marine resources monitoring, assessment and prediction, is conducted by the National Marine Fisheries Service on the continental shelf from the Gulf of Maine to Cape Hatteras. During the past decade this region of the continental shelf including the Gulf of Maine, Georges Bank, Southern New England, and the Mid-Atlantic Bight has been subjected to extreme fishing pressure. From 1968 to 1975 the biomass of the principal fish species declined approximately 50%. The decrease in biomass correlates with increased fishing effort, indicating an overfishing condition. Environmental conditions, coastal pollution, inter- and intra-specific competition may also have contributed to the decline, but quantitative estimates of this mortality are not yet available.

The full impact of the removal of several million metric tons of predators from the continental shelf ecosystem is not known. Significant questions remain unanswered. Does the reduction in the stocks of important predator species--herring, mackerel, cod, haddock, hake, and others--release secondary production to be consumed by short-lived, fast growing, smaller, less desirable species? What are the probabilities associated with the return of over-exploited species to former abundance levels? Studies are now underway by the Northeast Fisheries Center (NEFC) to address these questions. They focus on the critical linkages among the principal food species of fish and the recruitment, survival, and productivity of the fish stocks on the continental shelf from the Gulf of Maine to Cape Hatteras.

MARMAP Surveys. With the exception of relatively small groups of fishery scientists in the United States and elsewhere, particularly in Western Europe, society has not yet come to grips with the magnitude of the effort confronting the

scientific community in its attempt to provide information on resource population that can support management options within the fisheries management zones on both sides of the Atlantic. Fishery science is undergoing major changes in the approa to improving assessment of the abundance levels and forecasting potential yields fish stocks inhabiting these zones. The new approach represents a balance betwee the more traditional studies of biological and physical processes as they relate productivity of coastal waters and coastal populations, and the requirement for committing ships and personnel to fisheries-independent time-series surveys of annual changes in the productivity levels of plankton, fish, and benthos populations. Time-series surveys from ships represent routinized science, but science that is absolutely necessary for measuring population, environmental, and pollution changes over time and space and sorting out the causes of these changes with respect to fishing mortality, natural mortality, or mortality caused from th increasing introduction of pollutants into the continental shelf ecosystem. Technical advances in buoys, hydroacoustics, satellite and other aerial remote sensing, and electronic data processing when applied to the time-series approach will contribute significantly to increased efficiencies and reduced costs of the MARMAP ship surveys.

MARMAP surveys are conducted systematically at stations selected from a stratifie random design for fish, shellfish, benthos, phytoplankton, ichthyoplankton, and zooplankton. Bottom trawl surveys for fish are conducted in spring and autumn, a since 1977, in summer. Two shellfish surveys are made annually. Benthic samplin is limited, contingent on the analyses of 25 years of collections now being completed at the Woods Hole Laboratory of NEFC. Surveys of zooplankton - ichthyoplankton, phytoplankton, primary productivity, and hydrography are conduct on a bimonthly basis for a total of six surveys per year. The survey data is augmented with a comprehensive system for obtaining catch data at each of the maj fishing ports from Cape Hatteras to the Gulf of Maine. As required, special surveys are conducted to deal with specific problems (e.g., tagging, feeding, current meter deployment and retrieval, vertical distribution studies of ichthyoplankton, samplings for sharks and other large predators). MARMAP studies are conducted jointly with scientists and ships of the Federal Republic of Germar German Democratic Republic, Poland, and the USSR (Sherman, 1979, 1975; Grosslein, et al., 1978).

[1] Fisheries Conservation and Management Act of 1976, U.S.A. (FCMA) Public Law No. 94-265, 94th Congress H.R. 200, April 13, 1976.

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Grosslein, M.D., B.E. Brown, and R.C. Hennemuth. 1978. Research, assessment, a management of a marine ecosystem in the Northwest Atlantic--A case study. Paper presented at the Second International Ecological Congress Satellite Program in Statistical Ecology, University of Parma, Institute of Ecology, August 1978. 70 pp.

Sherman, K. 1975. The watch on our fisheries. NOAA, Vol. 5, No. 3, July 1975. p. 40-45.

ABSTRACT

CZCS Post-Launch Experimentation and

Bio-optical Relationships

Dennis Clark
National Environmental Satellite Service
Washington, D.C.

Spectral analyses of water color with concurrent measurements of the various particulate and dissolved constituents suspended in the water are necessary for a broad range of water types in order to quantify ocean color in terms of meaningful biological and physical parameters that potentially can be monitored by remote sensing. A series of Nimbus-G pre-launch, at sea experiments were conducted to support the science associated with the Coastal Zone Color Scanner (CZCS).

The development and preliminary functional forms of phytoplankton pigment concentration and total suspended particulate (TSM) concentration in-water algorithms, based upon upwelled spectral radiance ratios at the CZCS wavelengths, were both demonstrated to take the form of $\log_{10} a + b \log_{10} (R))$, where R is the ratio of subsurface radiance at two wavelenghts. These algorithms explain 94% to 98% of the variance in $\log_{10}$ pigment and $\log_{10}$ TSM over three orders of magnitude in concentration. In addition, the analysis suggests a very high degree of covariation between phytoplankton pigments and total suspended particulate matter.

In order to fully utilize the Nimbus-7 CZCS imagery, it is necessary to remove the effects of the intervening atmosphere between the sensor and the sea surface. The radiance added by the atmospheric backscattering can account for as much as 80% to 90% of the total radiance at the sensor. A simple-to-use algorithm has been developed which can, even with only a coarse estimate of the optical properties of the atomostphere, remove the bulk of this added radiance on a pixel by pixel basis This has been applied to a CZCS image of the Gulf of Mexico which was highly contaminated with haze. The resulting image reveals a truly remarkable series of eddy-like structures with spatial scales from tens to hundreds of kilometers. Thi corrected image appears to be of sufficient quality for "water mass" analysis whic is useful in many fisheries applications and could be produced routinely.

The derivation of quantitative pigment concentrations requires a substantially mo accurate atmospheric correction. To date, this has been effected by surface measurements, and direct comparisons between ship and CZCS pigment determinations show that the pigment concentration can be estimated to within the 1/2 log accura goal set by the CZCS experiment team. These comparisons should improve considerably with better navigation of the ship tracks relative to the images and by accounting for the water movement between ship and CZCS determinations.

In the absence of surface measurements, the atmospheric effects can be removed by locating an area of clear water in the image and estimating its subsurface radiance. This technique is presently under study and the initial results are ve promising.

Extensive post-launch, at-sea experiments have been conducted by the Nimbus experiment team. These experiments were conducted in waters of the Gulf of Mexico, Gulf of California, Southern California Bight, North Western Atlantic, and Gulf of Maine. Additionally, ground based atmospheric transmittance and sky radiance measurements are being acquired periodically at Bermuda and Southern California in support of the maritime atmospheric correction algorithm development. These data with coincident CZCS overpasses now from the base from which the preliminary algorithms will be tested and evaluated.

ABSTRACT

Coastal and Shelf Environmental Monitoring

And the Use of Remote Sensing Techniques

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The eastern seaboard of North America is characterized by extensive urbanization and industrialization. Large population concentrations are found surrounding the principal estuarine and riverine systems draining into the Atlantic Ocean. For th 1979 Statutory Meeting of the International Council for the Exploration of the Sea (ICES) a series of status of the environment papers was prepared for our major northeast systems. These included the waters off the south shore of Maine and the estuarine outflows from Boston Harbor, as well as Narragansett Bay, Long Island Sound, Raritan Bay/Hudson River estuary, Delaware Bay, and Chesapeake Bay. These papers were written by individual having extensive experience within the particula estuaries. The papers indicated that generally the waters found in the Gulf of Maine were relatively unpolluted although there is some concern for the condition immediately off the Portland Harbor area. Narragansett Bay has been demonstrated to have been significantly polluted from the end of the 18th century on. Long Island Sound was characterized by having heavily polluted and generally degraded waters in the western one-third of the Sound and at the offings of highly industrialized sites such as New Haven, Connecticut. The north shore of Long Island was relatively free of pollution.

As Narragansett Bay, Raritan Bay has been extensively polluted for well over one century and significant changes have occurred in the living resources of the Bay and adjunct coastal waters. Much the same is true for Delaware Bay, where el vat values of heavy metals and other contaminants have been reported in bivalves and other resource species.

Finally, major riverine systems draining into Chesapeake Bay are often characterized by extensive pollution. For instance, the Potomac and Patapsco rivers function as harbors for the cities of Washington and Baltimore and both of these riverine systems are characterized by extensive degradation and declines in biological resources. Many small rivers such as the James have also been shown t be heavily polluted, often with extremely toxic substances such as Kepone.

Since there has been a decided trend towards degradation of estuarines and coasta water quality, and concomitant changes in living resources, it has become essenti that a long-term monitoring and research program be developed which would assess, on a semiannual basis, the status of estuaries and coastal zones. This has been done and the program involves National Marine Fisheries Service (NMFS) scientists along with scientists from other federal and state agencies and the academic community, in an effort to measure the amounts of recognized contaminants in wate

and sediments and to make biological measurements which will indicate changes in biological responses to contaminants. The biological measurements include studies in the disciplines of experimental ecology, genetics (mutagenesis), pathobiology, physiology and biochemistry, behavior and classical bioassays.

The program has been designated as the Ocean Pulse monitoring program, elements of which are being combined with aspects of the Marine Ecosystems Analysis (MESA) Program and the Ocean Dumping Program. The Ocean Pulse program has been in operation since 1978 and has had several operational test phase (OTP) cruises to determine the feasibility of having several scientist, working in a number of disciplines, conducting measurements simultaneously. The results to date indicate that it is possible to have 12 to 13 scientists working together on a single cruise in order to make collections, measurements, and perform experiments which indicate the response of key species to changes in water quality.

In November 1978 it was decided that personnel from the Northeast Fisheries Center (NEFC) should begin to use the remote sensing techniques that are available through the National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite Services (NESS), and the National Aeronautic and Space Administration (NASA) to make synoptic measurements of certain variables and concomitant changes in the biota. Consequently, in April 1979, personnel from the NEFC worked with personnel of several state and federal agencies, as well as the academic community, to conduct an experiment to test the feasibility of measuring turbidity and chlorophyll standing stock along the entire eastern seaboard from the Canadian border to Cape Hatteras. NASA supplied U-2 and C-130 aircraft which conducted remotely sensed measurements and NEFC organized sea surface measurements at some two dozen locations along the eastern seaboard. The sea surface truth data, including turbidity, chlorophyll, and related hydrographic measurements have been analyzed and proved for correlations with remotely sensed data. The experiment was called Large Area Marine Productivity and Pollution Experiment (LAMPEX) and was deemed to be very successful. A second activity involved the collection of sea surface truth data for correlation with remotely sensed information collected by aircraft in September 1979. This experiment was called LAMPEX II and concentrated on a more circumscribed area contiguous with the Middle Atlantic Bight and Georges Bank.

Personnel of the NEFC are currently planning additional remote sensing operations to be conducted with personnel of NASA and NOAA/NESS. The three principal activities being planned include the Superflux operation for Chesapeake Bay, which will involve measuring the phenomena associated with the outflow or plume of the Chesapeake Bay. The second activity will involve working with the Southeast Fisheries Center (SEFC) in a program designed to use remote sensing for measurements to be made between the Canadian border and the Mississippi Delta. Finally, an operation called Superpatch is being designed to study the biological production system associated with Nantucket Shoals and Georges Bank.

ABSTRACT

Large Area Marine Productivity-Pollution Experiments (LAMPEX)

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Remote sensing offers real possibilities for beginning to piece together interrelationships between measurable abiotic factors (e.g. temperature, light) an the various trophic levels of the ecosystem over large areas (e.g. U.S. continenta shelf, Canada to Mexico) for fishery management and environmental assessment. Sampling of the planktonic component of the marine ecosystem through traditional approaches is labor intensive and currently inadequate because of the lack of simultaneity of measurement when investigating a large area. The problem is exacerbated by the the short generational time of many marine organisms, which for some (e.g. phytoplankton) is measured in days. The broad, synoptic, high frequenc coverage possible with remote sensing should enable us to illucidate the nature of 1) the spring bloom of phytoplankton; 2) patchiness; 3) year to year differences i spatial patterns; 4) the flux of materials and contaminants from the estuaries; 5) frontal systems; and 6) the circulation and continuity of such systems as Georges Bank with regard to year class survival of larval fish. For such research problems, the use of remote sensing should increase vessel effectiveness an order of magnitude or more by: 1) extending a "long" ship's observations outward spatially, and both forward and backward temporally and 2) by focusing ship operations on key areas.

LAMPEX was designed as a joint program between the National Oceanic and Atmospheri Administration (NOAA) and the National Aeronautics and Space Administration (NASA) with cooperative participation from academia to: 1) increase our understanding o regional marine ecosystem processes; 2) to provide an extensive, synoptic, integrated and timely data base for application to problems of ocean resources an environmental management; 3) to provide a basis for comparative studies of ecological and contaminant processes in boreal, temperate and subtropical coastal and oceanic waters; and 4) to advance the development of improved remote sensing systems and techniques for monitoring and assessing regional marine resources and environmental quality.

To date, two experiments have taken place to test the feasibility of mapping chlorophyll a and total suspended matter concentrations in surface waters of the continental shelf from Cape Hatteras to the Canadian border. LAMPEX I was conducted jointly by the NASA/Langley Research Center/Marine Environments Branch and the National Marine Fisheries Service (NMFS)/Northeast Fisheries Center (NEFC)/Division of Environmental Assessment during the period of 17-21 April 1979 part of the Ocean Pulse Program. NASA accomplished the remote sensing using two aircraft, a NASA U-2 flown at 19.7 km (65,000 ft) with an Ocean Color Scanner (OCS) and Mitchell-Vinton cameras using aerial color multispectral film (Principa Investigator - Craig Ohlhorst) and a NASA C-130 flown at 3.0 km (10,000 ft) with

multispectral scanner (Modular Multispectral Scanner M2S) and Zeiss mapping camera using aerial color film (Principal Investigator - Dr. Robert Johnson). NMFS, with other federal, state, and private research facilities, supplied the sea truth data at 20 locations (Figure 1) from Virginia to Maine.

As part of an Ocean Pulse Program cruise, NMFS conducted LAMPEX II 12-18 September 1979 with NASA/Goddard Space Flight Center and NOAA/National Environment Satellite Service to acquire sea truth data (total chlorophyll a, phaeopigment and total suspended matter) for the Nimbus-7 Coastal Zone Color Scanner (CZCS) at eight locations (Figure 2) from the Gulf of Maine-Georges Bank to Delaware Bay. The data were collected near mid-day to be concurrent with the overpass of the Nimbus-7 satellite.

Present plans are to expand LAMPEX to cover the continental shelf area from the Canadian border to Mexico. Site specific areas including the northern Gulf of Mexico off the Mississippi Delta, the Chesapeake Bay Plume, Georges Bank and Nantucket Shoals are to be investigated in greater detail.

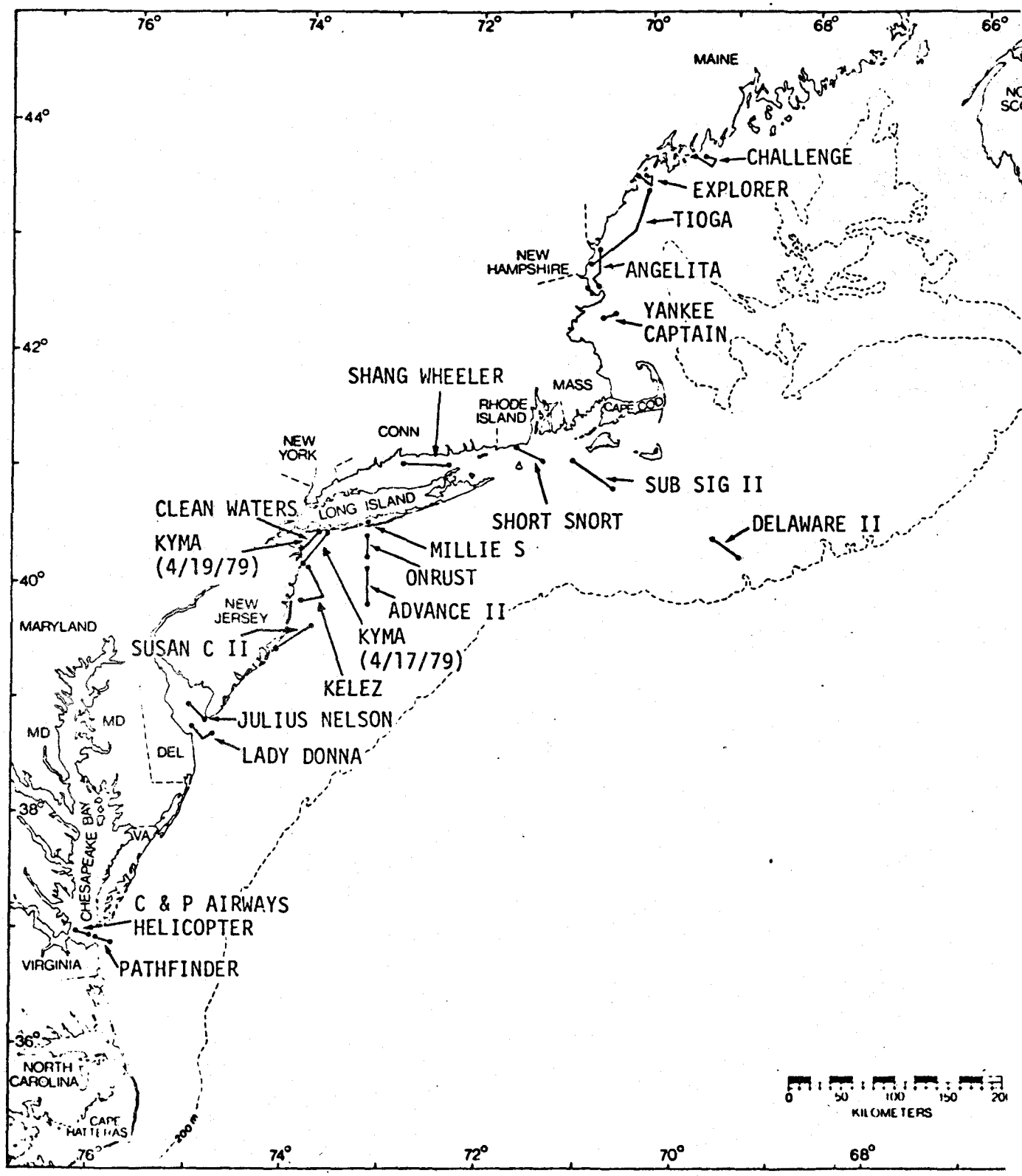
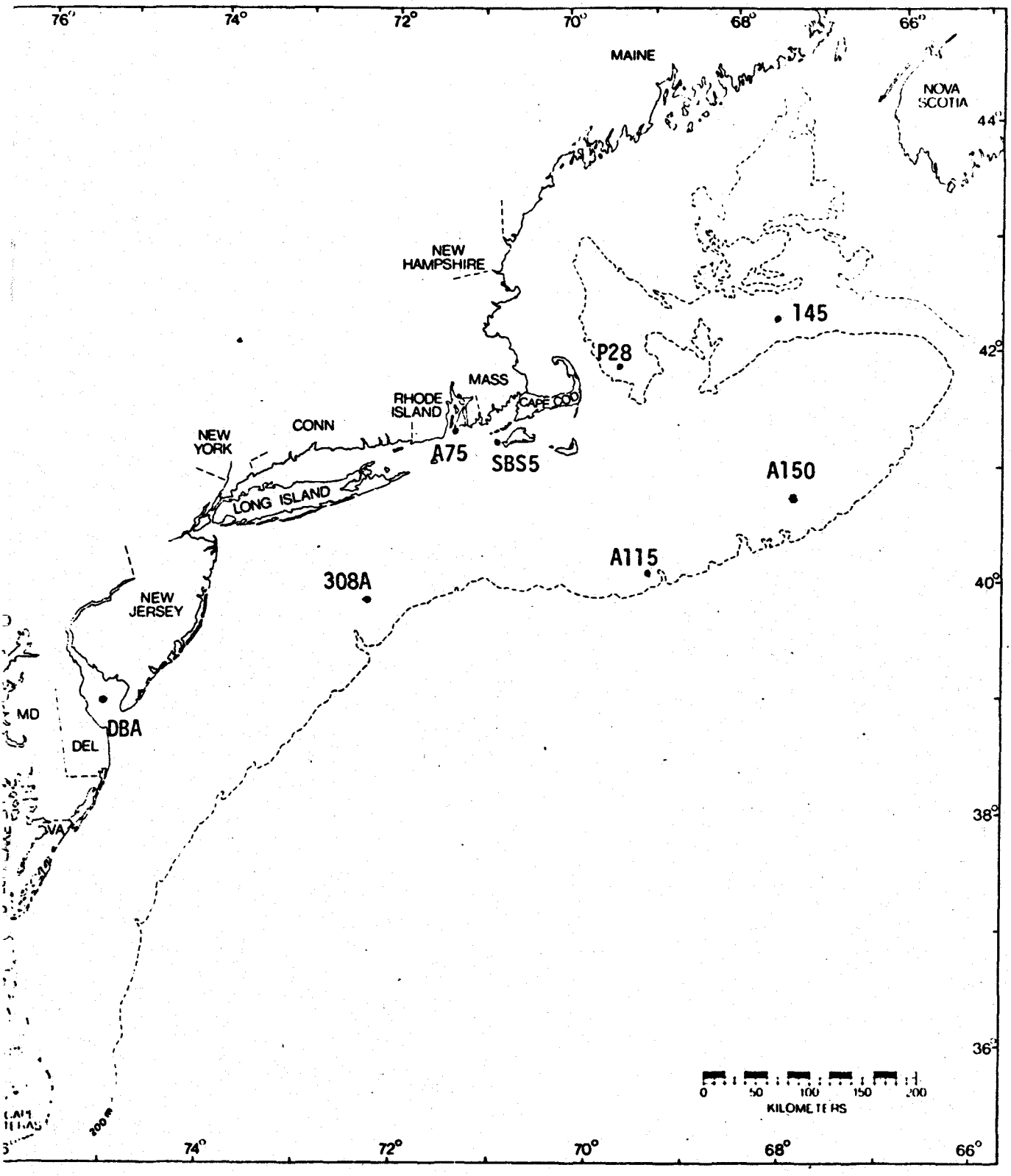


Figure 1. Cruise track locations for vessels collecting sea-truth data, April 17 a 19, 1979.



2. Stations sampled September 12-28, 1979 on Ocean Pulse cruise (AL-79-10) for total chlorophyll a and total suspended matter to be used as sea truth for the Nimbus-7 Coastal Zone Color Scanner (CZCS).

ABSTRACT

Remote Sensing of Coastal Productivity and Fisheries Resource

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To maintain the production of living marine resources, one must monitor and evaluate the fish-habitat relationships and be aware of the trends in available wetland habitat, including the primary productivity. Obtaining field measuremen on such facotrs has proven to be costly in terms of time, manpower, and funds. Also, the results are sample site specific and may not be representative of surrounding areas.

Remote sensing can provide considerable information for a minimal cost and time when large coastal areas are to be surveyed. Potential applications of remote sensing to determine available habitat, nutrient flow and fish biomass are shown Table I. Color and color infrared photography has been used to map tidal wetlan boundaries, vegetation species and net primary production. (Refs. 1, 2, 3 and 4 Multispectral digital satellite techniques have been employed to map plant types density and height of the standing crop; and other properties related to the quantity and quality of marsh biomass. (Refs. 5, 6, 7 and 8).

Both photographic and satellite data sources have advantages and limitations wit respect to providing all data elements in an accurate cost-effective manner. LANDSAT data processing is a least-cost method of producing coastal land cover m and tabular data for large areas. Planning studies, however, often require more detailed coastal vegetation/habitat information at an accuracy level that is difficult to provide consistently over a range of categories through the LANDSAT data extractive process. Manual interpretation of aerial photography is a more expensive and time-consuming process than digital multispectral processing, but yields a more detailed categorization of wetlands/habitats that many planning activities require.

As shown in Table 1, multispectral scanners and laser fluorosensors are being tested for monitoring of primary productivity of coastal surface waters and the outflow of plankton and detritus from marshes and estuarines. Four selected las excitation wavelengths have been used to induce chlorophyll fluorescence that is indicative of both the concentration and diversity of phytoplankton. (Refs. 9 a 10). To map concentrations of organic and inorganic substances in coastal wate multispectral scanner data is being analyzed by using the angular separation of eigenvectors representing each mapped substance in spectral signature space. (1 11). Both techniques are still experimental and will require cnsiderable field testing before their reliability is established. Satellite, aircraft and drogu techniques developed for monitoring the drift and dispersion of pollutants can adapted to chart the flow and dispersion of detritus and other suspended matter (Ref. 12).

Pelagic fish availability (in special cases also biomass) estimates are normally obtained from biological studies, fishing fleet results or fish product company reports. Small spotter planes are used to guide certain fishing boats to school of fish, such as menhaden. From satellite altitudes fish schools cannot be seen directly. However satellites have been employed to locate areas of high probability for fish availability, such as the highly productive, nutrient rich, upwelling areas off the coasts of Peru, western United States and Africa. Upwelling areas can be mapped by multispectral scanners primarily due to their strong thermal and spectral gradients caused by the colder upwelling waters and its spectrally different nutrient/chlorophyll content (Ref. 13). There also appears to be a correlation between certain coastal water properties such as water color turbidity, chlorophyll concentrations and the presence of fish. Computer classification of LANDSAT MSS data into hgih probability fishing areas off the coasts of Louisiana and Mississippi concentrated in these areas (Refs. 14 and 15). The applicability of similar techniques to locating other fish types, such as thread herring and croakers are being investigated. A summary of remote sensor applicability to fisheries resources studies is presented in Table II.

From these results it is reasonable to conclude that remote sensing techniques can be used effectively and reliably to map the location, size and quality of wetland habitat; to chart fronts, slicks and upwelling regions; to observe the dispersion of certain pollutants; and to monitor sea state conditions. However, remote sensing techniques being developed for determining surface water productivity, detritus/nutrient flow and fish availability require additional field testing to establish their reliability.

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AVAILABLE WETLAND HABITAT

Habitat size, location vegetation species, tidal conditions

- Aircraft color & color infrared photography
- Landsat MSS
- GT: Field checks (S)

Marsh productivity, plant vigor and water quality

- Aircraft color infrared photography
- Digital MSS from aircraft and satellites
- GT: Harvest & water sampling (L)

SURFACE WATER PRODUCTIVITY

Gross flow of organic detrital turbid water into estuaries and bays

- Aircraft multiband photography
- Satellite MSS
- GT: Current measurements & water sampling (M)

Concentration of chlorophyll and phytoplankton in estuaries, and coastal waters

- Digital MSS from aircraft or satellite
- Laser fluorosensing low altitude aircraft
- GT: Water sampling (L)

FISH AVAILABILITY

Upwelling and other water masses having unique spectral/ thermal signatures

- SMS, NOAA thermal infrared scanners (HRIR)
- Satellite MSS chlorophyll, turbidity and color (CZCS)
- GT: Boat fish catch (M)

Detection of fish schools and related properties

- Fish oil detection by aircraft spectrometers
- Fish-induced luminescense detected by sensitive TV cameras
- Fish egg and larvae drift into estuaries as a function of winds and currents measured by microwave sensors
- GT: Fishing boat reports, spotter planes (L)

GT = Ground truth required
S = Small amount
M = Moderate amount
L = Large amount
MSS = Multispectral Scanner

SMS = Synchronous Meteorological Satellite
CZCS = Coastal Zone Color Scanner
HRIR = High Resolution Infrared Radiometer
NOAA = NOAA Series Satellites

Table I. Summary of remote sensing techniques used to determine wetland habitat, water productivity and fish availability.

Table II. Remote sensing systems for fisheries applications

	Temperature	Salinity	Chlorophyll	Color	Suspended Sediment	Sea State	Fronts	Patchiness	Oil
LANDSAT MSS	0	0	1	2	3	1	2	2	2
NIMBUS - G (CZCS)	0	0	2	3	3	1	2	1	1
NOAA - 5 HRIR	3	0	0	0	0	1	3	1	1
DMSP	3	0	0	0	0	1	3	1	1
HCMM	3	0	0	0	0	0	2	1	1
SEASAT	3	1	0	0	0	3	2	2	2
HAA MSS (OCS)	0	0	2	3	3	1	2	3	3
HAA PHOTOGRAPHIC	0	0	1	1	2	1	2	3	2
MAA PHOTOGRAPHIC	0	0	1	2	2	2	2	3	2
MAA MSS (M2S)	3	0	2+	3	3	2	3	3	3
MAA INFRARED (THERMAL)	3	0	0	0	0	1	3	2	2
MAA MICROWAVE	2	2	0	0	0	3	2	1	2
MAA RADAR	0	1	0	0	0	3	1	2	2
HELICOPTER FLUOROSENSOR	0	0	2+	1	1	1	2	2	3
SMALL AIRCRAFT PHOTOGRAPHIC	0	0	1	1	2	2	2	3	3

HAA = High Altitude Aircraft (U-2)

MAA = Medium Altitude Aircraft (C-130)

HCMM = Heat Capacity Mapping Mission Satellite

DMSP = Defense Meteorological Satellite

MSS = Multispectral Scanner

OCS = Ocean Color Scanner (10 bands)

M2S = Modular Multispectral Scanner (11 bands, including thermal infrared)

Photographic = Zeiss and Mitchell - Vinten Cameras

0 = Not Applicable

1 = Limited Value (Future Potential)

2 = Needs Additional Field Testing

3 = Reliable (Operational)

ABSTRACT

Present Use of the Coastal Zone Color Scanner in

Red Tide Research in the Eastern Gulf of Mexico

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The Florida Department of Natural Resources Marine Research Laboratory (FDNRMRL) has actively pursued red tide research since the 1950's. Current research is centered on early bloom detection, sequence of bloom development and the life history of the organism. FDNRMRL has actively participated in surface truthing and developing the potential to use ocean color remote sensing in monitoring blooms of the red tide organism Ptychodiscus brevis (=Gymnodinium breve). In October 1977 an aircraft-bound Ocean Color Scanner detected a phytoplankton bloom off southwest Florida which was confirmed by FDNR as P. brevis. Immediately after the Nimbus 7 Coastal Zone Color Scanner (CZCS) was activated in early November 1978, NASA scientists observed a bloom structure again off southwest Florida. This was also confirmed as P. brevis. The FDNRMRL is actively surface truthing and sampling the west coast of Florida coastal waters in an attempt to assess water mass differentiation and circulation and to characterize those factors which may be responsible for red tide bloom initiation and transport. To this end, the CZCS appears to be an exciting new instrument for the future as an effective routine monitoring tool, not only in plankton bloom research, but also in many facets of fisheries concerns in the State of Florida (i.e., migatory patterns, larval recruitment).

ABSTRACT

The Use of Satellite Remote Sensing for the Identification of Ocean Fronts and it Application to Atlantic Bluefin Tuna (Thunnus Thynnus Thynnus) Utilization and Management.

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The principal objective of this program, supported by the National Aeronautics an Space Administration (NASA), is to contribute to fisheries forecasting, utilizati and management by use of satellite remote sensing (e.g. NIMBUS - Coastal Zone Col Scanner; TIROS - infrared, visible; GOES -ir., vis.; LANDSAT - Multispectral Colc Scanner). This task is being accomplished by integrating multispectral with infrared and visible remotely-sensed data for the identification and study of su environmental dynamics as circulation, frontal history, and ocean productivity. These ocean conditions are being correlated with distribution, movements, availability, catch, and spawning success of bluefin tuna in North Carolina - Virginia coastal waters, and in the Gulf of Mexico. Similar fisheries data are also being analyzed for other species including skipjack tuna (Katsuwonus pelami bluefish (Pomatomus saltrix), and the sand lance (Ammodytes americanus). Derive apparent relationships between environmental and fisheries variables are being cross-correlated with forcing mechanisms, such as insolation, winds, surface transport, upwelling, mixing, etc. Appropriate satellite imagery data tapes are being processed using the University of Miami's interactive computerized display system (black and white and color enhancement), which is presently capable of handling Coastal Zone Color Scanner data.

ABSTRACT

Sea Surface Temperature Determination

Using Infrared Techniques

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Infrared radiation in the wavelength region between 10 um and 13 um is both emitted and reflected from the ocean. The emission is from a microlayer less than 20 um thick and is therefore affected by sensible heat flux, evaporation, and the many other exchange processes at the air-sea interface. It is not unusual for the radiation temperature to be from -1.5°C to +0.5°C different from the water temperature 10 cm below the surface. Reflection at 11 um is less than 1% and except at the specular point of the sun, reflection is frequently neglected in surface temperature determination. RMS error associated with emission at the sea surface, compared with the bulk water temperature, is between ±0.4°C and ±0.5°C. Neglecting the reflection can cause an error $T = [T_a - T_s]$ where Ta is the radiative temperature of the atmosphere, T_s is the bulk temperature of the ocean, is the reflectivity and is the atmospheric transmissivity. T ranges from -0.2K to -0.7K with an average of -0.5K.

Radiation that has left the ocean interacts with the atmosphere before being detected at the aircraft or the satellite. In the 10-13 um region, the most significant absorbing atmospheric gas is water vapor. Typically about 40% of the radiation leaving the ocean is absorbed by atmospheric vapor and reemitted at the temperature of the gas. The radiometer measures the net effect of radiation that has interacted with the atmosphere and the non-interacted fraction; atmospheric effects of 2°C to 10°C are not uncommon depending on the temperature and the atmosphere and the amount of water vapor in the path. If atmospheric profiles of temperature and relative humidity are available, single channel infrared sensors can be corrected for this effect. In the future, atmospheric water vapor. RMS error associated with very careful application of radiative transfer calculation are about ±0.4°C to ±06°C.

Infrared radiation from the sea is strongly absorbed by clouds, and it is necessary to detect clouds in order to obtain accurate sea surface temperatures. Since low clouds have tempertures very near to surface values, temperature alone is not adequate as a detection technique. Dual channel (visible and infrared) radiometers provide the necessary data for cloud detection but recent studies show that automatic computer clustering techniques will not work because the temperature-reflectance correlations for cloud is not uniquely separated from the correlation for cloud-free areas. If as little as 10% of the radiometer's field of view is cloud contaminated an error of -0.5°C may result; this error is almost always negative.

Temperature gradients as well as absolute temperatures are effected by atmospheri water vapor. Surface temperature gradients are reduced by as much as 50% when measured by a satellite through a moist atmosphere. The effect can be quantified and is equal to the atmospheric transmissivity. Typical values of transmissivity off New England (Ocean Station H) are 0.73± 0.07 in February and 0.54± 0.05 in August for the geostationary satellite. The standard deviations of these transmissivity values suggest temperature-gradient variability of ±0.6°C per unit horizontal distance.

Summarizing the inherent errors associated with infrared measurement of sea surfa temperature, it is reasonable to expect that satellite detection is in the range ±0.8°C to ±1.6°C with current understanding of the physics. Instrumental noise i less than ±0.3°C in many radiometers today. High quality shipboard measurements for surface truth by immersion thermometers are within ±0.1°C; ship-of-opportunit surface truth measurements are probably an order of magnitude RMS higher. If surface truth is judiciously used to least squares adjust satellite observations ocean temperature, and corrections are carefully applied for radiative transfer a radiometric-thermometric temperature differences, it appears possible to keep the RMS error below 1°C. Without using surface truth, errors in excess of ±1K to ±4K are expected, and in fact are being reported.

ABSTRACT

Potential for Application of Remote Sensing

via the CZCS to Fisheries

and Ecological Studies in the

Southeast Region

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The potential for utilization of chlorophyll-a measurements from the Coastal Zone Color Scanner (CZCS) in the mission-oriented fisheries and ecological research of the Southeast Fisheries Center will be enhanced by proceeding in three phases of research. The phases are given in order of the liklihood of success in terms of immediately improving fisheries-management techniques. The first phase would be development of predictive or forecasting models of recruitment dependent on the chlorophyll-a data received from the CZCS. Shrimp-groundfish recruitment has been proposed as a likely candidate for predictive models because it is economically important and because it should be relatively easy to link population changes in these species to environmental variables, due to their short life spans and nearness to the base of the food chain. The methods for developing these models will be primarily statistical, since prediction is the immediate goal. We are willing to sacrifice the realism of more mechanistic approaches to meet this goal. Techniques to relate larval survey data and other measures of recruitment to chlorophyll and primary production measurements might include principle component, factor, and time series analyses. With appropriate choices of time lags and spatial displacement factors, a predictive model may be developed.

The second phase of this research is to study the processes of recruitment (as related to primary productivity) quantitatively using a mechanistic, process-oriented approach utilizing the synoptic view of chlorophyll changes over space and time. Results can indicate qualitative relationships for further study and provide feedback for improvement of the predictive models.

The third phase of the research is to begin collating a synoptic mapping of ecological variables of which the chlorophyll and primary production measurements would be the basis. This data base would allow development of more extensive ecosystem models and yet be tied to the management needs of the fisheries. The information on chlorophyll, coupled with biological and physical features such as location of reeffish communities, location and timing of critical spawning areas, and water circulation patterns, could be utilized to determine areas of critical impact to fisheries production and to improve the efficiency of fishing strategies.

ABSTRACT

Ecosystem Study of the North Central Gulf of Mexico

Joan A. Browder
Southeast Fisheries Center
National Marine Fisheries Service
Miami, Florida

An ecosystem model of the North Central Gulf of Mexico is being developed by the Office of Fisheries Management in cooperation with the Ecosystem Unit of the Mia Laboratory as part of the Southeast Fisheries Center's (SEFC's) new initiative c the multispecies approach to research for fishery management. This model will b an input-output model that couples marshes, estuaries, and offshore areas throug the flow of water, energy, and materials by means of water circulation and seaso size-specific shoreward and seaward migrations of fish and shellfish. Inputs tc the system are terrestrial, meteorological, and oceanic in origin. Outputs are harvested seafood products: shrimp, menhaden, and "groundfish" (principally croaker).

The North Central Gulf of Mexico was selected as the site of SEFC's first ecosy model because of the high productivity of this area, which produced 35% of total U.S. fishery landings in 1978 (the area is concentrated along only 4% of the nation's marine coastline).

The modeling effort will improve our understanding of the environmental basis f the observed annual fluctuations in abundances of commercial stocks and will provide a quantitative basis for evaluation of the potential effect on fishery production of proposed modifications in river-flow regimes, area of tidal marsh dredge-and-fill projects, and other alterations.

The temporal and spatial over-view of primary producers that can best be obtain through remote sensing is needed by the modeling effort to help relate environmental variables to recruitment of commercial species through their effe on the availability of food for early life history stages.

ABSTRACT

EDIS and Data Collection; MEAD and Ecological Modeling;

Relevancy to Nimbus 7 Color Scanner Output

Richard H. Wheeler
Environmental Data and Information Service
Center for Environmental Assessment Services
Marine Environmental Assessment Division
Washington, D.C.

Thirty-two Environmental Data Index (ENDEX) Files were provided the workshop. The files were selected for chlorophyll and particulate matter in the coastal Gulf of Mexico for the last two years. An abstract, grid locator for sample latitude and longitude, archive media, parameter indentification section and project contract were provided with each file. In order that information such as this can be made available, it must be submitted to EDIS by the researchers. Workshop participants are urged to submit the data that they collect so that it can be made available to future users. Questions regarding data should be relayed to either Mr. Jack Foremen (202-634-7324 for Strategic Petroleum Reserve Data) and/or NODC, Oceanographic Service Branch (202-634-7500) or to the Data Index Branch (202-634-7298).

MEAD has contracted for a Data Synthesis and Ecological Modeling effort in the Gulf of Mexico with Ecology Simulations, Inc. of Athens, Georgia. This effort is designed to develop a predictive instrument from which qualitative judgments with respect to the impact of brine on key commercial fisheries can be made. I am COTR on this contract.

Summary of Collected Data of the Gulf of Mexico and Western Atlantic Relevant to the Coastal Zone Color Scanner

Based on an EDIS search, the following CZCS-relevant information has been collected. Light attenuation, light intensity, total chlorophyll, chlorophyll a, chlorophyll b, chlorophyll c, total phaeophytin, phaeophytin a, carotenoids, astacin, photosynthetic rate, color, tannin, lignin, total solids, particulate matter, phyloplankton biomass, phytoplankton count, phytoplankton species determination, microbial count, and microbial species identification.

Most of the studies were still in progress at the time the search was made (October, 1979). The following table gives the investigator (or contact), the area of coverage, the dates of coverage, and specific data collected that are relevant to CZCS sea truth effort.

TABLE
CZCS-Relevant Data Collected in the
Gulf of Mexico and Florida Atlanta coast,
based on EDIS search

LIGHT ATTENUATION PARTICULATE MATTER, TEMPERATURE, SALINITY

Dr. George M. Griffin Dept. of Geology University of Florida 211 Floyd Hall Gainesville, FL 32611	Sept. 1972 - present Western Atlantic Florida coast Key Largo Pennekamp State Park

LIGHT ATTENUATION, TOTAL SOLIDS, ORGANIC CARBON, PARTICULATE INORGANIC MATTER, TEMPERATURE

Dr. Thomas Pyle Dept. of Marine Science University of South Florida 830 First St. South St. Petersburg, FL 33701	Oct. 1970 - Present Gulf of Mexico Coastal Florida Anclote River Estuary

LIGHT ATTENUATION, SUSPENDED ORGANIC CARBON, PARTICULATE MATTER, PARTICULATE INORGANIC MATTER, TEMPERATURE, SALINITY

Dr. Kendall Carter Department of Marine Science University of South Florida 830 First Street South St. Petersburg, Florida 33701	March 1974 - August 1974 June 1971 Gulf of Mexico, coastal Florida, Crystal River

LIGHT ATTENUATION, TEMPERATURE, SALINITY

Dr. Robert J. Livingston Dept. Biological Sciences Florida State University CON 213 Tallahassee, Florida	March 1972 - Present Gulf of Mexico, coastal Florida, Apalachicola Bay

LIGHT ATTENUATION, CHLOROPHYLL A, PHOTOSYNTHETIC RATE, PHYTOPLANKTON SPECIES DETERMINATION, TEMPERATURE, SALINITY

Dr. Richard L. Iverson
Dept. of Oceanography
Florida State University
PSA 515
Tallahassee, Florida 32306

July 1972 - Present

Gulf of Mexico, coastal Florida, Apalachicola Bay area

CHLOROPHYLL A, PHOTOSYNTHETIC RATE, PHYTOPLANKTON COUNT, PHYTOPLANKTON SPECIES DETERMINATION

Dr. W. Dunstan
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, Georgia 31406

August 1972 - Present

Western Atlantic, South Carolina to Florida

LIGHT ATTENUATION TOTAL CHLOROPHYLL, CHLOROPHYLLS A, B, AND C, PHYTOPLANKTON COUNT, PHYTOLANKTON SPECIES DETERMINATION, TOTAL SOLIDS, PARTICULATE MATTER, TEMPERATURE SALINITY

Alfred J. Shaw
Hillsboro County Environmental Protection Commission
906 Jockson St.
Tampa, Florida 33602

Jan. 1972 - Present

Gulf of Mexico
Coastal Florida
Tampa Bay

CHLOROPHYLL A, B, AND C, CAROTENOIDS, ASTACIN, PHOTOSYNTHETIC RATE, ZOOPLANKTON COUNT, ZOOPLANKTON SPECIES DETERMINATION, TEMPERATURE, SALINITY

Mr. Eugene Nakamura, Director
National Marine Fisheries Service
P.O. Box 4218
Panama City, Florida 32401

Jan. 1975 - Present

Gulf of Mexico
coastal Florida

LIGHT ATTENUATION, LIGHT INTENSITY, CHLOROPHYLL A AND C PHYTOPLANKTON COUNT, PHYTOPLANKTON SPECIES DETERMINATION, ZOOPLANKTON COUNT, ZOOPLANKTON SPECIES DETERMINATION, MICROBE COUNT AND SPECIES DETERMINATION

Dr. Ray D. Bowman
Dept. Natural Science
University of North Florida
Jacksonville, Florida 32216

Jan. 1975 - Present

Western Atlantic
coastal Florida
St. Johns River Estuary

LIGHT ATTENUATION, PHYTOPLANKTON COUNT, PHYTOPLANKTON SPECIES DETERMINATION

Dr. John Monis
Dept. of Biology
Florida Institute of Technology
Country Club Road
Melbourne, Florida 32901

Oct. 1974 - Present

Western Atlantic
coastal Florida
Indian River
Turnbull Creek

CHLOROPHYLL A, B, AND C, TOTAL PHAEOPHYTIN, CAROTENOIDS, PHYTOPLANKTON BIOMASS, PHYTOPLANKTON COUNT PHYTOPLANKTON SPECIES DETERMINATION, TEMPERATURE, SALINITY

Robert A. Gibson
Harbor Branch Foundation
North Old Dixie Highway
RFD 1 Box 196
Fort Pierce, Florida 33450

May 1974 - Present

Western Atlantic
coastal Florida
Indian River system

LIGHT ATTENUATION, COLOR, LIGNIN, TANNIN, CHLOROPHYLL A, PHAEOPHYLEN A, SALINIT TEMPERATURE

Charles Courney
Marco Applied Marine Ecology Station
990 North Barfield Dr.
Marco Island, Florida 33937

April 1971 - Present

Gulf of Mexico
coastal Florida
Marco Island area

LIGHT ATTENUATION, TEMPERATURE, SALINITY

Dr. George F. Crozier
Dauphin Island Sea Lab.
University of Alabama
P.O. Box 386
Dauphin Island, Alabama 36528

Jan. 1975 - Present

Gulf of Mexico
Coastal Alabama

LIGHT ATTENUATION, TEMPERATURE, SALINITY

Dr. Richard D. Garrity
Conservation Consultant, Inc.
726 Eighth Avenue
P.O. Box 35
Palmetto, Florida 33561

April 1970 - Present

Gulf of Mexico
coastal Florida
Tampa Bay

IRRADIANCE, TOTAL CHLOROPHYLL CHLOROPHYLL A AND B, TOTAL PHAEOPHYTIN PHOTOSYNTHETIC RATE, PHYTOPLANKTON COUNT, PHYTOPLANKTON SPECIES DETERMINATION, INORGANIC CARBON TEMPERATURE

Carolyn Stiles Lewis Dept. of Sanitary Services City of Tampa 120 N. Florida Avenue Suite 205 Tampa, Florida 33602	Sept. 1976 - Present Gulf of Mexico coastal Florida Tampa Bay Hillsboro Bay

CHLOROPHYLL A, TEMPERATURE, SALINITY

William Wilcox, Director Environmental Quality Lab. General Development Corp. 590-D N.W. Olean Blvd Port Charlotte, Florida 33952	Sept. 1976 - Present Gulf of Mexico coastal Florida Charlotte Harbor South Gulf Cove

LIGHT ATTENUATION, CHLOROPHYLL A, COLOR, INORGANIC CARBON, ORGANIC CARBON, TEMPERATURE, SALINITY

William Wilcox, Director Environmental Quality Lab. General Development Corp. 590-D N.W. Olean Blvd Port Charlotte, Florida 33952	June 1975 - Present Gulf of Mexico coastal Florida Charlotte Harbor South Gulf Cove

ABSTRACT

Present and Past Interagency Projects That Might Provide Surface Truth Information for the CZCS Algorithm

Charles W. Caillouet
Galveston Laboratory
Southeast Fisheries Center
National Marine Fisheries Service
Galveston, Texas

The Galveston Laboratory of the Southeast Fisheries Center acts as coordinator f a number of interagency environmental projects in the Gulf of Mexico that genera data with potential application as sea truth for the coastal zone color scanner. The data form these studies are transmitted to the Environmental Data and Information Service, Washington, D.C., for inventory, processing, archival and dissemination upon request. These studies, their initiation and completion date pertinent data, and contacts for information are as follows:

1. BLM South Texas Outer Continental Shelf Study (1977)
   Chlorophyll a and C^{14} primary productivity measurements were made.

   Contact: Dr. Richard Defenbaugh, BLM OCS Office, New Orlenas, Louisiana

2. NOAA/EPA Buccaneer Oil Field Project (1978-80)
   Suspended particulate matter, chlorophyll a, ATP, and energy charge ratio measured.

   Contracts: Dr. James Brooks, Texas A&M University, Department of Oceanography, College Station, Texas

   Dr. John Anderson, Rice University, Houston, Texas

3. NOAA/DOE Brine Disposal Site Survey off Louisiana (1977-1979)

   Chlorophyll, phaeophytin and suspended particulates were measured.

   Contacts: Dames and Moore,...
   Science Applications Inc., Oak Ridge, Tennessee
   Energy Resources Co., Cambridge, Massachusetts

4. NOAA/DOE Brine Disposal Site Survey off Freeport, Texas (1977-79)

   Suspended particulate matter was measured.

   Contact: Dr. Roy Hann, Department of Civil Engineering, Texas A&M University, College Station, Texas.

The data from studies listed above are transmitted to the Environmental Data and Information Service, Washington, D.C. for inventory, processing, archival and dissemination upon request.

Applications of the CZCS in the Gulf of Mexico should focus on:

1. Major fisheries in which yield is most likely to show a relationship to primary productivity, whether it be phytoplankton- or detritus-based.

2. Developing algorithms to predict recruitment to major estuary-dependent commercial fisheries such as shrimp, menhaden and groundfish.

Rationale for such focus is as follows:

1. These species are short-lived, exhibit high biotic potential, and exhibit a wide range in annual recruitment eventually expressed as yield from the fishery.

2. These species have both oceanic and estuarine life stages.

3. Early life stages and, in some cases, juvenile and adults of these species are close to the base of the tropic pyramid; i.e., they depend directly upon primary and secondary produtivity.

4. The amount of recruitment plus the harvesting strategy determines the annual yield from these fisheries.

ABSTRACT

Chlorophyll Measurements in the Gulf of Mexico

and Considerations in Remote Sensing

Sayed Z. El-Sayed
Texas A&M University
College Station, Texas

Study of the geographical and seasonal distribution of the standing crop of phytoplankton (in terms of chlorphyll a) and primary production of the Gulf of Mexico, which began at Texas A&M University in 1964 was reviewed (see El-Sayed e al., 1972). The initiation of the Offshore Ecology Investigation (O.E.I.) in Ju 1972 has contributed significantly to our understanding of the seasonal variatio of the standing crop and primary productivity in an area approximately 50 miles the Southwest Pass of the Mississippi River. The unusually high flood of the Mississippi River in Spring of 1973 was shown to have a significant effect on th increase of nutrient salts, phytoplankton standing crop, primary productivity an species composition of the phytoplankton in the standing crop, primary productiv and species composition of the phytoplankton in the O.E.I. study region (El-Saye 1974: Fucik and El-Sayed, in press). These and other studies underscored the gr influence of the Mississippi River discharge on the productivity of the north-central Gulf. These investigations clearly showed that the high productiv of the coastal Gulf regions is the result of: (a) the high nutrient influx fro the Mississippi River, and (b) the relatively large ratio of estuaries and shel the open Gulf.

Together with the plant nutrients, the Mississippi River discharge provides a l souce of detrital material which forms an important source of food to such economically important organisms as shrimp and oysters. Despite the obvious influence of the river discharge, we still have inadequate knowledge of the eff of such discharge on the chemistry, circulation, pollution and commercial fishe of the Gulf. In an effort to develop a better understanding of the influence o the Mississippi River discharge on biological productivity, pollutant behavior, phytoplankton growth kinetics, species composition of phytoplankton and nutrien chemistry, a group of scientists from Texas A&M and the Bigelow Laboratory for Ocean Sciences cooperated in writing a joint proposal to NOAA/NASA/EPA/NSF. Th long-range objective of the proposed study is to quantitatively describe the interaction between physical, chemical and biological processes operating off t mouth of the Mississippi River that may affect fisheries productivity and the transport of pollutants into the Gulf. Details of the proposed studies were discussed at the Workshop. Of special relevance to the theme of that Workshop the section in the proposed study on remote sensing, using data from the Coast Zone Color Scanner (CZCS) of the NIMBUS-7 and from NASA aircraft flights. The Sea-truth data from proposed cruises will be used in the interpretation of the satellite and aerial imagery.

Based on the chlorophyll a data collected by members of the NET (NIMBUS Experimental Team) in the Gulf of Mexico in November 1978 and a comparison of sea-truth data with satellite data, we are sufficiently encouraged regarding the use of CZCS as a valuable means of acquiring synoptic and dynamic information on phytoplankton abundance and distribution. The advantages of remote-sensing of phytoplankton populations should be compared to present methods of collecting these data from slow-moving, costly-run vessels with limited area coverage.

References

El-Sayed, S.Z., W.M. Sacket, L.M. Jeffrey, A.D. Fredericks, R.P. Saunders, P.S. Conger, G.A. Fryxell, K.A. Steidinger and S.A. Earle. 1972. In: Chemistry, Primary Productivity and Benthic Algae of the Gulf of Mexico, Folio 22, American Geographical Society, V. Bushnell (ed.), p. 1-29.

El-Sayed, S.Z. 1974. Effect of oil production on the ecology of phytoplankton off the Louisiana coast. GURC Final Report, 63 pp.

El-Sayed, S.Z. and K.W. Fucik. Effect oil production and drilling operations on the ecology of phytoplankton in the Louisiana oil patch. Rice University Study Series (in press).

ABSTRACT

Relationship Between Contaminants and Food Web Dynamics in the Northern Gulf of Mexico

Ford A. Cross
Beaufort Laboratory
Southeast Fisheries Center
National Marine Fisheries Service
Beaufort, North Carolina

During FY 79, NOAA's Office of Marine Pollution Assessment funded a collaborati research program with the Beaufort Laboratory's Division of Estuarine and Coast Ecology and AOML's Ocean Chemistry Laboratory to determine the biological assimilative capacity of selected areas in the Gulf for anthropogenic contamina particularly trace metals. This program is designed to address Title II, Secti 202 of the Marine Protection Research and Sanctuaries Act of 1972 (PL 92-532), which requires NOAA to conduct a comprehensive and continuing program of resear with respect to possible long-term effects of pollution on oceanic ecosystems.

A major portion of this collaborative program will be to determine the biologic response of larval fish and their food. The objectives of the biological aspec of the program are to:

1. Identify and describe the relationship among trophic levels which determine survival and growth of larvae of ecological and economically important fish in selected areas in the northern Gulf of Mexico.

2. Determine the effects of differences in concentrations and chemical from of selected trace metals (e.g., copper, cadmium and zinc) to marine planktonic communities, particularly those which support larval fish.

3. Develop predictive models to estimate the biological assimilative capacity selected areas in the Gulf of Mexico for anthropogenic additions of trace metals.

The effort is designed to be compatible with AOML's program entitled "Long Ter Chronic Effects Research in the Gulf of Mexico: Role of Organics in the Marin Environment (ROME): Source of Low Molecular Weight Halogenated Hydrocarbons." joint cruises are planned in FY80 (two aboard the Oregon II) and one joint cru was planned for FY 79 but was cancelled to divert the R/V Researcher to the ar the IXTOC I oil spill.

ABSTRACT

NOAA/ERL Plans in the Gulf of Mexico - ROME

Peter Ortner
Atlantic Oceanographic and Meteorological Laboratory
Miami, Florida

Role of Organics in the Marine Environment (ROME) is an ERL program conducted in close collaboration with a NMFS larval habitat protection study. Both five-year programs are funded by NOAA/OMPA as long-term chronic effects research. Biological and chemical sampling for ROME will provide detailed CZCS ground-truth information at a few specific sites in the Gulf of Mexico. Chemically diverse environments will be repeatedly sampled for a number of days on each cruise. Priority areas will be near the Mississippi River outflow and in the Northwestern Gulf of Mexico.

Biological measurements are as follows:

At each station we will initially define the approximate depth of maximum productivity and subsequently repeatedly sample that depth over a three day period to obtain water for direct water column characterization, field experiments, and subsequent laboratory experiments. Characterization methods include:

1. Determination and size fractionation of chlorophyll and ATP concentration.

2. Determination and size fractionation of ^{14}C uptake as an estimate of primary productivity.

3. Enumeration and identification of phytoplankton and bacterial populations resident at the depth of maximum productivity.

4. Sampling for subsequent isolation of dominant phytoplankton species.

Field experiments, which are as follows, include many to be conducted by scientists from NMFS/Beaufort.

1. The effect of the addition of different concentrations of Cu and/or artificial chelators upon total ^{14}C uptake by natural phytoplankton populations.

2. The effect of similar additions upon uptake of ^{3}H labelled organic substance by natural bacterial populations.

3. Bioassay of chelating potential by serial addition of copper and/or artificial chelators to previously-isolated phytoplankton and bacterial cultures growing in seawater collected at the different sites.

4. Qualitative partitioning of ^{14}C uptake amongst phytoplankton groups by differential centrifugation in osmotically-balanced density gradients following ^{14}C uptake experiments upon resident phytoplankton populations.

Laboratory experiments are as follows and also include many experiment to be conducted by scientists from NMFS/Beaufort.

1. The effect of additions of Cu and various natural chelators upon the gr of selected phytoplankton and bacterial cultures isolated from the spec sites.

2. The effect of similar additions upon bacterial growth.

3. The effect of similar additions upon the growth and development of larv commercial fish presently in culture.

In addition to the above effort, zooplankton and larval fish populations will b sampled with a specially modified MOCNESS net system. Our system has two uniqu characteristics in that it has a capability of using fine-nets (.063mm) to obta fish food and can be deployed in conjunction with synoptic acoustic profiling t optimize catch. For community analysis (and subsequent gut content comparison) samples will be processed by our newly described technique of high-speed silhou photography. Individual larval fish will be sorted from the catch of the large course net fraction sampled by MOCNESS.

The detailed information we are generating is necessary to ensure valid ecologi interpretation of specific chlorophyll profile measurements. Nonetheless as a signal, or indicator, integral-near-surface chlorophyll, as detected by CZCS, m be of great ecological utility. Its significance could be estimated by distribution-free analyses such as correspondence analysis, and predictive mode could be generated by Box-Jenkin's type models. Between ROME stations we will making surface chlorophyll determinations as we transit. These tracks may also useful to those assessing CZCS data.

Evaluation of Remote Sensing Techniques for Evaluating Coastal Wetlands

Donald R. Eckberg
Southeast Regional Office
National Marine Fisheries Center
St. Petersburg, Florida

A contract dealing with the evaluation of remote sensing techniques for surveying coastal wetlands has been completed recently by the College of Marine Studies at the University of Delaware. This study included:

1. Marsh ecology in relationship with fisheries.

2. Wetland information: requirements for management and current availability.

3. Methodologies for gathering wetland information.

4. Choice of data collection methodologies.

5. A pilot program for application of remote sensing to fishery habitat assessment and management.

Comparison of the wetland data requirements for management and data acquisition/research groups is given in summary form below.

This study should serve as a handbook for those who are interested in gathering wetlands information, particularly with reference to remote sensing methods and costs involved in obtaining data.

WETLAND DATA REQUIREMENTS

DATA REQUIREMENT	MGT.	DATA ACQUISITION
AREA DEALT WITH	10 HA	10 10,000 HA
WETLAND/UPLAND BOUNDARD	± 1 M	± 2-30 M
AREAL ACCURACY	±100 M^2	
AREAL ACCURACY OF PARTICULAR EMERGENT PLANTS	± 10 M^2	±10-100 M^2

	HAVE	DESIRE
Wetland/Upland Boundary	46% (Mgt)	91%
Area of Wetlands	64%	91%
Area of Non-Wetland	46% (Mgt)	75%
Emergent Plants	58%	84% (Mgt) 77% (Tot.)
Aquatic Plants	31%	85%
Emergent Plant Biomass	15-16%	65% (Mgt) 57% (All)
Plankton/Detritus in Water Column	20%	50%
Inorg. Material in Water Column	15% (Mgt) 20% (Tot.)	50%
Tidal Inundation	50%	80% (Mgt) 75% (Tot.)
Plant Stress	9-12%	60%

Remote Sensing Data Available at the Miami Satellite Field Service Station

Stephen Baig
Satellite Field Service Station
National Environmental Satellite Service
Miami, Florida

The Miami Satellite Field Service Station (SFSS) of the National Environmental Satellite Service (NESS) prepares and/or has available a number of products and services which can be of use to persons interested in fisheries. The bulk of these products and services are based on satellite-sensed thermal marine features.

The thermal marine features are sensed in the emitted infrared region of the electromagnetic spectrum, from about 10 microns to 13 microns. Data from the Geostationary Operational Environmental Satellite (GOES) and the Polar Orbiting Satellite (TIROS) series are used. The bulk of the data is displayed as imagery, 10x10 inch "photographs" of the field of view of the satellite. The imagery is usually enhanced to bring out the sometimes subtle differences in temperature between different water masses. Twenty four hours of imagery from the EAST Stationary satellite is geographically registered and an animated movie or video "loop" is prepared and displayed on a suitable base chart. The location of fronts and water masses of interest are transferred to the base chart each day.

Data from other still imagery, from both geostationary and polar orbiting satellites, are incorporated into the data on the base chart. From these daily analyses thrice-weekly charts are prepared for distribution, showing the Gulf Stream System from the Yucatan Channel to the vicinity of Nova Scotia. Coastal water mass boundaries of interest are also incorporated into these thrice-weekly charts. Early in January, 1980, the portion of the chart from the Yucatan Channel to Cape Hatteras will be available in every National Weather Service (NWS) office which has the DIFAX facsimile recording system. The chart presently has limited distribution on the NWS TROPAN facsimile circuit. A composite weekly chart is also prepared from these data, showing the latest position of water masses for the previous week. The chart is distributed by mail.

Another product is a daily composite of the actual thermal field sensed by the GOES satellite. The geographical area of coverage is the Gulf of Mexico and the East Coast of North America. These daily composites are screened to remove temperatures below $0^{o}c$, clouds, and the land. The data are displayed in an alphanumeric code and the display contains geographic location informaton. No attempt is made to reduce these satellite-sensed temperatures to actual surface temperatures, as the highly variable atmospheric attenuation is not precisely known. Gradients as slight as one celcius degree are displayed. A similar product can be generated on demand for any area between $25^{o}W$ and $125^{o}W$ between from $50^{o}N$ to $40^{o}S$.

A Global Ocean Sea Surface Temperature Composite (GOSSTCOMP) is available on a daily basis, at 100 km resolution. Fifty kilometer resolution data are available for selected areas near Hawaii, Alaska, the West and East coasts of North America,

and the Gulf of Mexico. The data are displayed as actual surface temperatures. GOSSTCOMP mainly relies on data from Polar Orbiting satellites.

On request, operational briefings can be given to ships operating at sea. These briefings can include position and temperature of water masses, and up-to-the-minute meteorological information which might affect ship-board operations. These briefings are given directly to the ship via radiotelephone. Hard copy charts have successfully been transmitted to ships via telecopier over regular high-seas telephone. Briefings of this type have been used to modify cruise plans so that less time is spent searching for areas of interest and more time is spent on-site.

The Miami Satellite Field Services Station will consider requests for any of the products and services listed above, and will assist in any way to help potential users of satellite-derived marine data.

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Miami, Florida 10/22-24/79

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