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AN ANNOTATED BIBLIOGRAPHY OF AERIAL REMOTE SENSING IN COASTAL ENGINEERING

by

Donald B. Stafford, Richard O. Bruno

and

Harris M. Goldstein

MISCELLANEOUS PAPER NO. 2-73
MAY 1973

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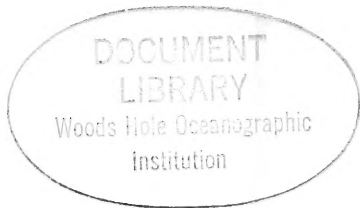
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AN ANNOTATED BIBLIOGRAPHY OF AERIAL REMOTE SENSING IN COASTAL ENGINEERING

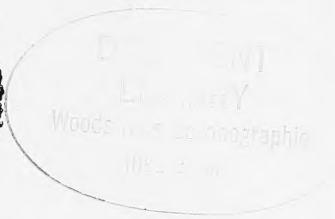
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ABSTRACT

This bibliography covers representative literature on the applications of aerial remote sensing techniques to coastal engineering. About 200 references published since 1934 are presented. Annotations accompany each bibliographic entry and are a concise and informative summary of the references describing the characteristics of each remote sensor in coastal engineering investigations. Computer indexes of authors, titles, and keywords are included.

FOREWORD

This bibliography was compiled and annotated by D. B. Stafford, Department of Civil Engineering, Clemson University. Computer indexing and report preparation was done by R. O. Bruno and H. M. Goldstein under the general supervision of D. W. Berg, Chief, Evaluation Branch, and G. M. Watts, Chief, Engineering Development Division.

Programs used were prepared by M. Keplinger of the National Bureau of Standards, and B. R. Sims of the Coastal Engineering Research Center. Mr. Sims adapted these programs specifically for the compilation of this bibliography.

At the time of publication, Lieutenant Colonel Don S. McCoy was Director of the Coastal Engineering Research Center; Thorndike Saville, Jr. was Technical Director.

NOTE: Comments on this bibliography are invited. Readers who find omissions or errors are encouraged to submit their suggestions.

This report is published under authority of Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

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I. INTRODUCTION

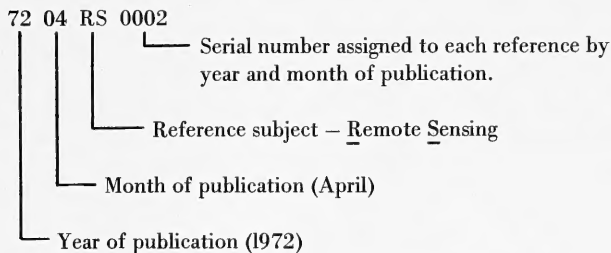
This annotated bibliography presents a compilation of literature describing the coastal engineering applications of aerial remote sensing. References in the compilation are annotated for a quick evaluation. The annotations are a concise, informative summary of the references. They describe the type of coastal engineering or related coastal environmental investigation discussed and the types of aerial remote sensors used in the study. Data obtained from the sensors are presented.

Although the bibliography is not a complete listing of available literature, it is a representative sampling of the important references. Including additional references would duplicate rather than broaden ideas and concepts.

A selected list of textbooks and manuals on the basic principles and concepts of aerial remote sensing and photogrammetry is included as background information. These references can be useful for coastal engineers not familiar with the characteristics of remote sensing techniques.

II. USE OF BIBLIOGRAPHY

Each entry of the bibliography has a coded reference number, author, title, source, keywords and annotation. The coded reference number is identified (using example 7204RS0002) as:



Where the year or month of publication is unknown, zeros are used. The reference numbers are designed to permit additional entries to the literature data base.

Special utility of the bibliography is in its *indexes*. Reference numbers, authors, titles and keywords are input to a computer indexing program. Each entry in the indexes is identified by the reference number. The author index is an alphabetical listing; the title index is an alphabetical listing of words taken out of context of the reference titles. To provide a subject index, keywords were chosen from the reference content and all entries are keyed to this listing. Keywords preceding each annotation are entered by subject in order of the 1) type of remote sensor discussed; 2) application to coastal engineering; and, 3) geographical area covered, if applicable. The subjects can be differentiated by keyword definition in lieu of a system separating the keywords by groups.

A keyword vocabulary identifying aerial remote sensors and coastal engineering applications follows:

TABLE

Remote Sensors	Coastal Applications
Aerial Photographs	Beach Erosion
Aerial Remote Sensors	Bibliography
Aerial Reconnaissance	Coastal Changes
Color Aerial Photographs	Coastal Engineering
Color Infrared Photographs	Coastal Mapping
Image Enhancement	Coastal Processes
Infrared Imagery	Coastlines
Multispectral Photographs	Ecology
Multispectral Imagery	Estuaries
Microwave Sensors	Geological Applications
Photogrammetry	Marine Resources
Radar Imagery	Marshlands
Satellite Photographs	Nearshore Ecology
	Oceanographic Applications
	Shoreline Delineation
	Soil Identification
	Storm Effects
	Thermal Anomalies
	Tidal Inlets
	Vegetation
	Water Currents
	Water Depths
	Water Penetration
	Water Pollution
	Wave Patterns
	Wave Surfaces

III. ANNOTATED BIBLIOGRAPHY

3410RS0001

LUCKE, JOHN B., "A Study of Barnegat Inlet, New Jersey, and Related Shoreline Phenomena," *Shore and Beach*, Vol. 2, No. 2, Oct. 1934, pp. 98-111.

Keywords: *Aerial Photographs, Coastal Processes, Tidal Inlets, Barnegat Inlet, New Jersey*

Article describes an early study that used photos to interpret coastal features. Study of Barnegat Inlet and adjacent beach is a detailed examination of the characteristics of coastal and submerged features. Photos were used to locate features and illustrate the relationship of coastal landforms. Basis for identifying coastal features such as channels, sediment deposits, and tidal deltas on photos is presented. Excellent photos of coastal landforms are included.

3907RS0001

HOWARD, ARTHUR D., "Hurricane Modification of the Offshore Bar of Long Island, New York," *Geographical Review*, Vol. 29, No. 3, July 1939, pp. 400-415.

Keywords: *Aerial Photographs, Storm Effects, Long Island, New York*

Article is one of the earliest to use photos illustrating effects of a hurricane. The southern shore of Long Island was examined after the 21 September 1938 hurricane. New inlets were formed in the barrier beach. Oblique photos taken after the storm showed the nature and characteristics of the inlets. The photos also showed many changes caused by the storm on the ocean and lagoon side of the once uniform and straight shoreline. No quantitative data were obtained.

3909RS0001

NICHOLS, ROBERT L., and MARSTON, ALWYN F., "Shoreline Changes in Rhode Island Produced by Hurricane of September 21, 1938," *Geological Society of America Bulletin*, Vol. 50, No. 9, Sept. 1939, pp. 1357-1370.

Keywords: *Aerial Photographs, Storm Effects, Rhode Island*

Article is an early report using photos to illustrate effects of a severe storm on coastal features. Oblique photos taken after the hurricane showed the inlets cut in the beach and other storm effects. No comparative photos were taken before the storm. Oblique photos made it difficult to extract quantitative data because of the varying scale. Considerable data collected by before and after field surveys are included. Area covers 12 miles of the Rhode Island shoreline.

4106RS0001

SHEPARD, FRANCIS P., EMERY, KENNETH O., and LaFOND, E. C., "Rip Currents: A Process of Geological Importance," *The Journal of Geology*, Vol. 49, No. 4, June 1941, pp. 337-369.

Keywords: *Aerial Photographs, Coastal Processes, Beach Erosion, California*

Use of photos in an investigation of the relationship between rip currents and beach erosion in California is described. Vertical and oblique photos show rip currents and their effects on

the beach. Rip currents were identified on the photos by gaps in the breaking waves and by areas of discolored water or foam being carried seaward. Photos were used primarily to examine the characteristics of the water rather than land features.

4200RS0001

EARDLEY, A. J., *Aerial Photographs—Their Use and Interpretation*, Harper and Brothers, New York, 1942, 203 pp.

Keywords: *Aerial Photographs, Geological Applications, Coastal Mapping*

This is an early textbook on photo interpretation containing basic concepts of making measurements on photos. Principles of stereo viewing and procedures for constructing mosaics are described. Much of the book is devoted to the applications of photo interpretation in geologic mapping. A brief section, by John B. Lucke, on the use of photos in shoreline studies is included. Advantages and limitations of photos in examining coastal features are discussed. Primary advantage of photos is noted as their depiction of submerged features such as channels and sediment deposits. The best time and weather conditions for taking photos showing underwater detail are described. Mosaics of two coastal areas show intricate submarine sedimentation patterns. Techniques for identifying submerged features are presented.

4300RS0001

SMITH, H.T.U., *Aerial Photographs and Their Applications*, Appleton-Century-Crofts, New York, 1943, 372 pp.

Keywords: *Aerial Photographs, Geological Applications, Coastlines*

This is an early textbook on photo interpretation. Emphasis is on geological applications of photos, although several engineering applications are discussed. Procedures for measuring on photos, stereo viewing, and mosaic construction are described. Section on coastal landforms presents techniques for the geological classification of coastlines from photo interpretation. Photos of coastal landforms are included.

4505RS0001

U.S. NAVAL PHOTOGRAPHIC INTELLIGENCE CENTER, "A Guide to Pacific Landforms and Vegetation for Use in Photographic Interpretation," Report No. 7, U.S. Naval Photographic Intelligence Center, Washington, D.C., May 1945.

Keywords: *Aerial Photographs, Coastlines, Coastal Mapping, Geological Applications, Vegetation*

Report describes landforms and vegetation typical in the Pacific. The report served as a training guide for interpreters to identify landforms and vegetation from photos. Emphasis is on coastal landforms, coral reefs and atolls. Many coastal features are illustrated by stereopairs. Many oblique and ground photos with descriptions of important features are included. Material may be useful to coastal engineers not familiar with photo interpretation techniques. Report can be used in geological applications.

4700RS0001

McCURDY, P. G., *Manual of Coastal Delineation from Aerial Photographs*, United States Navy Hydrographic Office Publication No. 592, United States Navy Hydrographic Office, Washington, D.C., 1947, 143 pp. (Reprinted, 1966).

Keywords: *Aerial Photographs, Coastal Mapping*

Book presents an extensive treatment on delineation of coastal features from photos for mapping and charting purposes and a well-illustrated discussion of types of coasts. Many illustrations are single photos or stereopairs. Procedures are given for locating the high water line on photos from slight changes in gray color tones of the beach. Difficulties in determining water depths accurately from small-scale photos are noted. However, it is concluded that shallow areas and other hazards to navigation can be identified by careful examination of photos. The many photos of coastal landforms are an outstanding feature.

4701RS0001

MUNK, W. H., and TRAYLOR, M. A., "Refraction of Ocean Waves; A Process Linking Underwater Topography to Beach Erosion," *The Journal of Geology*, Vol. 55, No. 1, Jan. 1947, pp. 1-26.

Keywords: *Aerial Photographs, Wave Patterns, California Coast*

This is a detailed study of wave refraction related to offshore topography. Refraction diagrams along the southern California coast near the Scripps Institution of Oceanography were compared to photos; there was a good correlation. The photos confirm the response of waves to underwater topography as predicted by refraction theory. Convergence of waves traveling over submerged ridges and divergence of waves moving over submarine canyons are illustrated by aerial and ground photos. Relation of refraction to coastal erosion is discussed.

4701RS0002

WILLIAMS, W. W., "The Determination of Gradients on Enemy-Held Beaches," *The Geographical Journal*, Vol. 109, No. 1, Jan. 1947, pp. 76-93.

Keywords: *Aerial Photographs, Water Depths, Shoreline Delineation*

Article describes and evaluates four methods of computing beach and nearshore profiles by photos as used during World War II. One method uses plots of the waterline made from photos taken at different times and tide tables to calculate the gradient between the high and low tide waterline. Method is susceptible to error and does not give profiles for any area covered at low tide. Three wave methods, based on relations between velocity, period, refraction, and water depths, are discussed. The wave-velocity procedure requires photos with the time lapse between exposures known to the nearest second. Wave-period method requires hydrographic data. The wave refraction procedure has not been used extensively. Photos are used to illustrate the methods.

4701RS0003

MOORE, J. G., "The Determination of the Depths and Extinction Coefficients of Shallow Water by Aerial Photography Using Color Filters," *Philosophical Transactions of the Royal Society of London, Series A*, Vol. 240, No. A816, 1947, pp. 168-217.

Keywords: *Aerial Photographs, Water Depths, Water Penetration*

A theoretical study of a method for determining water depths from photos is presented. Method is based on water penetration characteristics of different wavelength bands within the visible spectrum. Color filters were used to take photos in which the film was exposed with the desired part of the spectrum. The procedure for taking suitable photos is given. Results obtained from September 1944 to October 1945 are analyzed. Article is an early publication about light penetration characteristics of water.

4704RS0001

BEACH EROSION BOARD, "Test of Aerial Photogrammetry in Making Beach Surveys," *The Bulletin of the Beach Erosion Board*, Vol. 1, No. 1, Apr. 1947, pp. 1-10.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Mapping, Anna Maria Key, Florida*

A test and cost comparison of compiling topographic maps for a beach-erosion survey by field versus photogrammetry is presented. The test was conducted in cooperation with the Army Map Service at Anna Maria and Longboat Keys, Florida. Probably because of shape and topography of the test area, photogrammetry was not entirely successful in developing the topography and supplemental field surveys were required. Cost of using photogrammetry was determined to be much greater than a field survey using planetable procedures.

4712RS0001

DEITZ, ROBERT S. "Aerial Photographs in the Geological Study of Shore Features and Processes," *Photogrammetric Engineering*, Vol. 13, No. 4, Dec. 1947, pp. 537-545.

Keywords: *Aerial Photographs, Coastal Processes, Coastal Changes, Santa Monica, California*

Capabilities and qualities of photos in studies of shore features and processes are described. Emphasis is on underwater features shown in shallow water and under proper conditions. This permits study of submerged features by direct viewing of photos. Under conditions that prevent submerged features being depicted on photos, indirect methods, such as wave refraction and breaking, can be used to imply water depths. Shore features and processes are more susceptible to geological study because of their clear presentation on photos. As a result of manmade construction, changes in the coastline at Santa Monica over a 9-year period are illustrated by oblique photos. Photos are concluded to be a prime tool for studying changes in shore features.

4812RS0001

COLEMAN, C. G., "Photographic Interpretation of Coasts and Beaches," *Photogrammetric Engineering*, Vol. 14, No. 4, Dec. 1948, pp. 462-472.

Keywords: *Aerial Photographs, Coastal Mapping*

Article discusses photo interpretation of beaches and coasts for military reconnaissance in support of amphibious operations during World War II. Vertical and oblique photos were used for determining conditions of beaches for which reliable maps or charts were not available. The information required in amphibious planning was obtained from photos, even poor quality photos that were often the only ones available. A combination of photogrammetry and photo interpretation was used for the required information. Many military applications have counterparts in civilian coastal studies.

4812RS0002

LUNDAHL, ARTHUR C., "Underwater Depth Determination by Aerial Photography," *Photogrammetric Engineering*, Vol. 14, No. 4, Dec. 1948, pp. 454-462.

Keywords: *Aerial Photographs, Water Depths*

Report summarizes the methods developed during World War II to determine water depths near beaches from photos and includes a discussion of the advantages, disadvantages, and errors of each method. In using parallax methods, conventional stereopairs did not give suitable accuracy. Sonne continuous-strip stereo photos were more accurate, and were used extensively. Attempts to use film density were generally unsuccessful with the equipment available during World War II. Wave methods using fundamental equations of wave motion in conjunction with photos taken with a known time lapse are discussed. Wave methods using velocity, period, and refraction were used. Success of any of the three procedures is dependent on good quality photos. A method for determining beach slope that uses a plot of the waterline from photos taken at different stages of the tide is described.

5010RS0001

DICKERSON, LEWIS A., "Stereophotogrammetric Wave Measurement," *The Bulletin of the Beach Erosion Board*, Vol. 4, No. 4, Oct. 1950, pp. 40-45.

Keywords: *Photogrammetry, Wave Surfaces, Wave Patterns, Atlantic City Beach, New Jersey*

Article discusses two trials conducted by the Army Map Service for the Beach Erosion Board to measure ocean wave characteristics by photogrammetry. The photos used were stereopairs made with two cameras mounted on the Steel Pier at Atlantic City, New Jersey. The primary interest was wave height. The first test was unsuccessful because of unknown camera and orientation elements, although the results were encouraging to justify another trial. The second test produced a three-dimensional model of the water surface in a photogrammetric plotter. However, wave crests concealed the wave trough and heights could not be measured. The conclusion was that it was possible but difficult to use the method. It was also concluded that the technique might be more successful with improvements in the arrangement for taking photos, such as two cameras mounted in one or more low-flying, slow-speed aircraft.

5009RS0001

McCURDY, P. G., "Coastal Delineation from Aerial Photographs," *Photogrammetric Engineering*, Vol. 16, No. 4, Sept. 1950, pp. 550-555.

Keywords: *Aerial Photographs, Coastal Mapping*

Problems common in delineating shorelines from photos for maps and charts are presented. The shoreline, generally taken as the high water line, usually appears as a line between areas with slightly different color (gray) tone on the photos. Another line further inland is the debris line where material accumulates at the highest point of wave runup during high tides. Photos are also used to locate areas of shallow water or other hazards to navigation. Difficulties in using photos to define water depths accurate enough for charts are described.

5009RS0002

CAMERON, H. L., "The Use of Aerial Photography in Seaweed Surveys," *Photogrammetric Engineering*, Vol. 16, No. 4, Sept. 1950, pp. 493-501.

Keywords: *Aerial Photographs, Color Aerial Photographs, Water Penetration, Nearshore Ecology, Nova Scotia, Canada*

Article describes a project along the southern coast of Nova Scotia, to map the distribution of seaweed by photos. Black and white photos taken with conventional cameras using green and red filters, and black and white color photos taken with a Sonne continuous-strip camera were used. The photos taken with a green filter provided more subsurface detail and were better for seaweed mapping than the photos taken with a red filter. Color photos were better than black and white in the areas they covered. Seaweed type and distribution could be mapped in water 25 feet deep. Procedures used in planning and executing the mission to ensure that satisfactory photos were taken at selected tidal stages and the interpretation and mapping techniques are described.

5012RS0001

SHEPARD, FRANCIS P., "Photography Related to Investigation of Shore Processes," *Photogrammetric Engineering*, Vol. 16, No. 5, Dec. 1950, pp. 756-769.

Keywords: *Aerial Photographs, Coastal Processes*

Paper discusses the uses of ground and aerial photos to study waves, rip currents, beach features, and cycles of erosion. Photos are noted to be particularly useful in studying wave patterns along coastlines. Rip currents are illustrated by ground and aerial photos. Seasonal cycles of beach erosion and accretion can be investigated with periodic ground or aerial photos. Importance of accurate dating of historical photos is emphasized.

5012RS0002

TEICHERT CURT, and FAIRBRIDGE, R. W., "Photo-Interpretation of Coral Reefs," *Photogrammetric Engineering*, Vol. 16, No. 5, Dec. 1950, pp. 744-755.

Keywords: *Aerial Photographs, Coastal Mapping, Geological Applications*

Article presents information to identify and examine coral reefs and features on photos. Types of coral reefs and related features are described. Vertical and oblique photos illustrate coral reefs. Photos taken at low tide and at a scale of 1:5,000 or larger with 60 percent

overlap to permit stereo examination are recommended. Photos are concluded to be useful in this study since important submerged features are shown. Low oblique photos are useful in interpreting coral reef features.

5100RS0001

BELCHER, DONALD J., AMOUZEGAR, J., HODGE, R. J., LADENHEIM, H. C., and LUEDER, D. R., "A Photo-Analysis Key for the Determination of Ground Conditions," *Vol. 1—Coastal Plain Beaches, Vol. 2—Pocket Beaches, Vol. 3—Coral Beaches, Glaciated Beaches, River Mouth Beaches, and Terrace Beaches*, Beach Series, Technical Report No. 3 for the Office of Naval Research, Cornell University, Ithaca, N.Y., 1951.

Keywords: *Aerial Photographs, Coastlines, Coastal Mapping*

This three-volume report presents information to identify types of beaches and beach features on photos. Report covers all types of beaches and many of them are illustrated by photos, and the geographical distribution discussed. The material presented is useful to coastal engineers not familiar with photo interpretation techniques but wish to use photos in reconnaissance of coastal areas. Publication can also be useful in geological applications of photo interpretation in beach studies.

5200RS0001

SCHUMACHER, A., "Results of Exact Wave Measurements (by Stereophotogrammetry) with Special Reference to More Recent Theoretical Investigations," *Gravity Waves, Proceedings of the National Bureau of Standards Semicentennial Symposium on Gravity Waves* National Bureau of Standards Circular 521, Washington, D.C., 1952, pp. 69-78.

Keywords: *Photogrammetry, Wave Surfaces, Wave Patterns.*

The history and results of attempts to measure ocean waves by photogrammetry using stereo photos taken from a ship is presented. The advantages and capabilities of photogrammetry in such investigations are given for the types of additional data to be derived. Maps of wave patterns from this method are included. Use of rapid sequence stereo photos to gather data on changes in waves in space and time is discussed. Extension of the method from shipborne cameras to airborne cameras is mentioned. The article lists numerous German references on use of shipborne photogrammetry to measure descriptive wave parameters.

5203RS0001

CAMERON, H. L., "The Measurement of Water Current Velocities of Parallax Methods," *Photogrammetric Engineering*, Vol. 18, No. 1, Mar. 1952, pp. 99-104.

Keywords: *Aerial Photographs, Photogrammetry, Water Currents, Bay of Fundy, Canada*

Article describes the anomalous stereo effects on photos by water currents where the water surface is discolored enough to be opaque. Surface movement by water currents between exposures produces a parallax that causes the surface to appear as ridges and valleys in the stereo model. The possible use of this phenomena to measure current velocities and direction is discussed. Suggestions for applying this technique are given, such as the use of a slow-moving aircraft to obtain maximum water surface displacement, noting the stage of the

tide to correlate current velocity with tidal stage, and the use of powder or dye to ensure the water surface is opaque. A description of trials at three locations in the Bay of Fundy includes three stereopairs showing the anomalous water surface and numerical examples using data from one of the stereopairs.

5203RS0002

OROS, CHARLES N., "River Current Data from Aerial Photography," *Photogrammetric Engineering*, Vol. 18, No. 1, Mar. 1952, pp. 96-99.

Keywords: *Aerial Photographs, Water Currents, Columbia River, Oregon*

Report describes a study by the Corps of Engineers to determine river current velocity and direction on a section of the Columbia River known as Fivemile Rapids for use as background data to design the Dalles Dam. Photos of floating targets painted on a sheet of plywood supported by two connected oil drums were used. The targets were released upstream and their progress traced on overlapping photos. By comparing adjacent photos taken at a known time interval, the velocity and direction of the target movement were determined. Flights were planned at specific river stages when current data were desired. Radio communications between boats releasing targets and a ground operations base and signal flag communications between the operations base and the aircraft coordinated operations. Satisfactory current data were obtained for a situation in which other methods would have been almost impossible. Technique could possibly be modified for use in measuring current velocity and direction in coastal engineering applications.

5207RS0001

WARD, H. A., "A Method of Separating Multiple Systems of Ocean Waves for Detailed Study of Directions and Other Properties," *The Bulletin of the Beach Erosion Board*, Vol. 6, No. 3, July 1952, pp. 1-13.

Keywords: *Aerial Photographs, Wave Patterns.*

A procedure is described for using photos of nearshore areas to determine direction of multiple ocean wave trains. Inadequacy of other methods of determining wave direction is discussed. Improvements in wave refraction and longshore current calculations that may result from collection of more reliable wave direction data are noted. The proposed procedure can detect and analyze two or more systems of waves approaching the shoreline. A transparent sheet with a series of parallel lines drawn at about 0.1-inch intervals is placed over the photo and rotated to detect the wave systems. When the parallel lines are aligned with the obvious series of wave crests, these lines cover the obvious wave system and permit less obvious wave patterns to be observed. These minor wave systems are usually difficult or impossible to detect on photos. Examples of the device and technique are included.

5406RS0001

LUEDER, DONALD R., ROCKWELL, W. H., and BELCHER, DONALD J., "Determination of Beach Conditions by Means of Aerial Photographic Interpretation," *Relations Between Beach Features and Beach Conditions*, Technical Report No. 6, Vol. 1, School of Civil Engineering, Cornell University, Ithaca, N.Y., June 1954.

Keywords: *Aerial Photographs, Coastlines, Coastal Processes*

Report is one of a series describing the results of a research program conducted for the Office of Naval Research to develop techniques for determining beach trafficability from photos. Since trafficability is related to other characteristics, the material presented may be useful in determining from photos beach characteristics useful in coastal engineering. Characteristics such as average foreshore slope, grain size of beach material, beach width, and presence of ripple marks and beach cusps were found related to beach trafficability. The report concludes that good quality, large-scale photos are necessary to accurately measure beach characteristics. Although the median grain size of beach material cannot be determined directly from photos, the report indicates that it can be estimated from beach slope and width.

5406RS0002

LUEDER, DONALD R., and BELCHER, DONALD J., "Determination of Beach Conditions by Means of Aerial Photographic Interpretation," *Photographic Gray Tones as an Indication of the Size of Beach Materials*, Technical Report No. 6, Vol. 4, School of Civil Engineering, Cornell University, Ithaca, N.Y., June 1954.

Keywords: *Aerial Photographs, Coastlines, Soil Identification*

Report is one of a series that describe results of a research program conducted for the Office of Naval Research to develop techniques for determining beach trafficability from photos. Report discusses the use of photo gray tones to determine grain size of beach materials, a technique that may be useful in coastal engineering. The technique measures photo density with a microdensitometer along a line perpendicular to the waterline. Variation in gray tone or photo density along the line is related to the moisture content of beach material which is a function of the predominant grain size. Tonal characteristics of the boundary between the gray tone of the dry backshore and the gray tone of the periodically wetted foreshore is a key factor in determining the grain size. Characteristic gray tone patterns for beaches composed of fine and coarse sands are described. This report may be useful in locating the high water line on photos for beach erosion studies.

5406RS0003

LUEDER, DONALD R., and BELCHER, DONALD J., "Determination of Beach Conditions by Means of Aerial Photographic Interpretation," *A Method for Estimating Beach Trafficability from Aerial Photographs*, Technical Report No. 6, Vol. 5, School of Civil Engineering, Cornell University, Ithaca, N.Y., June 1954.

Keywords: *Aerial Photographs, Coastlines, Coastal Processes*

Report is one of a series describing the results of a research program conducted for the Office of Naval Research to develop techniques for determining beach trafficability from

photos. Since the techniques are based on the measurement of other beach characteristics on photos, the approach may be useful in coastal engineering. Beach properties from photos include average foreshore slope, beach width, grain size of beach material, and presence of ripple marks and beach cusps. Report recommends specifications for photos to be used in determining trafficability. Photos taken at low tide ± 2 hours at a scale of 1:2,500 or larger were recommended. Procedures used to determine beach characteristics related to trafficability from photos are described.

5503RS0001

MARKS, WILBUR, and RONNE, F. C., "Aerial Stereo-Photography and Ocean Waves," *Photogrammetric Engineering*, Vol. 21, No. 1, Mar. 1955, pp. 107-110.

Keywords: *Aerial Photographs, Wave Patterns*

Article discusses a plan to use stereopairs to experimentally verify theories of ocean wave generation, propagation, and decay. Advantages of photogrammetry over other procedures are noted. The plan required cameras installed in two aircraft flying in tandem at a constant horizontal separation with an FM radio link to ensure simultaneous triggering of both cameras and to produce a stereopair of the moving and changing sea surface. A ship towing a raft was used to determine the scale. Wave heights at discrete points were determined from the stereopairs to yield a two-dimensional energy spectrum of the sea surface.

5600RS0001

KELLY, ROBERT A., "Applications of Terrestrial Photogrammetry for Determination of Shore Movements," Master of Science Thesis, Department of Geology, Ohio State University, Columbus, Ohio, 1956.

Keywords: *Photogrammetry, Coastal Changes, Beach Erosion, Lake Erie Shoreline, Ohio*

Thesis presents results of an investigation of terrestrial photogrammetry applications in beach erosion and coastal change studies. Terrestrial photogrammetry was used along the Lake Erie shoreline to determine beach profiles for use in computing volume changes in the beach and also to examine changes in a laboratory beach subject to wave action. Before-and-after topographic maps were plotted for the laboratory beach to compute volume changes caused by different wave conditions. A proposed technique for using photogrammetry with photos of vertical graduated rods of known length for nearshore bottom mapping is described. The advantages, limitations, and recommendations for improving terrestrial photogrammetry in beach studies are discussed.

5600RS0002

COX, CHARLES, "Optical Measurements of Sea Surface Roughness," *Proceedings of the First Conference on Coastal Engineering Instruments*, Edited by R. L. Wiegel, Council on Wave Research, University of California at Berkeley, Calif., 1956, pp. 1-15.

Keywords: *Aerial Photographs, Wave Patterns*

A method of using special photos of the sea surface to measure the roughness is outlined. Method is based on reflections from the sun recorded on the photos. Four K-17 cameras were mounted in an aircraft; two cameras were arranged with their axes vertical, and two

with their axes tilted. Two cameras, one vertical and one tilted, were modified to take out-of-focus photos. These are termed photometric photos and were used to determine average sea surface brightness. The in-focus or image photos were used to determine the aircraft altitude and to note problems such as white caps, slicks, or cloud shadows. Report concludes that optical methods offer possibilities of determining two-dimensional sea surface roughness but that suitable techniques were in an early stage of development in 1955.

5604RS0001

McBETH, FRANK H., "A Method of Shoreline Delineation," *Photogrammetric Engineering*, Vol. 22, No. 2, Apr. 1956, pp. 400-405.

Keywords: *Aerial Photographs, Coastal Mapping, Shoreline Delineation*

A procedure for delineating the high water line on photos in the preparation of nautical charts and maps is described. It is based on photo textural and tonal differences and a banded appearance caused by debris. Procedure varies depending on whether the shoreline is composed of rock or clastic materials (sand, gravel, and shell). Although the high water line for the last high tide is delineated by this procedure, the author maintains that the distinction between the mean high water line and the usual high water line is insignificant for most mapping purposes. Several photos of coastal areas illustrate the technique.

5604RS0002

TEWINKEL, G. C., "Hydrographic Application of Photogrammetry in the United States Coast and Geodetic Survey," *Photogrammetric Engineering*, Vol. 22, No. 2, Apr. 1956, pp. 263-267.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Mapping, Shoreline Delineation*

Article presents a brief review of the uses of photos and photogrammetry by the USC&GS in its Photogrammetry Division. Photogrammetry is used primarily in the compilation and revision of charts, and by hydrographic survey teams. Review mentions that the Survey attempts to obtain photos at low tide, and delineates the high water line from the photos. Photos were useful in periodic revisions of charts, because changes in coastal features can be easily evaluated. Black and white infrared photos are most suitable for delineating the land-water boundary because water photographs dark compared to the adjacent land.

5704RS0001

BROOKS, H. R., "Chart Revisions," *Photogrammetric Engineering*, Vol. 23, No. 2, Apr. 1957, pp. 303-306.

Keywords: *Aerial Photographs, Coastal Mapping, Shoreline Delineation*

Paper describes use of photos to revise USC&GS charts. Charts must be revised periodically to ensure that land and water information is current. Chart revision is necessary where storms and cultural development cause frequent changes in land and water detail. Photos at periodic intervals show where natural and manmade changes have occurred and chart revision is required. Black and white infrared photos are often used in areas of deltas and tidal flats for easier delineation of the shoreline.

5704RS0002

JONES, BENNETT G., "Photogrammetric Surveys for Nautical Charts," *Photogrammetric Engineering*, Vol. 23, No. 2, Apr. 1957, pp. 291-302.

Keywords: *Aerial Photographs, Coastal Mapping, Shoreline Delineation*

Report discusses production, maintenance, and revision of nautical charts by the USC&GS using photogrammetry. Types of photos used are described along with shoreline delineation techniques. Field inspectors frequently mark the high water line on photos by referring to debris lines or other markings to aid the chart compiler. Black and white infrared photos make water areas appear very dark and permits shoreline delineation with less field inspection.

5704RS0003

JONES, BENNETT G. "Low-Water Photography in Cobscook Bay, Maine," *Photogrammetric Engineering*, Vol. 23, No. 2, Apr. 1957, pp. 338-342.

Keywords: *Aerial Photographs, Coastal Mapping, Shoreline Delineation, Cobscook Bay, Maine*

Article describes a project by the USC&GS for the Corps of Engineers to delineate the shoreline at low- and half-tide levels as part of a tidal power study. Cobscook Bay has an irregular shoreline with numerous tidal flats. Photos were taken simultaneously using panchromatic and black and white infrared film at low tide and half tide. The infrared film was ideal for the task since a thin film (3 inches or less) of water photographed very dark or black in marked contrast with the adjacent land areas. Time of photography and tide level were correlated from tide observations at several stations within the bay. A panchromatic and an infrared photo illustrate a part of the area.

5704RS0004

ZEIGLER, JOHN M., and RONNE, F. C., "Time Lapse Photography—Aid to Studies of the Shorelines," *Naval Research Reviews*, No. 4, Office of Naval Research, Washington, D. C., Apr. 1957, pp. 1-6.

Keywords: *Aerial Photographs, Color Aerial Photographs, Coastal Changes*

Report describes a program to obtain photos of the Eastern United States coastline by scientists at the Woods Hole Oceanographic Institution. Vertical photos were taken of parts of the coast for making mosaics of coastal features and oblique color photos of the entire east coast were taken at a rate of two frames per second with a movie camera. This article is primarily concerned with oblique photos, and discusses the equipment and procedures used. Changes in coastal features over about a 6-month period are illustrated for Fire Island Inlet, New York, and Capes Hatteras and Fear, North Carolina. Coastal changes are described in qualitative terms because of the difficulty of extracting quantitative data from the oblique photos. Users and uses of such photos are discussed. The group planned to continue the flights, at least annually.

5706RS0001

RIB, HAROLD T., "The Application of Aerial Photography to Beach Erosion Studies," Unpublished Master of Science Essay, Department of Civil Engineering, Cornell University, Ithaca, N.Y., June 1959.

Keywords: *Aerial Photographs, Beach Erosion, Coastal Processes*

Essay discusses applications of photos to beach erosion studies, and indicates how photos can be used more in this field. Use of photos in determining the source and rate of accumulation or loss of beach materials, investigating wave refraction, and evaluating the performance of shore protection structures is discussed. Photogrammetry and interpretation are reviewed and suggested specifications for photos are given. A scale of 200 feet per inch or larger was recommended. Several photos illustrate beach features and phenomena.

5810RS0001

ZEIGLER, JOHN M., and RONNE, F. C., "Coastline Photography," *Industrial Photography*, Vol. 7, No. 1, Oct. 1958, pp. 40-41.

Keywords: *Color Aerial Photographs, Coastal Changes, Tidal Inlets, Eastern U.S. Coast*

Article describes a program by scientists at Woods Hole Oceanographic Institution to produce periodic color photos of the Eastern United States coast. Photos were taken with a 16-mm. movie camera at two frames per second. The coast from Maine to Texas was covered. Oblique color photos were taken from 2,500 to 5,000 feet. The camera and the film viewing system are described. Significant short term changes in dynamic coastal features are discussed. Tidal inlets are rapidly changing coastal features. Several color photos are presented. Practical applications of time-lapse photos in coastal studies are described.

5811RS0001

CHIERUZZI, ROBERT, and BAKER, ROBERT F., "A Study of Lake Erie Bluff Recession," Bulletin 172, Engineering Experiment Station, Ohio State University, Columbus, Ohio, Nov. 1958.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Changes, Lake Erie, Ohio*

Report presents a study of bluff recession along a short section of Lake Erie shoreline in Ohio. In one phase, the investigators used topographic maps compiled by photogrammetry from photos taken in May and August 1957 and May 1958. The maps were used to plot profiles of bluffs to determine the amount of recession during the time intervals. Report notes that the use of photos for determining bluff recession is most applicable to long term changes where the magnitude of the changes would be significantly greater than the errors inherent in the technique. Report discusses important aspects of bluff recession.

5811RS0002

EMERY, K. O., "Wave Patterns Off Southern California," *Journal of Marine Research*, Vol. 17, Nov. 1958, pp. 133-140.

Keywords: *Aerial Reconnaissance, Wave Patterns, Southern California Coast*

Article presents a study of wave direction and period from aerial reconnaissance. Wave characteristics were observed and recorded. Observations were used to construct

wave-pattern maps showing direction and period. Several maps are presented. Visual observation was superior to photos because of uncertainties in orientation and interpretation of the photos, the small area included in each photo, and the need to observe for several minutes to determine direction and period of smaller wave trains. Aircraft location was by radar. Study covered an area off southern California. Applications of wave-pattern maps are discussed; the influence of offshore islands on wave patterns is described.

5900RS0001

LUEDER, DONALD R., *Aerial Photographic Interpretation—Principles and Applications*, McGraw-Hill, New York, 1959, 462 pp.

Keywords: *Aerial Photographs, Soil Identification, Coastlines*

Text is widely used in photo interpretation. First part covers principles of photo interpretation, and describes elements of the photo pattern. Second part describes procedures for interpreting various landforms and soils. Third part covers applications of interpretation techniques to engineering, water resources, geology, and other fields. Chapter 5 discusses color (gray) tones of beaches composed of materials with different gradations and predominant sizes. Text indicates that tone is a function of surficial moisture content and predominant grain size. Effect of beach slope on gray tone of the beach is also discussed. The book is a comprehensive compilation of basic information.

5903RS0001

PINCUS, HOWARD J., "Some Applications of Terrestrial Photogrammetry to the Study of Shorelines," *Photogrammetric Engineering*, Vol. 25, No. 1, Mar. 1959, pp. 75-82.

Keywords: *Photogrammetry, Coastal Changes, Coastal Processes*

Although this article does not describe a remote sensing technique, it does discuss terrestrial photogrammetry in the study of coastal processes. Capabilities of terrestrial photogrammetry in studying shoreline changes compared to aerial photogrammetry are outlined. Terrestrial photogrammetry has been useful in measuring bluff recession, determining beach profiles, and calculating volume changes. Ground photos were also used in the laboratory to monitor changes in model beaches in a wave tank. Obtaining photos during bad weather and collecting beach material samples, are particular advantages of terrestrial photogrammetry. The technique is best adapted to small sections of coastline.

5907RS0001

POWERS, WILLIAM E., and KOHN, CLYDE E., "Aerial Photo-Interpretation of Landforms and Rural Cultural Features in Glaciated and Coastal Regions," *Northwestern University Studies in Geography*, Number 3, Department of Geography, Northwestern University, Evanston, Ill., July 1959.

Keywords: *Aerial Photographs, Coastal Mapping, Massachusetts*

Report covers techniques for interpreting landform and rural cultural features of glaciated areas in the United States from photos and contains brief sections on photo identification of shore features associated with glacial landforms and seaside resort settlements, primarily in Massachusetts. Several shore features are illustrated by black and white stereopairs and

ground photos. Section on interpretation of seaside resort settlement features describes a seven-category, land-use classification system for coastal development, and several stereo-pairs illustrate the types of development.

5909RS0001

THEURER, CHARLES, "Color and Infrared Experimental Photography for Coastal Mapping," *Photogrammetric Engineering*, Vol. 25, No. 4, Sept. 1959, pp. 565-569.

Keywords: *Aerial Photographs, Color Aerial Photographs, Coastal Mapping*

Article discusses use of photos in the preparation and revision of hydrographic charts by the USC&GS. Color and black and white infrared photos were first used only to supplement panchromatic photos, but the unique characteristics of each type increased their usefulness. Infrared film is best suited for delineating the land-water interface because water appears very dark or black on the photos, and the sandy beach appears very light or white. However, lack of contrast in land areas on infrared film makes difficult the identification of terrain features, and limits the use of the film. Color film shows underwater topography and is useful in planning hydrographic surveys.

6000RS0001

AMERICAN SOCIETY OF PHOTOGRAMMETRY, *Manual of Photographic Interpretation*, American Society of Photogrammetry, Falls Church, Va., 1960, 868 pp.

Keywords: *Aerial Photographs, Coastal Processes, Water Penetration*

Comprehensive text discusses all aspects of photo interpretation and contains sections on the use of photos to investigate erosion and deposition by waves and coastal landforms in Chapter 4, pp. 201-219. One section discusses types of coasts, with several photos illustrating landforms and features. List of technical articles and reports that made extensive use of photos in studying coastal features and processes is included. Another section illustrates the central Louisiana coast as an example of photo interpretation in coastal geomorphology. Marshlands, swamps, beaches, and other features are discussed and illustrated by aerial and ground photos. Appendix C to Chapter 2, pp. 93-97, is a discussion by Russian scientists of factors that must be considered in taking good photos of underwater objects, including recommendations for selection of camera, film type, and filters for use with water bodies having various levels of transparency.

6000RS0002

COLWELL, ROBERT N., ed., *Manual of Photographic Interpretation*, American Society of Photogrammetry, Falls Church, Va., 1960, 868 pp.

Keywords: *Aerial Photographs, Coastal Processes, Water Depths*

See No. 6000RS0001.

6000RS0003

WILLIAMS, W. W., *Coastal Changes*, Routledge and Kegan Paul, Ltd., London, 1960, 220 pp.

Keywords: *Aerial Photographs, Coastal Changes*

A discussion of coastal changes includes a review of forces that cause them. A chapter on evidence on coastal changes and observational methods discusses measurement techniques in coastal erosion surveys. Inaccuracies of many personal observations and old maps are mentioned. The small scale of many nautical charts and the infrequency of revision are listed as the primary limitations in erosion studies. Use of photos in coastal-change studies is described. The problem of scale variation between photos is noted, and the necessity of using distances from charts or maps to determine the scale of each photo rather than use of the nominal photo scale is emphasized. The desirable scale and other characteristics of photos taken for coastal-change studies are given.

6000RS0004

RAY, RICHARD G., "Aerial Photographs in Geologic Interpretation and Mapping," Professional Paper 373, U.S. Geological Survey, Washington, D.C., 1960.

Keywords: *Aerial Photographs, Photogrammetry, Geological Applications, Beach Erosion*

Publication covers the geological applications of photos. Principles and techniques for using photos in different types of geological studies are described. Section on interpretation of photos in engineering geology discusses their use in beach erosion studies. Principles of photogrammetry related to measurements on the photos that are useful in geological applications are also covered. Publication provides useful background information in which geological considerations are relatively important.

6003RS0001

KOWALCZYK, CHESTER E., and STREES, LEO V., "New Attacks on Special Photogrammetric Problems," *Photogrammetric Engineering*, Vol. 26, No. 1, Mar. 1960, pp. 44-47.

Keywords: *Aerial Photographs, Water Depths, Coastal Mapping*

Article reviews problems of the U.S. Navy Hydrographic Office (USNHO) in using photogrammetry to prepare nautical charts; one is the difficulty in determining water depths from photos. Measurement of water depths (to a maximum of about 20 feet) by parallax methods with linear correction to the observed depth has been used to a limited extent by USNHO. The difficulty is in obtaining photos with sufficient penetration of water bodies for practical hydrographic mapping. Use of aerial and shipboard photos to determine wave characteristics is discussed. Two aircraft in tandem taking simultaneous photos of the water surface have been used as an approach to the problem.

6003RS0002

SWANSON, LAWRENCE W., "Photogrammetric Surveys for Nautical Charting—Use of Color and Infrared Photography," *Photogrammetric Engineering*, Vol. 26, No. 1, Mar. 1960, pp. 137-141.

Keywords: *Aerial Photographs, Color Aerial Photographs, Coastal Mapping, Water Depths*

Article discusses uses of color and black and white infrared photos in the preparation and maintenance of nautical charts by USC&GS and the advantages and disadvantages of these photos. The superior definition of color photos permits identifying objects that previously required field reconnaissance when using only panchromatic film. Color photos show bottom features to depths of 60 to 70 feet in some areas. Water depths measured on a Kelsh Plotter using color photos and corrected for refraction were within ± 5 percent of the values from hydrography in a test near the Virgin Islands. This quality is useful in planning nearshore hydrographic surveys, and has been used to plot bottom contours with modified photogrammetric plotters. The superior shoreline delineation on infrared photos is mentioned.

6004RS0001

ZEIGLER, JOHN M., "Beach Studies in the Cape Cod Area Conducted During the Period August 1953—April 1960," Reference No. 60-20, Woods Hole Oceanographic Institution, Woods Hole, Mass., Apr. 1960.

Keywords: *Aerial Photographs, Coastal Changes, Beach Erosion, Tidal Inlets, Cape Cod, Massachusetts*

Report describes beach studies on Cape Cod by Woods Hole Oceanographic Institution scientists supported by the Office of Naval Research. An important part of the study was the use of photos to examine short-term coastal changes. Use of periodic photos was a more feasible approach to monitor changes than field surveys using plane-table mapping. Monthly changes in Nauset Inlet are illustrated by mosaics of photos taken during 1955-58. Drastic changes occurred in the configuration of the inlet. The photos indicate the dynamic nature of many tidal inlets over a brief time. Beach-erosion data obtained from field surveys on the east side of Cape Cod are presented. A brief description is given of a program to annually photograph the Atlantic and Gulf coasts of the United States.

6012RS0001

FORRESTER, W. D., "Plotting of Water Current Patterns by Photogrammetry," *Photogrammetric Engineering*, Vol. 26, No. 5, Dec. 1960, pp. 726-736.

Keywords: *Aerial Photographs, Photogrammetry, Water Currents, Rideau River, Canada*

Report treats one approach to the use of photogrammetry for measuring water currents by the Canadian Hydrographic Service. Parallax caused by water currents moving objects on the water surface is used to determine the velocities. A field trial in measuring current velocities on the Rideau River in Ottawa, Canada is described and the results are discussed. In the trial, natural foam was used on the water and several white markers were dropped from a bridge into the river. Results were encouraging, but improvements in equipment would have provided better quality photos and fewer problems in extracting data from the photos and also improved accuracy.

6100RS0001

MILLER, VICTOR C., *Photogeology*, McGraw-Hill, New York, 1961, 253 pp.

Keywords: *Aerial Photographs, Photogrammetry, Geological Applications*

Textbook covers the fundamentals and applications of photogeology or the use of photos in geology. Part I covers basic material on the characteristics of photos, stereo viewing principles, and photo measuring instruments. Part II covers principles of photo interpretation, particularly in geological applications. Part III gives a series of exercises that illustrates geological applications of photos. These exercises are excellent stereo photos (only one coastal area) with explanatory text and supplemental figures. Although not oriented toward coastal engineering applications, this book contains background information that may be useful for coastal studies in which geology is important. An extensive bibliography on photogeology is included.

6103RS0001

COLWELL, ROBERT N., "Some Practical Applications of Multiband Spectral Reconnaissance," *American Scientist*, Vol. 49, No. 1, Mar. 1961, pp. 9-36.

Keywords: *Aerial Photographs, Shoreline Delineation, Water Penetration*

Article reviews applications of photos (and other remote sensors) which use film sensitive to various parts of the electromagnetic spectrum. Review discusses the use of panchromatic versus black and white infrared film for delineating shore features. Film and filter combinations that give the best results in studying underwater details are also discussed. Article contains a stereo view that shows bottom detail clearly through 30 feet of water.

6107RS0001

TANNER, WILLIAM F., "Mainland Beach Changes Due to Hurricane Donna," *Journal of Geophysical Research*, Vol. 66, No. 7, July 1961, pp. 2265-2266.

Keywords: *Aerial Photographs, Coastal Changes, Storm Effects, Florida*

Report presents changes caused by Hurricane Donna along the lower west coast of Florida using before-and-after photos. Photos taken in 1953, 1957, and 1958 before the hurricane in September, 1960, were compared with those taken in October and November of 1960. The assumption that the more obvious differences between the coastline on the prestorm and the 1960 photos were due primarily to storm effects was used to detect coastal changes and to compute sand movement by the storm. An average depth of 5 feet for eroded and accreted areas was also assumed to convert areal changes to volume changes. The author concluded that the storm only accelerated already active processes, and that there was about 100 years of sand movement during the storm period.

6200RS0001

VON BANDAT, HORST F., *Aerogeology*, Gulf Publishing, Houston, Tex., 1962, 363 pp.

Keywords: *Aerial Photographs, Photogrammetry, Geological Applications*

This book gives a comprehensive coverage of photogeology or the geological applications of photos. Part I covers basic characteristics and geometry of photos, fundamentals of photogrammetry, and stereo viewing principles. Part II describes geologic mapping

techniques and discusses specialized applications of geologic photo interpretation. Parts III, IV, and V cover principles of geologic photo interpretation. Part VI describes applications of photos in geomorphological studies of landforms. Important in this section are chapters on marine and lacustrine landforms and coral reefs. Discussion of coastal landforms is included, and several single and stereo photos are used to illustrate them. Although not oriented toward coastal engineering applications, this book contains background information that may be useful in coastal studies in which geology is important.

6200RS0002

FISHER, JOHN J., "Geomorphic Expression of Former Inlets Along the Outer Banks of North Carolina," Master of Science Thesis, Department of Geology, University of North Carolina, Chapel Hill, N.C., 1962.

Keywords: *Aerial Photographs, Tidal Inlets, Coastal Changes, Outer Banks, North Carolina*

Thesis describes a study of former tidal inlets along the Outer Banks of North Carolina by using photos. Photos were examined to identify features that would indicate former tidal inlets. Old tidal deltas in the lagoons behind the beach were used to locate the inlets. Old coastal charts and topographic maps were also used. Information on the historical distribution and migration patterns of tidal inlets is presented. Photos were an effective tool to locate and examine the characteristics of these inlets, and several photos are included.

6203RS0001

CAMERON, H. L., "Water Current and Movement Measurement by Time-Lapse Air Photography—An Evaluation," *Photogrammetric Engineering*, Vol. 28, No. 1 Mar. 1962, pp. 158-163.

Keywords: *Aerial Photographs, Photogrammetry, Water Currents*

Article evaluates technique of using photos that show anomalous stereo effects of the water surface to map currents. Author reviews principles of using parallax measurements on ridges and depressions visible on opaque water surfaces to determine current velocities. The two primary conditions necessary for using the method are: (1) the water surface must be naturally opaque as a result of discolored water, foam, or ice or the surface must be marked artificially before the photos are obtained, and (2) some fixed object along the shore must be visible in the stereo model to provide a vertical reference. A series of trials in using the technique in Canada is discussed. The problems encountered and a description of the results of each trial are discussed. The maximum and minimum velocities determined by photogrammetry are discussed, and two primary limitations of the procedure are described.

6207RS0001

WAUGH, J. E., "Storm Damage Survey," *Photogrammetric Engineering*, Vol. 28, No. 3, July 1962, pp. 516-517.

Keywords: *Aerial Photographs, Color Aerial Photographs, Storm Effects, Coastal Mapping.*

Article describes a program initiated by the USC&GS after the March-1962 east coast storm to update coastal charts. Immediately after the storm, about 900 miles of coastline from Long Island to North Carolina was photographed with panchromatic film, and all major inlets, harbor entrances, and major breakthroughs were photographed with color film. The

photos showed that many of the coastal charts were made obsolete by the storm. Photos were used to produce chartlets to show mariners the major changes caused by the storm. Chartlets were to be used until all regular charts could be revised. Color photos were concluded to be very useful in investigating storm damage and changes along coastlines.

6209RS0001

HERATH, L., "Shoreline Development and Protection of Negombo Beach, Ceylon: An Aerial Photographic Approach," *Transactions of the Symposium of Photo Interpretation*, International Archives of Photogrammetry, International Society for Photogrammetry, Delft, The Netherlands, Vol. 14, Sept. 1962, pp. 453-460.

Keywords: *Aerial Photographs, Coastal Mapping, Negombo Beach, Ceylon*

Paper discusses results of a photo study of the coastline near Negombo Beach, Ceylon. Objectives were to gather information on the stages of coastal development, to classify the type of shoreline, and to make preliminary determinations of the best shoreline protection method. Difficulty was encountered in selecting the protection methods from photo interpretation without field observations. However, information from the photos is valuable in guiding future field surveys. Study is based on an examination of 10 photos at a scale of 1:40,000.

6216RS0001

KENNEY, NATHANIEL T., "Our Changing Atlantic Coastline," *National Geographic Magazine*, Vol. 122, No. 6, Dec. 1962, pp. 860-877.

Keywords: *Aerial Photographs, Storm Effects, Coastal Changes, Eastern United States*

A well-illustrated, nontechnical, review of the severe damage caused by the March-1962 storm along the coast of Eastern United States is presented. Photos show before-and-after conditions of beaches and resorts from Long Island to Cape Hatteras. An excellent color oblique photo of the breakthrough (inlet) on Hatteras Island is shown. Many examples of storm damage to structures and natural coastal features are included.

6300RS0001

EL-ASHRY, MOHAMED T., "Effects of Hurricanes on Parts of the United States Coastline as Illustrated by Aerial Photographs," Unpublished Master of Science Thesis, Department of Geology, University of Illinois, Urbana, Ill., 1963.

Keywords: *Aerial Photographs, Coastal Changes, Storm Effects, North Carolina*

Thesis investigates effects of hurricanes on coastal features, primarily in North Carolina, as depicted on photos. Effects of hurricanes and other storms on Cape Hatteras, Hatteras Island, Hatteras Inlet, Ocracoke Island, Cape Lookout, Cape Fear, and Corncake Inlet and vicinity were determined from periodic photos taken between 1958 and 1962 and from topographic maps. The effects of Hurricane Helene in 1958 were determined by comparing photos taken after the storm with older topographic maps. The effects of the storm of March 1962 were determined by comparing before-and-after photos. Although some measurements were made on the photos, the coastal changes were described primarily in qualitative terms. A discussion of the meteorology of hurricanes and the factors upon which the hurricane damage depends is included. An appendix describes changes in La Costa Island, Florida from periodic photos.

6300RS0002

EMERY, K. O., "An Aerial Study of Hawaiian Wave Patterns," *Pacific Science*, Vol. 17, 1963, pp. 255-260.

Keywords: *Aerial Reconnaissance, Wave Patterns, Hawaii*

Although this study did not use photos, the survey was accomplished entirely by aerial reconnaissance of wave direction and period. Flights over a large area surrounding the Hawaiian Islands were made to record wave directions and periods to compile a wave-pattern map. The map illustrated the effects of wave refraction and shielding caused by the different islands. Beach conditions on the islands correlated with the predominant wave characteristics at a particular location. Wave directions were easily correlated with meteorological conditions at the time of the survey.

6300RS0003

KELLER, MORTON, "Tidal Current Surveys by Photogrammetric Methods," *Photogrammetric Engineering*, Vol. 29, No. 5, Sept. 1963, pp. 824-832.

Keywords: *Aerial Photographs, Photogrammetry, Water Currents, Charleston Harbor, South Carolina, Ocracoke Inlet, North Carolina.*

Use of photogrammetry for tidal current surveys by the USC&GS is presented. Photogrammetry can determine currents at a number of points over a large area. Floating targets are placed on the water and their movement is recorded on photos; data reduction is accomplished on a stereo plotter where target movement appears as x-parallax. Comprehensive current surveys were conducted in Charleston Harbor, South Carolina; Ocracoke Inlet, North Carolina; and Tampa Bay, Florida. Important factors are discussed, including photo characteristics, camera type, film type, weather, sunspots, and target design and placement. Panchromatic film is concluded to be best for current surveys. USC&GS intends to increase use of photogrammetry in tidal current surveys and prepare more detailed data on the procedures used.

6306RS0001

ATHEARN, W. D., and RONNE, F. C., "Shoreline Changes at Cape Hatteras: An Aerial Photographic Study of a 17-Year Period," *Naval Research Reviews*, No. 6, Office of Naval Research, Washington, D. C., June 1963, pp. 17-24.

Keywords: *Aerial Photographs, Coastal Changes, Cape Hatteras and Hatteras Inlet, North Carolina*

Report discusses use of periodic photos to determine shoreline changes at Cape Hatteras and Hatteras Inlet, North Carolina. Measurements were made on eight photo coverages from 1945 to 1962. The south beach at Cape Hatteras eroded about 1,500 feet between 1945 and 1953 and an additional 300 feet between 1953 and 1958 but was stable after 1958. The east beach was stable and the spit at the tip of the Cape changed orientation. The western side of Hatteras Inlet eroded about 6,000 feet during the 17-year period and the eastern side accreted about 400 feet.

6309RS0001

KELLER, MORTON, "Tidal Current Surveys by Photogrammetric Methods," Technical Bulletin No. 22, U.S. Coast and Geodetic Survey, Washington, D. C., 1963.

Keywords: *Aerial Photographs, Photogrammetry, Water Currents, Charleston Harbor, South Carolina*

Bulletin describes procedure employed in the USC&GS to measure tidal currents by photogrammetry. The basic principles of the photogrammetric measurement of current velocity and direction are discussed. Technique is based on measurement of the movement of floating surface targets between the exposure of overlapping photos. Design and placement of the surface targets are covered. Report describes a photo survey of tidal currents in Charleston Harbor, South Carolina. Current surveys at Ocracoke Inlet, North Carolina, and Tampa Bay, Florida, are discussed. A comparison of current velocities with data from current velocities with data from current meters in Charleston Harbor indicated satisfactory results by photogrammetry.

6311RS0001

SMITH, JOHN T., JR., "Color—A New Dimension in Photogrammetry," *Photogrammetric Engineering*, Vol. 29, No. 6, Nov. 1963, pp. 999-1013.

Keywords: *Color Aerial Photographs, Coastal Mapping*

Article discusses use of color photos in nautical chart preparation and maintenance in the USC&GS and the advantages of color over black and white photos. Color photos show clearer bottom detail. Several excellent color photos show Key West and Everglades National Park, Florida; Hyannis Port, Massachusetts; Seattle, Washington; and a large eddy north of St. John's Island in the Caribbean. Procedures for exposing and processing color photos are given. The problem of sunspots on color photos of water and techniques for reducing the detrimental effects of the sunspots is discussed.

6311RS0002

TEWINKEL, G. C., "Water Depths from Aerial Photographs," *Photogrammetric Engineering*, Vol. 29, No. 6, Nov. 1963, pp. 1034-1042.

Keywords: *Aerial Photographs, Water Depths*

Report discusses factors that cause errors in water depths determined from photogrammetry. Under consideration are depths of clear shallow water. The primary factor is the light refraction at the air-water interface. An equation is derived for a factor that, when multiplied by water depths determined in a stereoplotter, corrects for the refraction. Correction factor varies with location in the stereo model and also with water depth. Average value of the factor is between 1.4 and 1.5 for a water depth of 60 feet. Water depths from a plotter and corrected for refraction are not affected by camera tilt; horizontal locations of bottom details are not affected by refraction when using a plotter. Surface waves cause an error averaging about 8 percent in depth determinations and produce a y-parallax that can cause an erroneous orientation of the model if underwater points are used.

6400RS0001

PIERCE, JACK W., "Recent Stratigraphy and Geologic History of the Core Banks Region, North Carolina," Ph. D. Dissertation, Department of Geology, University of Kansas, Lawrence, Kans., 1964.

Keywords: *Aerial Photographs, Coastal Changes, Tidal Inlets, Core Banks, North Carolina*

Dissertation describes use of photos in a study of the stratigraphy and geologic history of the Core Banks Region of North Carolina. Photos taken in 1945, 1954–55, 1958–1960, and 1962 were examined to determine the short term changes in coastal features along about 45 miles of barrier island coastline. In addition, a series of USC&GS charts produced between 1864 and 1952 were analyzed for coastal changes over a longer period. Most coastal changes from the photos are described in qualitative terms. No details of the photogrammetry are given. Photos were also used to determine the distribution and migration of small tidal inlets in a part of the area at six different times over a 17-year period. The inlets were shown to be a transient feature although uniformity in location was noted. Report contains data on volume changes in the shores. A theory of the geologic evolution of the area is presented.

6404RS0001

WAUGH, JOSEPH E., "Photogrammetric Measurement of Tidal Currents," *Proceedings of the American Society of Civil Engineers*, Journal of the Surveying and Mapping Division, Vol. 90, No. SU 1, Paper No. 3857, 1964, pp. 17-29.

Keywords: *Aerial Photographs, Photogrammetry, Water Currents, Charleston Harbor, South Carolina*

Paper describes the procedure used by the USC&GS to measure tidal currents by photogrammetry. The technique provides an economical approach for synoptic current measurements over a large area. By taking photos at intervals throughout the tidal cycle, current directions and velocities at tide stages can be determined. Current velocity is measured by the movement of floating surface targets between the exposure of two overlapping photos. Current measurement, target designs, and problems such as sun spots are discussed. Procedure is well-adapted to the production of tidal current charts because of the ease with which currents can be determined in a dense network of data points.

6407RS0001

VAN WIJK, M. C., "Discussion Paper-Water Depths from Aerial Photographs by G. C. Tewinkel," *Photogrammetric Engineering*, Vol. 30, No. 4, July 1964, p. 647.

Keywords: *Aerial Photographs, Water Depths*

Article reviews a paper titled, "Water Depths from Aerial Photographs," published in *Photogrammetric Engineering*, Volume 29, No. 6, November, 1963, pp. 1034-1042, and authored by G. C. Tewinkel. Main point of this discussion paper is whether refracted light rays from two camera stations intersect at a point beneath the water surface. The paper states that generally they do not. Equations are derived to show that only for special cases does the intersection occur, and otherwise there are vertical and horizontal displacements of

underwater features. The fact that the corresponding rays do not intersect generally has the effect of making the theoretical formulation of equations for determining water depths from photos more involved.

6409RS0001

SWANSON, LAWRENCE W., "Aerial Photography and Photogrammetry in the Coast and Geodetic Survey," *Photogrammetric Engineering*, Vol. 30, No. 5, Sept. 1964, pp. 699-726.

Keywords: *Aerial Photographs, Color Aerial Photographs, Coastal Mapping.*

Article reviews functions of the USC&GS, and discusses the use of photogrammetry within the Survey with special emphasis on color photos. Discussion covers such phases of color photos as camera equipment, exposure conditions, film, suitable weather, sun spots, and laboratory processing. A discussion of the advantages of color photos in the Survey program is included. Color photos of coastal and other terrain features are included. These excellent photos show the enormous amount of detail depicted on color photos. A brief review, with an accompanying comparative illustration, of the characteristics of black and white infrared photos concludes the article.

6410RS0001

HARRIS, WILLIAM D., and JONES, BENNETT G., "Repeat Mapping for a Record of Shore Erosion, Cape Kennedy, Florida," *Shore and Beach*, Vol. 32, No. 2, Oct. 1964, pp. 31-34.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Mapping, Coastal Changes, Cape Kennedy, Florida*

Paper discusses use of black and white infrared photos and photogrammetry by the USC&GS to map the coast near Cape Kennedy, Florida. Photos were taken at about high tide so that the high water line could be interpreted from the black and white infrared photos even with a moderate surf. Characteristics and advantages of infrared film are discussed. Map compiled from the photos was compared to old charts dated 1877, 1929, and 1948, to measure erosion. Amount of erosion or accretion is given for five selected points along the shore.

6411RS0001

GROENEVELD MEIJER, W. O. J., "Formula for Conversion of Stereoscopically Observed Apparent Depth of Water to True Depth, Numerical Examples and Discussion," *Photogrammetric Engineering*, Vol. 30, No. 6, Nov. 1964, pp. 1037-1045.

Keywords: *Aerial Photographs, Photogrammetry, Water Depths*

A formula is derived for converting apparent water depths observed in a stereo model produced from photos to true depths. Correction factor is a variable that is dependent on apparent water depth, index of refraction, location within the model, altitude, and base length. The apparent water depth is multiplied by the computed correction factor, a positive number generally between 1.3 and 1.5, to obtain true depths. The derived formula is

converted for numerical calculation by computer. Series of correction factors are given to show the variation of the factor with different variables. The correction factor is shown to vary in an elliptical manner about the center of the model with a minimum value at the center. Convenience of using a digital computer to calculate the correction factor is discussed. Author notes that there is not horizontal displacement of underwater features in stereo models.

6411RS0002

SONU, CHOULE J., "Study of Shore Processes with Aid of Aerial Photogrammetry," *Photogrammetric Engineering*, Vol. 30, No. 6, Nov. 1964, pp. 932-941.

Keywords: *Aerial Photographs, Coastal Processes*

Article discusses basic requirements for shore process investigations, limitations of conventional methods, and possibilities of using photos to supplement or replace conventional study procedures. Qualifications of photogrammetry in coastal studies are given, especially determination of underwater topography. Procedures for using photos to study landforms, wave characteristics, currents, and littoral drift are discussed. Aircraft, film, and lens requirements and problems in photogrammetry applications to shore processes are summarized. Pertinent literature is included.

6504RS0001

CAMERON, H. L., "Sequential Air Photo Interpretation in Coastal Change Studies," *Maritime Sediments*, Vol. 1, No. 2, Apr. 1965, pp. 8-12.

Keywords: *Aerial Photographs, Coastal Changes, Nova Scotia, Canada*

Article describes use of comparative photos to determine changes at two locations along the coast of Nova Scotia. Two sets of photos dated 1945 and 1955 were compared for Rose Bay and four sets dated 1939, 1945, 1950, and 1960 were analyzed for Advocate Harbor. Directions of littoral drift and growth of spits and bars were determined from periodic photos. Availability of comparative photos and their potential for studies of coastal changes were emphasized.

6500RS0002

CAMERON, H. L., "Coastal Studies by Sequential Air Photography," *Canadian Surveyor*, Vol. 19, No. 4, 1965, pp. 372-381.

Keywords: *Aerial Photographs, Coastal Changes, Nova Scotia, Canada*

Paper describes use of comparative photos to study changes in coastal features. Rose Bay and Advocate Harbor, Nova Scotia were studied. Photos were used to examine sedimentation processes associated with wave and current action. The author concluded that photos were useful for studying coastal changes and proposed a program to photograph the Canadian coastline periodically to monitor the changes. The author maintained that this would give results worth more than the cost.

6503RS0001

EL-ASHRY, MOHAMED T., and WANLESS, HAROLD R., "Birth and Early Growth of a Tidal Delta," *The Journal of Geology*, Vol. 73, No. 2, Mar. 1965, pp. 404-406.

Keywords: *Aerial Photographs, Coastal Changes, Tidal Inlets, Hatteras Island, North Carolina*

Article describes use of photos to monitor growth of a tidal delta and a new inlet on Hatteras Island, North Carolina, by an extratropical cyclone during March 1962. The tidal delta was formed in Pamlico Sound on the lagoon side of the barrier island and covered an area of 0.11 square miles at age 5 days, 0.20 square miles at 2 months, and 0.35 square miles at 10 months. Growth of the delta was monitored from photos taken by the USC&GS. It was concluded that periodic photos are excellent for studying dynamic coastal features.

6504RS0002

EWING, GIFFORD C., "Oceanography from Space," Reference No. 65-10, Woods Hole Oceanographic Institution, Woods Hole, Mass., Apr. 1965.

Keywords: *Satellite Photographs, Aerial Remote Sensors, Oceanographic Applications*

Conference proceedings on the feasibility of oceanographic explorations from aircraft and manned orbital spacecraft are presented. Proceedings contain about 75 articles on use of remote sensors in oceanography. Authors of the articles are well-known authorities in oceanography and related fields. Many applications discussed are related to coastal engineering investigations, such as determination of currents, wave refraction patterns, state of sea, and considerations of coastal geography, geology, and engineering applications by remote sensors.

6510RS0001

CAMERON, H. L., "The Shifting Sands of Sable Island," *The Geographical Review*, Vol. 55, No. 4, Oct. 1965, pp. 463-477.

Keywords: *Aerial Photographs, Coastal Changes, Coastal Mapping, Sable Island, Canada*

Article describes changes in size, shape, and position of Sable Island, Canada, determined from comparative photos. Photos taken in 1952, 1955, 1959, and 1964 were used to map the island. Photos compared to charts prepared in 1766, 1851, and 1899 show that the island had migrated eastward about 10 miles between 1799 and 1959. Short term changes were also observed by comparative photos. The article discusses the history, geology, and ecology of Sable Island.

6600RS0001

EL-ASHRY, MOHAMED T., "Photointerpretation of Shoreline Changes in Selected Areas Along the Atlantic and Gulf Coasts of the United States," Ph. D. Dissertation, Department of Geology, University of Illinois, Urbana, Ill., 1966.

Keywords: *Aerial Photographs, Coastal Changes, Storm Effects, South Carolina, Florida, Texas*

Report describes shoreline changes at selected locations along the Atlantic and Gulf coasts as determined from periodic photos. Study areas were southern South Carolina (Beaufort,

Charleston, and Georgetown Counties), west coast of Florida (Lee County), and Matagorda Peninsula and other areas (Matagorda, Brazoria, and Cameron Counties) in Texas. Comparative photos ranging in date from 1939 to 1962 were used to analyze coastal changes. Effects of storms and long term coastal processes on the shoreline are illustrated and described in qualitative terms. Advantages of comparative photos for studies of coastal change are discussed. Changes in beaches, beach ridges, barrier islands, tidal inlets, deltas, spits, shoals, and other features are described.

6600RS0002

GAWNE, CONSTANCE E., "Shore Changes on Fenwick and Assateague Islands, Maryland and Virginia," Unpublished Senior Thesis, College of Liberal Arts and Sciences, University of Illinois, Urbana, Ill., 1966.

Keywords: *Aerial Photographs, Beach Erosion, Fenwick and Assateague Island, Maryland and Virginia*

Report describes a study of the magnitude and rate of beach erosion along 40 miles of coast on Fenwick and Assateague Islands by use of periodic photos. Beach erosion magnitude was determined by comparing ground distances computed from measurements made directly on the comparative photos. Photo scale was derived from measurements on the photos and small-scale topographic maps. Erosion values were measured at 4-mile intervals along the coast.

6600RS0003

PLUSQUELLEC, PAUL L., "Coastal Morphology and Changes of an Area Between Brigantine and Beach Haven Heights, New Jersey," Unpublished Master of Science Thesis, Department of Geology, University of Illinois, Urbana, Ill., 1966.

Keywords: *Aerial Photographs, Coastal Changes, New Jersey*

Thesis presents a study of changes in coastal features between Brigantine and Beach Haven Heights, New Jersey, by use of photos and old USC&GS field sketches. Field sketches dating back to 1840 and periodic photos dating from 1932 to 1964 were used. Planimetric maps sketched from photos were compared to each other and to the field sketches and changes in coastal features were noted. Photos were corrected for scale variation but not for tilt in compiling the maps. Changes were described in qualitative terms although some measurements define the erosion and accretion of spits and other coastal features. Differences between changes caused by normal wind, tide, wave, and longshore currents and by major storms are stated. Net change for the area was a significant amount of erosion.

6600RS0004

AMERICAN SOCIETY OF PHOTOGRAMMETRY, *Manual of Photogrammetry*, 3rd. ed., Vols. 1 and 2, American Society of Photogrammetry, Falls Church, Va., 1966, 1199 pp.

Keywords: *Photogrammetry, Aerial Photographs, Coastal Mapping*

Comprehensive text covers all aspects of photogrammetry in two volumes. Chapters on optics, the photo process, stereo viewing principles, planning photogrammetry projects,

aerial cameras, and types of photos are included. Photo mapping techniques and photogrammetric plotting equipment are presented. Chapters on terrestrial photogrammetry, radar techniques, mosaic construction, and mapping from oblique photos are also included. Book contains a comprehensive glossary of photogrammetry terms and an extensive list of references.

6600RS0005

THOMPSON, MORRIS M., ed., *Manual of Photogrammetry*, 3rd ed., Vols. 1 and 2, American Society of Photogrammetry, Falls Church, Va., 1966, 1199 pp.

Keywords: *Photogrammetry, Aerial Photographs, Coastal Mapping*

See No. 6600RS0004.

6605RS0001

BARNETT, T. P., "Oceanographic Interpretation of Two Gemini 5 Photographs," Informal Manuscript Report No. 0-20-66, Unpublished Manuscript, Marine Sciences Department, U.S. Naval Oceanographic Office, Washington, D. C., May 1966.

Keywords: *Satellite Photographs, Water Currents, Salton Sea, California, California Coast*

Report discusses the oceanographic interpretation of two Gemini V satellite photos. One photo covers the Salton Sea in California and shows a large area of discolored water that appears to be a counterclockwise current pattern. Explanation of the discolored water and current patterns is presented, based on prior knowledge and published data. The second photo shows the Southern California coast and Channel Islands and lacks significant oceanographic data but applications of satellite photos in coastal studies are discussed. Importance of prior information in interpreting satellite photos is emphasized. Potential use of satellite photos in planning large-scale field surveys is noted.

6612RS0001

LUDIUM, ROGER L., and van LOPIK, JACK R., "A Remote Sensing Survey of Areas in Central Coastal Louisiana, Part 1—Discussion," NTIS Acquisition No. AD 808904, Sciences Services Division, Texas Instruments, Inc., Dallas, Tex., Dec. 1966.

Keywords: *Aerial Remote Sensors, Coastal Mapping, Central Louisiana Coast*

Report investigates the use of remote sensing in evaluating terrain along the central Louisiana coast. The study, conducted for the Office of Naval Research, was to determine the capability of remote sensors in detecting and delineating landforms, land-water contacts, and vegetation types in a deltaic region. Sensors evaluated include conventional panchromatic, black and white infrared, color, and color infrared photos and day and night infrared imagery in the 8 to 14 micron band. Description of the study areas and results of the remote sensor interpretation and evaluation are given. Useful information on photos and infrared sensors is included. Color infrared film was the most useful. Many example photos of features taken with different film types are also included.

6700RS001

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, "Earth Photographs from Gemini III, IV, and V," NASA Special Publication 129, Office of Technology Utilization, National Aeronautics and Space Administration, Washington, D. C., 1967.

Keywords: *Satellite Photographs, Coastal Processes, Oceanographic Applications*

Publication presents 244 color satellite photos from the Gemini III, IV, and V missions. The photos are enlargements of film taken with a handheld Hasselblad 70-mm camera. About 25 percent of the photos show coastal features and processes. A description of the area covered and the features in each photo are included. Littoral currents, sediment patterns, and variable water depths are visible on satellite photos. The photos can be used to illustrate coastal features and processes from satellite altitudes and to investigate their potential coastal engineering and oceanographic applications. An index of Gemini III, IV, and V satellite photos and a geographic index are included.

6702RS0002

NAVAL OCEANOGRAPHIC OFFICE, "Spacecraft Oceanography Project Bibliography," Issue 1, Spacecraft Oceanography Project, U.S. Naval Oceanographic Office, Washington, D. C., Feb. 1967.

Keywords: *Aerial Remote Sensors, Bibliography, Oceanographic Applications*

Bibliography covers a wide range of topics related to oceanography and remote sensing. It was prepared to collect scattered references in a practical form for investigators in spacecraft (and aircraft) oceanography. Bibliography is divided into five major categories, including oceanography background information, surface phenomena, observations by remote sensors, economic benefits of remote sensors in oceanography exploration, and unpublished reports. Section on remote sensors is subdivided by type and includes photo sensors, infrared sensors, radar sensors, microwave sensors, and lasers and masters. About 600 references are listed in the bibliography.

6703RS0001

DUXBURY, ALYN C., "Currents at the Columbia River Mouth," *Photogrammetric Engineering*, Vol. 33, No. 3, Mar. 1967, pp. 305-310.

Keywords: *Color Aerial Photographs, Photogrammetry, Water Currents, Columbia River Mouth*

Article describes a study of surface currents near the mouth of the Columbia River by use of color photos. Color photos were taken of floating targets consisting of color-coded, vinyl air mattresses dropped from a boat. Photos were taken during flood tide and ebb tide. Targets were distributed at about 1/2-mile intervals across the river mouth and surrounding area. The mattresses were filled with water to prevent wind interference. Ground control was provided by anchored navigational buoys and adjacent landforms. Surface current trajectories and velocities were determined by comparing the position of targets on photos taken during successive flights with a known time lapse, although details of target movement measurement procedure are not given. Procedure was concluded to give satisfactory results and advantageous for dynamic surface current patterns over a large area.

6704RS0001

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, "A Survey of Space Applications for the Benefit of All Mankind," NASA Special Publication 142, Office of Space Science and Applications, National Aeronautics and Space Administration, Washington, D. C., Apr. 1967.

Keywords: *Satellite Photographs, Aerial Remote Sensors, Oceanographic Applications*

Publication presents information on applications of satellites, satellite photos and other remote sensors in earth resources includes sections on geology, geography, cartography, hydrology, water resources, and oceanography. Possible space applications and an assessment of the economic benefits of satellite photos and other remote sensors in each field is included. Advantages of using sequential coverage to investigate dynamic features and phenomena are discussed. Applications of remote sensors in monitoring coastal deltas, mapping shoals, and determining water depths are described. Areas for future research in remote sensing of earth resources studies are noted.

6704RS0002

ZDANOVICH, V. G., et al., "Application of Aeromethods for Investigation of the Ocean," NTIS Acquisition No. AD 662 577, Foreign Technology Division, U.S. Air Force, Wright-Patterson Air Force Base, Ohio, Apr. 1967.

Keywords: *Aerial Photographs, Water Currents, Water Depths, Wave Patterns, Oceanographic Applications*

Edited machine translation of a Russian report published in 1963 describing applications of photos in oceanography and hydrology. Primary applications of photos discussed are water current determinations, wave pattern investigations, water depth measurements, shallow water charting, and spectral sea brightness determinations. Advantages, disadvantages, and limitations of photos in oceanography are discussed. Technique for measuring ocean wave parameters on photos taken simultaneously from two aircraft, and the electronic equipment with procedures for measuring the spectral brightness of the ocean from an aircraft are described. Best types of photos for oceanography are discussed.

6700RS0002

STRANDBERG, CARL H., *Aerial Discovery Manual*, Wiley, New York, 1967, 249 pp.

Keywords: *Aerial Photographs, Aerial Reconnaissance, Water Pollution*

Textbook covers basic characteristics of photos and describes photo interpretation equipment and techniques. Section on, "Photohydrology" emphasizes use of photos for analyzing water bodies, water pollution, streams, aquatic vegetation, and other water-related problems. Information is applicable to coastal engineering investigations in estuaries and bodies of shallow water. Other sections give important aspects of photo interpretation.

6700RS0003

FISHER, JOHN J., "Development Pattern of Relict Beach Ridges, Outer Banks Barrier Chain, North Carolina," Ph. D. Dissertation, Department of Geology, University of North Carolina, Chapel Hill, N. C., 1967.

Keywords: *Aerial Photographs, Coastlines, Outer Banks, North Carolina*

Dissertation describes a study of relict beach ridges by photos and field studies. The study was to determine the location of former shorelines by mapping relict beach ridges on the barrier islands and adjacent mainland near the Outer Banks of North Carolina and Virginia. Photos were viewed stereoscopically and also at a low-viewing angle to detect and map the linear beach ridges. Viewing photos from a point 5° or 10° above the horizontal plane and slowly rotating the photos has been successful in locating linear features difficult to detect. Description of shoreline locations based on relict beach ridges are presented. Photos illustrating beach ridges and other coastal landforms are included.

6700RS0004

MOFFITT, FRANCIS H., *Photogrammetry*, 2nd ed., International Textbook, Scranton, Pa., 1967, 551 pp.

Keywords: *Photogrammetry, Aerial Photographs, Coastal Mapping*

Widely used text for university photogrammetry courses. Book provides a comprehensive coverage of photogrammetry in a clear and simplified manner. Chapters on camera characteristics, photo geometry, flight planning, and photo measurements are included. Use of photogrammetry for mapping is covered in chapters on radial line plotting and planimetric mapping, stereo viewing principles and parallax measurements, geometry of overlapping vertical photos, photo orientation, stereo plotting instruments, and mosaic construction. Chapters on mapping from oblique photos and terrestrial photogrammetry are also included. Book is a good introduction to the field of photogrammetry.

6702RS0001

EL-ASHRY, MOHAMED T., and WANLESS, HAROLD R., "Shoreline Features and their Changes," *Photogrammetric Engineering*, Vol. 33, No. 2, Feb. 1967, pp. 184-189.

Keywords: *Aerial Photographs, Coastal Changes, Storm Effects*

Report presents an investigation of shoreline features and their changes from periodic photos. Photos illustrate changes in coastal features at Price Inlet, South Carolina; Matagorda Peninsula and the Brazos River Delta, Texas; Cape Lookout, North Carolina; and La Costa Island, Florida. Advantages and disadvantages of using photos in studying coastal changes are discussed. Other uses of periodic photos in investigating dynamic phenomena are mentioned. Comparing periodic photos with older maps and charts in determining long term trends in shorelines is also discussed. Periodic photos were concluded to be an excellent tool for studying shorelines and shoreline changes.

6707RS0001

CONROD, A. C., "Investigation of Visible Region Instrumentation for Oceanographic Satellites," Vol. 1, Report RE-31, Experimental Astronomy Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., July 1967.

Keywords: *Aerial Photographs, Water Penetration, Oceanographic Applications; Argus Island, Bahamas*

Paper reviews visible region passive remote sensors in investigations of the ocean or other water bodies. Review develops background information on planning of satellites for oceanographic data collection. Report discusses water transparency and light attenuation in water as a function of wavelength. Report also describes a photo test at Argus Island in the Bahamas to collect oceanographic data. Test was only partly successful. Report suggests areas of investigation for a better understanding of the use of photos for oceanographic applications. Discussion of multispectral photo characteristics and capabilities is included.

6712RS0001

HORIKAWA, KIYOSHI, and SUNAMURA, TSUGUO, "A Study of Erosion of Coastal Cliffs by Using Aerial Photographs," *Coastal Engineering in Japan*, Vol. 10, Dec. 1967, pp. 67-83.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Changes, Japan*

Article describes a procedure using topographic maps to determine erosion of coastal cliffs. Topographic maps were prepared from photos by use of photogrammetry and a stereo plotting instrument. The maps were used to avoid tilt problems and relief distortions in making measurements on photos. Results obtained at two locations along the coast of Japan are presented. Recession of the cliffs was determined by plotting profiles in different years based on topographic maps. Change in cliff profiles was used to compute volume of eroded sediment. Authors also discussed relationship between cliff erosion rates and resistance of rocks composing the cliffs.

6800RS0001

AMERICAN SOCIETY OF PHOTOGRAMMETRY, *Manual of Color Aerial Photography*, American Society of Photogrammetry, Falls Church, Va., 1968, 550 pp.

Keywords: *Color Aerial Photographs, Color Infrared Photographs, Coastal Mapping*

Book presents a comprehensive and detailed description of color and color infrared photos. Information on color films, cameras, color film processing, printing color photos, and planning color photo missions is included. Color and color infrared and satellite photos are shown, including examples of coastal features. Discussion of using color photos for coastal mapping is presented. An extensive bibliography on color and color infrared photos is also included.

6800RS0002

SMITH, JOHN T., JR., ed., *Manual of Color Aerial Photography*, American Society of Photogrammetry, Falls Church, Va., 1968, 550 pp.

Keywords: *Color Aerial Photographs, Color Infrared Photographs, Coastal Mapping*

See previous No. 6800RS0001.

6800RS0003

EL-ASHRY, MOHAMED T., and WANLESS, HAROLD R., "Photo Interpretation of Shoreline Changes Between Capes Hatteras and Fear (North Carolina)," *Marine Geology*, Vol. 6, 1968, pp. 347-379.

Keywords: *Aerial Photographs, Coastal Changes, North Carolina*

Article presents a comprehensive description of changes in coastal features along the North Carolina Coast between Cape Hatteras and Cape Fear based on periodic photos taken between 1939 and 1962. Changes in capes, inlets, and beaches are illustrated by photos and diagrams. Measurements were made on photos and changes were related to storms and other environmental conditions. Photos were also used to illustrate the large shoal area south of Cape Lookout. Article concludes that periodic photos are an excellent tool for studying coastal morphology and change.

6800RS0006

JERLOV, NILS G., *Optical Oceanography*, Elsevier Oceanography Series, Vol. 5, Elsevier Publishing Co., Amsterdam, 1968, 194 pp.

Keywords: *Water Penetration*

Book is a comprehensive treatment of the theory and techniques of optical oceanography. Applications of optical oceanography in marine science, physical oceanography, and related subjects are discussed. Large amount of data on optical properties of ocean water are presented. One chapter discusses theory and attenuation of visible light in ocean water. Techniques for measuring optical properties of water are also presented. Section on definitions and terminology and bibliography are included. Book can be useful in water penetration studies using aerial and satellite photos, multispectral photos, and multispectral imagery.

6800RS0007

EVERY, T. EUGENE, *Interpretation of Aerial Photographs*, 2nd ed., Burgess, Minneapolis, Minn., 1968, 332, pp.

Keywords: *Aerial Photographs, Aerial Remote Sensors, Photogrammetry, Vegetation, Coastal Mapping*

Textbook in photo interpretation and photogrammetry. Although oriented toward forestry applications, information useful in other applications of photo interpretation is presented. Chapters on stereo viewing, photo geometry, parallax measurements, sources of photos, and mapping are included. One chapter presents the characteristics and applications of infrared imagery, radar imagery, and satellite photos. Chapters on interpretation of physiographic features and agricultural, urban, and engineering applications are also included. Film types

and filters used in taking photos are described. Stereo photos of landforms and other features are presented. Examples of color photos are included.

6801RS0001

GEARY, EDMUND L., "Coastal Hydrography," *Photogrammetric Engineering*, Vol. 34, No.1, Jan. 1968, pp. 44-50.

Keywords: *Aerial Photographs, Color Aerial Photographs, Coastal Mapping, Water Depths*

Article reviews applications of photos in hydrographic surveys. Black and white photos are described as useful in planning hydrographic surveys and in revising nautical charts. Use of a satellite photo to revise a chart is illustrated. Data obtained in a test to determine water depths from color photos of a study area on Wake Island are presented. Data indicated 75 percent of recorded depths were within ± 1.0 foot of the survey depths and 95 percent were within ± 2.0 feet. Plans for a test of depth determination from color photos in the Florida Keys are given. Photo equipment and other factors in obtaining good color photos of coastal areas are described. Color photos were concluded to provide a rapid means for depth information in nearshore areas.

6801RS0002

STEVENSON, ROBERT E., and NELSON, RUTH M., "An Index of Ocean Features Photographed from Gemini Spacecraft," Contribution No. 253, Bureau of Commercial Fisheries Biological Laboratory, Galveston, Tex., prepared for the Manned Spacecraft Center, National Aeronautics and Space Administration, Houston, Tex., Jan. 1968.

Keywords: *Satellite Photographs, Oceanographic Applications, Coastal Processes*

Report is an index of ocean and coastal features photographed during Gemini Missions IV, V, and VII through XII. Total of 575 photos are listed by Gemini mission number. Index contains subject listing of oceanographic features, including coastal sediments, coastal deposits, currents, deltas, lagoons, surf, and other coastal subjects. A geographic index is also included. Photos were taken with a handheld 70-mm camera. An example color satellite photo from each mission is included in the index. Index is useful in selecting Gemini photos of oceanographic or coastal features covering specific geographic areas.

6802RS0001

MOFFITT, FRANCIS H., "Wave Surface Configuration," *Photogrammetric Engineering*, Vol. 34, No. 2, Feb. 1968, pp. 179-188.

Keywords: *Photogrammetry, Wave Surfaces*

Article describes use of photogrammetry to define the surface of water waves generated by towing a ship model in a shallow test basin. Study was a pilot program using photogrammetry for measuring the wake produced by the model. Cameras and other equipment were used to take and analyze the photos. Contour lines defining the water surface in the wake of the towed ship were used for data presentation. Although problems were encountered, the technique was concluded to be feasible. Suggestions for improving the equipment are presented. The ability to photograph the surface of a wave and then measure the water surface was noted to be a useful tool in hydraulic studies.

6803RS0001

SCHNEIDER, WILLIAM J., "Color Photographs for Water Resources Studies," *Photogrammetric Engineering*, Vol. 34, No. 3, Mar. 1968, pp. 257-262.

Keywords: *Color Aerial Photographs, Color Infrared Aerial Photographs, Nearshore Ecology, Marshlands*

Article discusses applications of color and color infrared photos in water resources investigations, including coastal studies. Advantages of color photos are concluded to be depth penetration and vegetation discrimination. Ability to use photos to extend field observations over large areas is also important. Applications discussed include the relationship between hydrologic and vegetation conditions and examination of coastal and marshland vegetation in the Florida Everglades, fresh-water discharge along the Florida coast, water circulation and sediment movement and deposition in Great Salt Lake, and water pollution sources and dispersion in Lake Erie. Color photos are also used to detect changes in marshland vegetation.

6803RS0002

WALTERS, ROBERT L., "Radar Bibliography for Geoscientists," CRES Report No. 61-30, Remote Sensing Laboratory, Center for Research, Inc., Engineering Science Division, University of Kansas, Lawrence, Kans., Mar. 1968.

Keywords: *Radar Imagery, Bibliography*

Report is a comprehensive bibliography relating to geoscience applications of radar imagery. Applications include geology, geography, agriculture, hydrology, oceanography, and related subjects. Bibliography lists 266 references, including unpublished reports and manuscripts. Emphasis is on side-looking radar imagery, but references on radar scatterometry, terrain reflectivity of radar energy, and other topics are also included. This bibliography is an excellent source of background information on radar imagery. A subject index is included.

6803RS0003

CONROD, A. C., BOERSMA, A., and KELLY, M. G., "Investigation of Visible Region Instrumentation for Oceanographic Satellites," Vol. 11, Report RE-31, Experimental Astronomy Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., Mar. 1968.

Keywords: *Aerial Photographs, Oceanographic Applications, Bahama Banks*

Report describes a test of photos for oceanographic data collection on the west edge of the Bahama Banks. Paper presents information interpreted from photos taken in June 1967, and based on a field survey in April 1967. Test was more successful than the Argus Island test described in Volume 1 of this report and useful oceanographic data were obtained from the photos. Suggestions on planning photo tests for oceanographic data collection are presented.

6804RS0001

LUKENS, JOHN E., "Color Aerial Photography for Aquatic Vegetation Surveys," *Proceedings of the Fifth Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Apr. 16-18, 1968, pp. 441-446.

Keywords: *Color Aerial Photographs, Nearshore Ecology, Finger Lakes, New York*

Report describes use of color photos to map aquatic vegetation in the shallow water of Finger Lakes, New York. Techniques used apply to studies of nearshore ecology in marshlands, estuaries, and other coastal areas. Factors in selecting the best film-filter combination, photo scale, overlap, exposure settings, and other variables are discussed. Color photos were found to be better than color infrared or black and white photos. Techniques and results in mapping the vegetation of Cayuga Lake are described. Vegetation was mapped to depths of from 12 to 18 feet. Use of periodic color photos to examine the spread and retreat of vegetation is mentioned. The use of remote sensing in monitoring a project that employed chemicals to control floating vegetation in a part of Chesapeake Bay is described.

6804RS0002

ZAITZEFF, JAMES B., and SHERMAN, JOHN W., III, "Oceanographic Applications of Remote Sensing," *Proceedings of the Fifth Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Apr. 16-18, pp. 497-527.

Keywords: *Aerial Photographs, Satellite Photographs, Aerial Remote Sensors, Image Enhancement, Oceanographic Applications*

Paper discusses the applications of remote sensors to oceanographic studies. Characteristics and capabilities of remote sensing are also discussed. Advantages of remote sensing in providing a broad synoptic coverage of large-scale oceanic phenomena are noted. Applications of interest to coastal engineers include reconnaissance by radar, evaluation of sea state conditions, and determination of water depths by image enhancement. Oceanographic features and processes are illustrated by remote sensor devices. The film density analysis method of image enhancement for determining water depths from Gemini satellite photos is given.

6804RS0003

WITMER, RICHARD E., "A Multispectral Survey of a Coastal-Intracoastal Environment," Technical Report No. 5, Geography Branch of the Office of Naval Research, Department of Geography, Florida Atlantic University, Boca Raton, Fla., Apr. 1968.

Keywords: *Aerial Photographs, Color Aerial Photographs, Infrared Imagery, Coastal Mapping, Vegetation, Boca Raton, Florida*

Report is a study of coastal landforms and manmade development as shown on conventional panchromatic, black and white infrared, and color infrared photos and infrared imagery. Study area was located near Boca Raton, Florida, and extended from the beach to beyond the Intracoastal Waterway; area included both developed and undeveloped land. An example of each type of photo is presented and features identifiable on the photos are discussed. A description of the coastal vegetation and ground photos of vegetation species and types of

manmade development are also included. Report discusses the advantages and disadvantages of aerial sensors in the coastal environment.

6804RS0004

YOST, EDWARD, and WENDEROTH, SONDRA, "Coastal Water Penetration Using Multispectral Photographic Techniques," *Proceedings of the Fifth Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Apr. 16-18, 1968, pp. 571-586.

Keywords: *Multispectral Photographs, Water Penetration*

Paper is a study of the exposure and spectral filtration conditions to determine the depth at which submerged objects can be detected. Study was to determine water penetration of wavelength bands in northern coastal waters which contain large quantities of suspended particles. A four-lens multispectral camera and filters were used to produce photos exposed with light in wavelength bands. Photos were taken of two identical target arrays with four color panels and six gray panels. One target array was placed at the surface and the other was submerged. Data analysis procedures are given. Data indicated that the green spectral band had twice the water penetration of the red band and three times that of the blue band. One problem with the submerged array was the growth of algae on the panels which affected the data at greater depths.

6805RS0001

RAMEY, EVERETT H., "Measurement of Ocean Currents by Photogrammetric Methods," Technical Memorandum C&GSTM-5, NTIS Acquisition No. PB 179083, Coast and Geodetic Survey, U.S. Department of Commerce, Rockville, Md., May 1968.

Keywords: *Color Aerial Photographs, Photogrammetry, Water Currents, Oceanographic Applications*

Report describes a technique for determining ocean currents by photogrammetry using time-lapse color photos. Test was conducted in the Gulf Stream off the coast of South Carolina in 1965. Fifteen floating targets were distributed at about 1,500-foot intervals along a line perpendicular to the Gulf Stream. Nine targets were red or white wooden panels and six targets were formed by aluminum powder. A single-photo technique in which a ship provided azimuth ground control and aircraft altitude was used to compute the photo scale. This was a feasible method of current velocity measurement and a satisfactory accuracy was obtained. Report also describes a two-photo method. Factors that affect accuracy of current velocities from photogrammetry is included.

6806RS0001

VAN LOPIK, JACK R., PRESSMAN, ALBERT E., and LUDLUM, ROGER L., "Mapping Pollution with Infrared," *Photogrammetric Engineering*, Vol. 34, No. 6, June 1968, pp. 561-565.

Keywords: *Infrared Imagery, Thermal Anomalies, Water Pollution, Water Currents, Galveston Bay, Texas*

Article is a study of thermal anomalies in Galveston Bay, Texas, by the use of infrared imagery in the 8-14 micron wavelength band. Characteristics of infrared radiation and

infrared imaging techniques are given. Infrared image showing surface current directions is presented. Another image shows use of heated water discharges to trace prevailing current patterns. Potential applications of infrared in deltaic process and sedimentology investigations are noted.

6807RS0001

LEPLEY, L. K., "Coastal Water Clarity from Space Photographs," *Photogrammetric Engineering*, Vol. 34, No. 7, July 1968, pp. 667-674.

Keywords: *Satellite Photographs, Water Penetration*

Article describes a study to estimate the percentage of the world's nearshore areas that are clear enough to permit mapping of submarine topography using airborne remote sensors and to determine the feasibility of using satellite photos for coastal water clarity. Satellite photos (color transparencies) taken during the Gemini missions were used to classify water clarity in relation to depths, as: muddy (less than 5 meters), typical (5-20 meters), and clear (greater than 20 meters). A map shows water clarity along coastlines where Gemini photos were available. The report concluded that water clarity can be observed from satellite photos and that 35 percent of the world's coastal waters will allow mapping of the seafloor to depths of 20 meters by photogrammetry. A complete list of references is included.

6808RS0001

STAFFORD, DONALD B., "Development and Evaluation of a Procedure for Using Aerial Photographs to Conduct a Survey of Coastal Erosion," A Report Prepared for the State of North Carolina, Department of Civil Engineering, North Carolina State University, Raleigh, N.C., Aug. 1968.

Keywords: *Aerial Photographs, Beach Erosion, North Carolina*

Report describes the use of photos for a beach erosion survey along the North Carolina Coast. Onslow and Carteret counties were used as a study area in developing and evaluating the procedure. Advantages and disadvantages of using photos for beach erosion surveys are discussed and a review of pertinent literature is included. An effort was made to develop procedures to minimize photo errors. Changes in two locations along the beach, the dune line and the high water line, were determined. The use of photos for beach erosion surveys was concluded to be applicable to coastal development and has important advantages over other collection methods.

6809RS0001

ANDERSON, RICHARD R., "Remote Sensing of Marshlands and Estuaries Using Color Infrared Photography," *Earth Resources Aircraft Program Status Review*, Vol. 3, Hydrology, Oceanography, and Sensor Studies, Section 26, pp. 1-23, National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex., Sept. 1968.

Keywords: *Color Infrared Photographs, Marshlands, Estuaries, Patuxent River, Maryland*

Preliminary report discusses the capability of low-altitude color infrared photos for evaluating marshland vegetation and water quality in estuaries. Various filters were used with color infrared film to determine the optimum filter for the best photos of the estuarine

environment. Several color infrared photos of the Patuxent River in Maryland are shown. Information on water salinity, turbidity, currents, pollution, marshland vegetation, and submerged vegetation can be obtained from color infrared photos. A tabular summary of identifiable imagery on color infrared photos of marshlands and estuaries is included.

6810RS0001

ANSON, ABRAHAM, "Development of Aerial Color Photography for Terrain Analysis," *Photogrammetric Engineering*, Vol. 34, No. 10, Oct. 1968, pp. 1048-1057.

Keywords: *Color Aerial Photographs, Water Penetration, Key West, Florida*

Article describes the comparison of black and white, color, and color infrared photos for terrain analysis, including a test of water penetration capability of color and color infrared film. Test was conducted by the U.S. Naval Oceanographic Office near Key West, Florida. Excellent underwater imagery was obtained with the color and color infrared photos. Considerable ocean bottom detail was also recorded on color infrared photos taken at altitudes of 2,000 and 5,000 feet.

6811RS0001

CONROD, A. C., KELLY, M. G., and BOERSMA, A., "Aerial Photography for Shallow Water Studies on the West Edge of the Bahama Banks," Report RE-42, Experimental Astronomy Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., Nov. 1968.

Keywords: *Color Aerial Photographs, Image Enhancement, Nearshore Ecology, Vegetation, Water Depths, Bahama Banks*

Report describes a study of the shallow water ecology on the west edge of the Bahama Banks. Capabilities and advantages of photos for nearshore ecological studies and marine geology are discussed. Unique features and relationships of the marine biota can be interpreted from photos that are difficult or impossible from the surface or by diving. A vegetation map prepared from the photos is presented. Results of image enhancement experiments to improve the capability of extracting data from photos are described. Image slicing and film density tracing techniques were examined and found useful. Several example photos and enhanced images are presented. An appendix discusses the use of photos to determine water depths.

6811RS0002

STROUD, LINDA M., and COOPER, ARTHUR W., "Color Infrared Aerial Photographic Interpretation and Net Primary Productivity of a Regularly-Flooded North Carolina Salt Marsh," Report No. 14, Water Resources Research Institute, North Carolina State University, Raleigh, N. C., Nov. 1968.

Keywords: *Color Infrared Photographs, Marshlands, Vegetation, Oak Island, North Carolina*

Report discusses the use of color infrared photos to estimate the primary productivity of the grasses in a tidal marsh at Oak Island, North Carolina. Photos were taken at a scale of 500 feet per inch. Color photos were also available, but did not show the marsh grasses in detail. The color infrared photos were used to classify the species of marsh grass and the vegetation height within the species communities; and to determine the areal distribution of

the vegetation community types. Grass samples were collected to determine productivity of the different classes. Authors conclude that color infrared photos can be used successfully to map the distribution of pure stands of tidal marsh but that ground checks are necessary in mixed vegetation.

6812RS0001

LANGFELDER, L. JAY, STAFFORD, DONALD B., and AMEIN, MICHAEL, "A Reconnaissance of Coastal Erosion in North Carolina," A Report Prepared for the State of North Carolina, Department of Civil Engineering, North Carolina State University, Raleigh, N. C., Dec. 1968.

Keywords: *Aerial Photographs, Beach Erosion, North Carolina*

Paper presents results of a coastal erosion survey along 330 miles of coast using photo and wave refraction methods. Advantages and limitations of the techniques are discussed. The photo procedure uses measurements on photos taken at different points along the dune line and high water line of the transient beach. Difference in ground distances computed by multiplying the measurements by the photo scale represents the change in the dune line and high water line. Total erosion is converted to annual rates. Results of the photo survey are presented and compared to the wave refraction method.

6812RS0002

MOFFITT, FRANCIS H., "History of Shore Growth from Analysis of Aerial Photographs," Report No. HEL-2-21, Hydraulic Engineering Laboratory, University of California, Berkeley, Calif., Dec. 1968.

Keywords: *Aerial Photographs, Coastal Changes, Monterey Bay, California*

Report is essentially the same as No. 6904RS0001.

6812RS0003

ADAMS, WILLIAM M., and LEPLEY, LARRY K., "Infrared Images of the Kau and Puna Coastlines on Hawaii," Technical Report No. 26, Water Resources Research Center, University of Hawaii, Honolulu, Hawaii, Dec. 1968.

Keywords: *Infrared Imagery, Thermal Anomalies, Hawaii*

Report describes a program for infrared coastal imagery of the Kau and Puna Districts of Hawaii. An infrared scanner with oscilloscope that monitored and recorded on film was used. This system has a narrow field of view requiring a 11,000-foot altitude for an image of 1,000 feet on each side of the scanner. Equipment and operating procedures are described. The infrared imagery survey was to detect and evaluate areas along the coast where springs were discharging cool ground water into the warmer ocean water. Report notes that not all thermal anomalies are spring discharges and a ground survey should be made along with the infrared surveys.

6900RS0001

BADGLEY, PETER C., MILOY, LEATHA, and CHILDS, LEO, "Oceans from Space," *Proceedings of a Symposium on the Status of Knowledge, Critical Research Needs, and Potential Research Facilities Relating to the Study of the Oceans from Space*, Gulf Publishing Co., Houston, Tex., 1969, 233 pp.

Keywords: *Aerial Photographs, Satellite Photographs, Oceanographic Applications, Image Enhancement*

In symposium proceedings, articles describe oceanographic applications of satellite photos and other remote sensors. Several articles relate to coastal engineering. Introductory section describes characteristics and capabilities of remote sensors. Photos, including many taken during the Gemini program, illustrate coastal processes. Section of most interest to coastal engineers is titled, "Color Enhancement for Ocean Cartography," by Donald S. Ross. Techniques for color separations representing images corresponding to different parts of the spectrum are described. Several examples of enhanced photos are presented. Image enhancement techniques have potential uses in coastal engineering, such as photo density contouring for evaluating underwater topography and depth determination.

6900RS0002

ROSS, DONALD S., "Color Enhancement for Ocean Cartography," *Oceans from Space*, Gulf Publishing Co., Houston, Tex., 1969, 233 pp.

Keywords: *Satellite Photographs, Image Enhancement, Water Depths, Coastal Mapping*

See No. 6900RS0001

6900RS0003

BURTON, IAN, KATES, ROBERT W., and SNEAD, RODMAN E., "The Human Ecology of Coastal Flood Hazard in Megalopolis," Research Paper No. 115, Department of Geography, University of Chicago, Chicago, Ill., 1969.

Keywords: *Aerial Photographs, Storm Effects, Coastal Changes, Eastern United States*

Paper describes damage from tidal flooding after the great Atlantic coastal storm of March 1962. Study was based on photos of selected locations along 1,300 miles of coast from Massachusetts to North Carolina. Some 65 locations averaging 2.2 miles long were studied, representing 10 percent of the study area. Photos were used to determine the coastal development and rate of growth. Density of structures and the built-up part of the coast were used as measures of development. For most locations, comparative photos taken in the late 1930's, about 1950, and late 1960's were used to determine the changes.

6900RS0004

JOHNSON, PHILIP L., *Remote Sensing in Ecology*, University of Georgia Press, Athens, Ga., 1969, 244 pp.

Keywords: *Aerial Remote Sensors, Multispectral Photographs, Marshlands, Estuaries, Nearshore Ecology*

Book has 14 papers on remote sensing in ecology presented at a symposium held in 1968 at Madison, Wisconsin. Papers cover a variety of topics, but most are vegetation studies. A few

papers discuss remote sensing applications in marshlands, estuaries, and shallow water bodies. Chapter XII, "Aerial Photographic Studies of Shallow Water Benthic Ecology," describes topics related to coastal engineering. Described are applications of color and color infrared photos, multispectral photos, multispectral scanner imagery, and infrared scanner imagery. An extensive bibliography is included.

6900RS0005

LIND, AULIS O. "Coastal Landforms of Cat Island, Bahamas," Research Paper No. 122, Department of Geography, University of Chicago, Chicago, Ill., 1969.

Keywords: *Aerial Photographs, Coastlines, Coastal Mapping, Coastal Processes, Cat Island, Bahamas*

Paper presents an investigation of coastal landforms of Cat Island, Bahamas. Photo interpretation was an integral part of the study. Two sets of photos dated 1943 and 1958 were used. Patterns of coastal landforms are described and illustrated. Although the study examined the Holocene accretionary topography and evidence of sea-level change on the island, it is useful as a general investigation of coastal geomorphology. Coastal landforms of Cat Island are described in detail.

6901RS0001

TAYLOR, JAMES I., and STINGELIN, RONALD W., "Infrared Imaging for Water Resources Studies," *Proceedings of the American Society of Civil Engineers*, Journal of the Hydraulics Division, Vol. 95, No. HY1, Paper No. 6331, Jan. 1969, pp. 175-189.

Keywords: *Infrared Imagery, Water Currents, Water Pollution, Estuaries*

Paper describes water resources applications of infrared imagery. Basic characteristics and operation of infrared scanners are described. Infrared imagery taken at four tidal stages to examine currents in the Merrimack River estuary of Massachusetts is discussed. Location of river water—sea water interface was observed on infrared imagery and applications of the imagery in thermal effluent dispersion studies are presented. Image enhancement techniques to improve interpretation of infrared imagery are discussed. Authors state that temperatures of 1° centigrade can be detected and recorded on infrared imagery taken with the proper combination of detector parameters. Infrared imagery provides a synoptic view of the thermal characteristics of large water bodies and is concluded to be a useful tool.

6902RS0001

SONU, CHOULE J., "Tethered Balloon for Study of Coastal Dynamics," *Proceedings of the Symposium on Earth Observations from Balloons*, Sponsored by the American Society of Photogrammetry, Washington, D.C., Feb. 6-7, 1969, pp. 91-103, (Also Technical Report No. 66, Coastal Studies Institute, Louisiana State University, Baton Rouge, La.).

Keywords: *Color Aerial Photographs, Coastal Processes, Water Currents*

A study of coastal processes using color photos taken from a tethered balloon is presented. Equipment was a homemade polyethylene balloon with an aerodynamic shape and a radio controlled 35-mm camera. Time-lapse photos of dye released in wave-generated longshore currents were used to analyze dynamic coastal processes in the surf zone. The system

produced high resolution photos and broad coverage for a qualitative analysis of nearshore processes. Analysis of successive photos of dye patches determined water movements. Problems in developing the balloon system and plans for improvement are discussed. Potential use of the system for other remote sensors and the development of quantitative study techniques are noted.

6903RS0001

CURRENT, IRA B., "A Blue-Insensitive Anscochrome Aerial Film," *Proceedings of the 35th Annual Meeting of the American Society of Photogrammetry*, Washington, D.C., Mar. 9-14, 1969, pp. 43-54.

Keywords: *Color Aerial Photographs, Water Penetration*

Paper describes characteristics of a color film developed by the GAF Corporation (Anscochrome) for the U.S. Naval Oceanographic Office. To improve depth penetration capability, the film is produced without the upper blue-sensitive emulsion layer. The film is insensitive to blue wavelengths which are susceptible to aerial and underwater scattering, and has a higher speed, faster processing and drying, and higher resolution. Data on the properties and processing characteristics of the film are presented. Tests were conducted with the new film to determine its advantages and disadvantages; its designation is SS48895.

6904RS0001

MOFFITT, FRANCIS H., "History of Shore Growth from Aerial Photographs," *Shore and Beach*, Vol. 37, No. 1. Apr. 1969, pp. 23-27.

Keywords: *Aerial Photographs, Coastal Changes, Monterey Bay, California*

Article discusses a procedure for computing the historical location of the shoreline from photos. Technique is an analytical photogrammetric approach accommodating photos of different scale and relating the shoreline location to known ground points. Data are presented on shoreline changes of Monterey Bay from measurements on 12 sets of photos taken between 1929 and 1967. A method for correcting the shoreline location on the photos for tidal stage is included. This technique is best for short sections of shoreline.

6904RS0002

KELLY, MAHLON G., and CONROD, ALFRED C., "Aerial Photography," *Bioscience*, Vol. 19, No. 4, Apr. 1969, pp. 352-353.

Keywords: *Aerial Photographs, Nearshore Ecology, Bahama Banks*

Article discusses the use of photos in coastal and shallow water ecology, and the difficulty of conducting surveys of shallow water biota. Distribution of bottom conditions and vegetation in an example photo of the Bahama Banks is presented. Suggestions are given for taking photos of shallow water areas. Importance of selecting the proper film and filter combination for a particular situation is also discussed. Article states that photos can be used for nearshore ecological data.

PESTRONG, RAYMOND, "Multiband Photos for a Tidal Marsh," *Photogrammetric Engineering*, Vol. 35, No. 5, May 1969, pp. 453-470.

Keywords: *Multispectral Photographs, Marshlands, San Francisco Bay, California*

Article describes tidal marsh morphology and characteristics by analysis of multispectral photos. The photos were taken by a nine-lens multispectral camera and a panchromatic, color, and color infrared photo corresponding to each set of nine-lens camera photos. Each photo covered a narrow range of the spectrum between 400 and 900 millimicrons. Study area covered a tidal marsh in southwest San Francisco Bay. Investigation included drainage features, water penetration, location of the land-water boundary, and vegetation types. The nine-lens camera photos gave excessive duplication. A four-photo combination of color, color infrared, black and white infrared, and a photo within the 550-630 millimicron wavelength range was concluded to be the best system. Color photos were best for general interpretation. A microdensitometer was concluded to be a useful interpretation tool.

ANDERSON, RICHARD R., "The Use of Color Aerial Photography in Marshland and Estuarine Studies," *Seminar Proceedings—New Horizons in Color Aerial Photography*, Sponsored by the American Society of Photogrammetry, Held in New York City, June 9-11, 1969, pp. 281-286.

Keywords: *Color Aerial Photographs, Color infrared Photographs, Marshlands, Estuaries, Patuxent River, Maryland*

Paper discusses applications of color and color infrared photos in studies of marshlands and estuaries of the Patuxent River estuary in Maryland. The color and color infrared photos were used for plant species identification and indications of water quality, turbidity, pollution, and salinity. Salinity was determined from plant species associations. Color infrared photos were superior to color photos in many respects. A summary of features and interpretation keys for color infrared photos of marshlands and estuaries is presented.

KELLY, MAHLON G., "Aerial Photography for the Study of Near-shore Ocean Biology," *Seminar Proceedings—New Horizons in Color Aerial Photography*, Sponsored by the American Society of Photogrammetry, Held in New York City, June 9-11, 1969, pp. 347-355.

Keywords: *Color Aerial Photographs, Nearshore Ecology*

Paper describes an investigation of nearshore biological resources in Biscayne Bay, Florida, from color photos. Various species of biota in the bay were mapped from color photos and results compared to field data obtained by diving, sample collection and identification, underwater photography, and sediment type and depth observations. Many features, distributions, and relationships between vegetation and bottom conditions identified on the photos would be difficult or impossible to recognize in the field. Photos showed good correlation between bottom material (soft sediment or hard rock) and vegetative cover, permitting the bottom to be mapped by interpretation of vegetation characteristics. Use of

color photos is advantageous and efficient in synoptic studies of the biota over large areas. Author also concludes that manmade effects on nearshore ecology can be analyzed from photos.

6906RS0003

VARY, WILLARD E., "A New Non-Blue-Sensitive Aerial Color Film," *Seminar Proceedings—New Horizons in Color Aerial Photography*, Sponsored by the American Society of Photogrammetry, Held in New York City, June 9-11, 1969, pp. 127-130.

Keywords: *Color Aerial Photographs, Water Penetration, Andros Island, Bahamas*

Paper describes a new color film, Anscochrome SS48895, developed for the U.S. Naval Oceanographic Office to improve depth penetration capability. The objective was to obtain photos for measuring depths in shallow coastal areas by photogrammetry. This film is not sensitive to blue in the spectrum. Absence of a blue-sensitive emulsion layer eliminates the aerial and underwater haze common in color photos of water bodies. The film was used in a test at Andros Island, Bahamas, in 1968. The test showed important advantages in recording bottom detail and eliminating undesirable effects of blue light. Further tests of the new film were conducted in 1969.

6906RS0004

WELCH, ROBIN I., "The Use of Color Aerial Photography in Water Resource Management," *Seminar Proceedings—New Horizons in Color Aerial Photography*, Sponsored by the American Society of Photogrammetry, Held in New York City, June 9-11, 1969, pp. 315-346.

Keywords: *Aerial Photographs, Color Aerial Photographs, Color Infrared Photographs, Water Currents, Water Pollution, California*

Paper presents the results of a comprehensive investigation of photo applications in water resources studies in California, many of which are related to coastal problems. The studies cover water movement and pollution investigations, oil pollution detection, kelp inventory, and selecting underwater park sites. Black and white photos taken with different filters and color and color infrared photos were examined. Optimum type of photos for different applications is summarized in tabular form. Color photos were best for water movement and water pollution studies and color infrared photos were best for inventorying kelp and selecting underwater park sites. Panchromatic photos were used for oil pollution detection studies. Water movement involved the monitoring of dye and suspended sediment in various locations, including the surf zone.

6906RS0005

WENDEROTH, SONDRÁ, "Hydrographic and Oceanographic Applications of Multispectral Color Aerial Photography," *Seminar Proceedings—New Horizons in Color Aerial Photography*, Sponsored by the American Society of Photogrammetry, Held in New York City, June 9-11, 1969, pp. 115-125.

Keywords: *Color Aerial Photographs, Multispectral Photographs, Water Penetration*

A description of an investigation of water penetration capability in different parts of the spectrum related to multispectral photo applications is presented. The investigation

provided data for the best selection of multispectral camera filters. Data on attenuation of wavelengths are presented. The study analyzed photos of gray scale and color panel targets located above and below water. Test results at three locations are given. Additive color viewing for multispectral photo analysis is described.

6906RS0006

WOBBER, FRANK J., "Environmental Studies Using Earth Orbital Photography," *Photogrammetria*, Vol. 24, No. 3/4, June 1969, pp. 107-165.

Keywords: *Satellite Photographs, Coastal Processes, Oceanographic Applications, Geological Applications*

Article describes applications of satellite photos in environmental studies. Gemini and Apollo satellite photos are shown with annotations of features and processes that can be identified; many photos cover coastal areas in different parts of the world. Several types of coastal features and processes are illustrated, including suspended sediment plumes, nearshore current patterns, coastal landforms, tidal marshes, ocean wave patterns, longshore sediment transport, and water depths. Coastal, geological and oceanographic applications of satellite photos are discussed.

6907RS0001

KELLY, MAHLON G., "Applications of Remote Photography to the Study of Coastal Ecology in Biscayne Bay, Florida," A Contribution of the Department of Biology, University of Miami, Coral Gables, Fla., July 1969.

Keywords: *Aerial Photographs, Color Aerial Photographs, Nearshore Ecology, Coastal Mapping, Biscayne Bay, Florida*

Report describes the use of photos to investigate synoptic distribution on bottom biotic cover. Black and white, color, and color infrared photos were used. Information from photo interpretation includes: (1) type distribution of biological cover on the bottom, (2) determination of basic relationships between the biological communities, and (3) analysis of man's activities on the ecology. This data were compared to field surveys. Use of photos to map bottom conditions (hard rock or soft sediments) from the distribution of cover was demonstrated. Report concludes that photos are a valuable tool in ecological surveys. Photos of coastal areas, maps of shallow water vegetation, and underwater photos are presented.

6908RS0001

ROSS, DONALD S., "Experiments in Oceanographic Aerospace Photography, I—Ben Franklin Spectral Filter Tests," Report No. TR-DA2108, Space and Re-entry Systems Division, Philco-Ford Corporation, Palo Alto, Calif., Prepared for the Spacecraft Oceanography Program, U.S. Naval Oceanographic Office, Washington, D.C., Aug. 1969.

Keywords: *Multispectral Photographs, Water Penetration, Oceanographic Applications*

Report describes a test to examine water penetration of various wavelength bands. Test consisted of photos of a white target painted on the submersible Ben Franklin while the vessel was at depths of 0, 10, 15, and 25 meters. Photos were taken with a four-lens multispectral camera. Test confirmed the capability of the blue band to record underwater

detail during atmospheric haze. Study concludes that two spectral bands, 460-510 millimicrons and 510-560 millimicrons, should be used to optimize depth penetration. If only one is used, the 460-580 band is recommended. Technical aspects of films and filters for photo studies of water bodies is included in report.

6909RS0001

BERRYHILL, HENRY L., JR., "Remote Sensing Techniques as Applied to Coastal Sedimentation, South Texas," *Second Annual Earth Resources Aircraft Program Status Review*, Vol. 1, Geology and Geography, Section 6, National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex., Sept. 16-18, 1969, pp. 1-15.

Keywords: *Color Aerial Photographs, Color Infrared Photographs, Coastal Processes, Padre Island, Texas*

Report describes a study of sedimentation and erosional processes and features along the coast of Padre Island from color and color infrared photos. Color photos were best for interpreting water currents from sediment patterns and for bottom detail. Color infrared photos were superior for sand features on land and in shallow water. The study demonstrated the usefulness of synoptic coverage of a coastal region on a sequential basis by remote sensing. Several coastal processes are discussed and illustrated, including suspended sediment plumes and sediment deposition patterns. Periodic photos show the effects of storms and the healing of storm-produced effects by long term coastal processes.

6909RS0002

RICHERSON, JERRY A., "Passive Microwave Sensing of the Earth's Environment: A Bibliography with Abstracts," Technical Report RSC-03, Remote Sensing Center, Texas A&M University, College Station, Tex., Sept. 1969.

Keywords: *Microwave Sensors, Bibliography*

A compilation of literature describing passive microwave sensor applications in earth-related studies. References on the characteristics of passive microwave sensors and the theory of microwave radiometry are included. The bibliography is in three parts: a list of books and proceedings (without abstracts), a general list of publications on passive microwave sensor applications (with annotations), and a list of articles on microwave absorption and attenuation in the earth's atmosphere (without annotations). Many meteorological, geological, geophysical, and oceanographical applications are described. Bibliography is an excellent source of background information on the characteristics and applications of passive microwave sensors.

6909RS0003

KELLY, MAHLON G., "The Study of Coastal Ecology Using Remote Photography," *Second Annual Earth Resources Aircraft Program Status Review*, Vol. 3, Oceanography and Hydrology, Section 53, National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex., Sept. 16-18, 1969, pp. 1-17.

Keywords: *Color Aerial Photographs, Nearshore Ecology, Coastal Processes, Southern Florida Coast*

Report describes a study of the applications of color photos in nearshore vegetation and

bottom mapping at three sites along the Florida Straits. Sites investigated were the Bahama Banks south of Bimini, the southern half of Biscayne Bay, and the central Florida Keys. Submerged features and important relationships between vegetation and bottom conditions identified on the photos are described. The bottom was mapped from vegetation type. Manmade features, water pollution and their ecological effects were interpreted from the photos. Color photos are a useful tool in coastal ecological surveys.

6910RS0001

VARY, WILLARD E., "Remote Sensing by Aerial Color Photography for Water Depth Penetration and Ocean Bottom Detail," *Proceedings of the Sixth International Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Vol. 2, Oct. 13-16, 1969, pp. 1045-1059.

Keywords: *Color Aerial Photographs, Water Penetration, Florida Keys, Andros Island, Bahamas*

Paper describes the results obtained by the U.S. Naval Oceanographic Office in two tests of water penetration capability of color film. The tests were to develop techniques for improving water penetration by color film for use in charting nearshore bottom detail and measuring water depths. One test in 1967 off the Florida Keys was an analysis of color photos taken at different altitudes of gray scale and color targets placed on land and underwater. Test showed that blue light limited depth penetration, but green light gave the greatest penetration. A new color film (Ansochrome SS48895), produced by the GAF Corporation, omits the blue-sensitive emulsion layer. This film, using various filters, was tested in 1968 at Andros Island, Bahamas. The film was capable of water penetration to 150 feet with good image contrast. Detailed bottom features and depth penetration was obtained from photos exposed with the 560 millimicron part of the spectrum.

6910RS0002

JONES, DON A., "Mapping the Coastal Zone for Boundary Demarcation," *Shore and Beach*, Vol. 37, No. 2, Oct. 1969, pp. 34-37.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Mapping, Shoreline Delineation*

Article presents the coastal mapping program of the USC&GS (now the National Ocean Survey). Importance of mapping in the development of the coastal zone is emphasized. The need for accurately locating the coastline to establish the offshore boundaries that define state and federal ownership is noted. The role of photogrammetry in coastal mapping is described. Use of black and white photos in delineating the waterline at tidal stages is also noted. Difficulty in defining the shoreline in marshes and swamps is discussed. Coastal mapping programs by USC&GS with state support in Louisiana and Florida are described.

6910RS0003

ROSS, DONALD S., "Enhanced Oceanographic Imagery," *Proceedings of the Sixth International Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Oct. 13-16, 1969, pp. 1029-1044.

Keywords: *Satellite Photographs, Multispectral Photographs, Image Enhancement, Oceanographic Applications, Water Depths*

Paper describes the remote sensing interpretation problems of oceanographic features (including nearshore features). Color separations (enhanced images) in the blue and green wavelength bands obtained from Apollo IX satellite photos of coastal areas in North and South Carolina illustrate the subsurface information available in these bands. Multispectral photos of the submerged Ben Franklin submarine, taken with a four-lens camera, show use of the blue part of the spectrum in applications related to the penetration of light in water bodies. Author concludes that wavelengths shorter than 500 millimicrons can improve the quantity and quality of the information from photo interpretation of oceanographic features.

6910RS0004

POLCYN, FABIAN C., and SATTINGER, I. J., "Water Depth Determinations Using Remote Sensing Techniques," *Proceedings of the Sixth International Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Oct. 13-16, 1969, pp. 1017-1028.

Keywords: *Aerial Photographs, Multispectral Imagery, Water Depths, Wave Patterns*

A description of two remote sensing techniques for determining water depths is presented. Data collection and processing techniques to make shoal detection and water depth determinations automatic and accurate is emphasized. The techniques are computer processing of multispectral imagery and optical processing of aerial or satellite photos to determine changes in wave refraction patterns. The multispectral imagery approach is based on the spectral signature of the bottom reflection at two different wavelength bands. This analysis can be performed by computer processing and a map of water depths printed by the computer. Wave analysis techniques use optical processing to develop the Fourier transform of the wave patterns on the photos. Wave direction and wavelength are determined from these transforms. A laser ranging technique for water depth measurement is discussed.

6910RS0005

LIBBY, L. M., LIBBY, W. F., and LAWRENCE, S. S., "Measurement of Ocean Waves in a Satellite Photograph," NTIS Acquisition No. AD 696492, Rand Corp., Santa Monica, Calif., Oct. 1969.

Keywords: *Satellite Photographs, Wave Patterns*

Report is a study of wave patterns on an Apollo 6 satellite photo. The photo covered about 10,000 square miles in the Atlantic and showed a clear view of the wave patterns. Trough to trough wavelength measurements were made for 1,000 waves. Distribution of wavelengths was analysed in relation to weather conditions before photo exposure. There was good correlation of wavelength distribution with wave propagation theory. Potential use of

satellite photos for monitoring global wave patterns is described. Possibility of measuring wave heights from deformation of the edges of cloud shadows is discussed.

6910RS0006

YOST, EDWARD, and WENDEROTH, SONDRA, "Agriculture and Oceanographic Applications of Multispectral Photography," *Proceedings of the Sixth International Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Oct. 13-16, 1969, pp. 145-173.

Keywords: *Multispectral Photographs, Image Enhancement, Water Penetration, Oceanographic Applications*

Paper describes the theory and design of a multispectral additive color viewing system. System uses a four-lens camera that takes multispectral photos in four bands ranging from 0.36 to 0.90 microns and permits the photos to be projected to form a single color or false color presentation. The authors discuss agricultural and oceanographic applications of multispectral photos and additive color viewing. An experiment in the Tongue of the Ocean Straits in the Bahamas to investigate multispectral techniques for imaging subsurface topography is described. Maximum penetration in clear water was obtained with a wavelength of 0.48 microns. Additive color viewing tests showed targets and the bottom at depths of 150 feet. Test results at sites in the Gulf of Mexico off the Florida-Alabama coast and in the Great South Bay of Long Island are also presented. Potential use of these techniques for detection of phytoplankton and sediment concentrations is noted. Problems in using multispectral photos are also discussed.

6910RS0007

HICKMAN, G. D., HOGG, JOHN E., SPADARD, A. R., and FELSCHER, MURRAY, "The Airborne Pulsed Neon Blue-Green Laser: A New Oceanographic Remote Sensing Device," *Proceedings of the Sixth International Symposium on Remote Sensing of Environment*, University of Michigan, Ann Arbor, Mich., Oct. 13-16, 1969, pp. 1061-1074.

Keywords: *Aerial Remote Sensors, Water Depths, Coastal Processes*

Paper describes an airborne-pulsed neon laser device for measuring water depths and other nearshore applications. The laser emits energy in a narrow wavelength bands of 540 millimicrons as part of the spectrum showing minimum attenuation in water. Depth is determined by measuring the time interval between the reflection of the laser beam from the water surface and from the bottom. Presence of suspended sediment is a limiting factor in use of the laser. Depths ranging from a few feet to 26 feet have been determined. Reported are a series of laser-emitted light transmission and scattering experiments in a tank with different levels of water turbidity. Authors conclude that the laser is feasible for depth determination and may have potential for the measurement of water turbidity, identification of bottom composition, and tracking of water currents.

6911RS0001

NICHOLS, MAYNARD M., "Aspects of Coastal Oceanography from Space Photography,"
Paper Presented at the Annual Meeting of the Geological Society of America, Atlantic City, N.J., Nov. 10, 1969, 10 pp.

Keywords: *Satellite Photographs, Coastal Processes, North Carolina*

Paper discusses patterns of turbid water plumes along coastlines as recorded on Apollo IX photos. Patterns are interpreted as suspended sediment being transported by currents. The horizontal gradient of the water color or intensity of the turbid water plumes is correlated with sediment concentration. Data is presented on capability of color, color infrared, and black and white films to record turbidity patterns at different sediment concentrations. Analysis of turbid plumes can be used to examine circulation patterns in coastal areas. Repeat photo coverage to study dynamic coastal conditions is emphasized. Slides were used to show turbid plumes in different areas; most covered the North Carolina coast.

6911RS0002

STOERTZ, GEORGE E., HEMPHILL, WILLIAM R., and MARKLE, DAVID A., "Airborne Fluorometer Applicable to Marine and Estuarine Studies," *Marine Technology Society Journal*, Vol. 3, No. 6, Nov. 1969, pp. 11-26.

Keywords: *Aerial Remote Sensors, Water Currents*

Article describes the prototype equipment and operating principles of an airborne fluorometer which operates on the principle of a Fraunhofer line discriminator and can detect fluorescence in rhodamine aqueous solution. Concentrations of five parts per billion can be detected in turbid water. In controlled tests over a tank, the device detected concentrations of one part per billion. Results of shipboard and airborne tests from a helicopter are presented. The device is not effective on cloudy days since sunlight is required to excite fluorescence. The airborne fluorometer is useful in current and dispersion studies in bays and estuaries and has the potential to detect certain types of water and oil pollution.

6912RS0001

SUNAMURA, TSUGUO, and HORIKAWA, KIYOSHI, "A Study on Erosion of Coastal Cliffs by Using Aerial Photographs," *Coastal Engineering in Japan*, Vol. 12, No. 2, Dec. 1969, pp. 99-120.

Keywords: *Aerial Photographs, Photogrammetry, Coastal Changes, Japan*

Article describes a study in comparing the location of coastal cliffs on topographic maps to determine the rate of cliff recession due to wave erosion. The maps were prepared by photogrammetry from photos taken in 1960, 1965, and 1967. Study area was on the east-central coast of Japan and was 9 km. long. A brief description on the use of photos was presented. Article has additional data on cliff erosion.

7000RS0001

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, "Ecological Surveys from Space," NASA Special Publication 230, Office of Space Science and Applications, National Aeronautics and Space Administration, Washington, D.C., 1970.

Keywords: *Satellite Photographs, Water Depths, Coastal Processes, Oceanographic Applications*

Report describes the applications of satellite photos in geography, agriculture, forestry, geology, hydrology, oceanography, and cartography. Several applications relate to coastal studies. Excellent color photos from the Gemini and Apollo programs are included, and several show coastal features and processes; many are annotated. Coastal applications discussed are water depths, coastal processes, and mapping. Coastal phenomena identified on the photos include suspended sediment plumes, longshore currents, bottom features, and sediment deposits. Examples of satellite photo interpretation in compiling small-scale maps of coastal features are also included.

7000RS0002

HOWARD, JOHN A., *Aerial Photo-Ecology*, American Elsevier Publishing Co., New York, 1970, 350 pp.

Keywords: *Aerial Photographs, Ecology, Vegetation*

This book is not oriented toward coastal engineering, but it contains material useful in such applications. The first part covers the characteristics of photos and the manner in which they are influenced by the atmosphere and the interaction of light and vegetation. The second, third, and fourth parts describe the planning of photo missions, the elements of photogrammetry, and basic photo interpretation. The fifth part covers photo interpretation techniques in geography, geology, biology, forestry, and ecology. Several chapters emphasize forestry and is useful for coastal vegetation and ecology studies. An extensive bibliography and several stereo photos are included.

7000RS0003

COMMITTEE ON REMOTE SENSING FOR AGRICULTURAL PURPOSES, *Remote Sensing with Special Reference to Agriculture and Forestry*, National Academy of Sciences, Washington, D.C., 1970, 424 pp.

Keywords: *Aerial Remote Sensors, Estuaries, Marshlands*

Book covers remote sensing applications in agriculture and forestry. Information on the basic characteristics of remote sensors is presented. Material on the interaction of vegetation and electromagnetic radiation is potentially useful to coastal engineers studying marshlands and estuaries and monitoring the environmental effects of coastal engineering projects. Although oriented toward agriculture and forestry, many of the techniques apply to other remote sensing applications.

7000RS0004

WAGENER, H. D., "Beach Erosion in the Charleston Harbor Area," *Environmental Geology Series 1*, Division of Geology, South Carolina State Development Board, Columbia, S.C., 1970.

Keywords: *Aerial Photographs, Beach Erosion, Charleston Area, South Carolina*

Report describes a study of beach erosion at Isle of Palms, Sullivans Island, and Folly Beach, South Carolina, from photos and field observations. Periodic photo mosaics or photo index sheets were used in the investigation. Mosaics of photos taken in 1941, 1949, 1954, 1958, and 1964 were compared to determine changes in the location and configuration of the beaches. Changes interpreted from the mosaics are described. Current erosional conditions and the performance of erosion control structures are described from field observations in 1969. The author states periodic photos can be used to monitor coastal changes and recommends a study group for the South Carolina coast; incipient erosion problems can then be detected and preventive measures taken before any severe damage.

7000RS0005

SINHA, EVELYN, "Oceanography from Space and Aircraft," Ocean Engineering Information Series, Vol. 2, Ocean Engineering Information Service, La Jolla, Calif., 1970.

Keywords: *Aerial Remote Sensors, Bibliography, Oceanographic Applications*

This is an annotated bibliography of the technology and applications of oceanography studies from spacecraft and aircraft. It contains 428 references with abstracts covering a wide range of subjects related to oceanography. Many references describe oceanographic and geologic applications in the coastal zone. Some references have useful background information on the characteristics of remote sensors and sensing techniques. A subject and author index are included.

7000RS0006

EASTMAN KODAK CO., "Applied Infrared Photography," Kodak Publication No. M-28, Eastman Kodak Co., Rochester, N.Y., 1970.

Keywords: *Aerial Photographs, Color Infrared Photographs*

Report presents the technical aspects of black and white infrared and color infrared photos. Basic information on the near-infrared spectrum and on characteristics of films sensitive to infrared radiation is given. Capabilities of infrared-sensitive films are described. The applications of black and white infrared and color infrared photos are included. Recommended filters for black and white infrared and color infrared films are given. Procedures for exposing, processing, and printing infrared film are also described. The haze penetration of infrared films is emphasized.

7001RS0001

ROSS, DONALD S., "Oceanographic Image Enhancement," Technical Report No. TR-DA2164, Space and Re-entry Systems Division, Philco-Ford Corp., Palo Alto, Calif., Jan. 1970, (NTIS Acquisition No. AD 722 482).

Keywords: *Satellite Photographs, Image Enhancement, Oceanographic Applications*

Report describes image enhancements of Gemini and Apollo satellite photos of coastal

areas. The image slicing technique in which photo density levels are isolated from the composite photo was used for image enhancement. Depth contours were compared with photo density levels. Good correlation of image density levels and charted depth contours to a depth of 20 fathoms was found in on photo; none was optimum for water penetration. Image enhancement is also useful in identifying suspended sediment patterns. Several enhanced photos cover coastal areas of North Carolina, South Carolina, and Georgia. Major features on the enhanced images are described. Image enhancement of satellite photos is concluded to be useful for determining water depths and other coastal applications.

7002RS0001

ADAMS, WILLIAM M., LEPLEY, L.K., WARREN, C., and CHANG, S. "Coastal and Urban Surveys With Infrared," *Photogrammetric Engineering*, Vol. 36, No. 2, Feb. 1970, pp. 173-180.

Keywords: *Infrared Imagery, Thermal Anomalies, Coastlines, Hawaii*

Article describes an airborne infrared scanner with oscilloscope and camera recording to examine thermal anomalies along the coast of Hawaii. The study was to detect areas where cool ground water was being discharged by springs into the warmer ocean water. Thermal anomalies were best detected on imagery obtained in the early morning. The scanner was concluded to be useful for coastal reconnaissance of thermal anomalies. Monitoring dispersion patterns of cool water discharges may have application in the qualitative evaluation of coastal currents.

7002RS0002

HELGESON, GAYLORD A., "Water Depth and Distance Penetration," *Photogrammetric Engineering*, Vol. 36, No. 2, Feb. 1970, pp. 164-172.

Keywords: *Color Aerial Photographs, Water Penetration*

Article discusses approaches to increase the water penetration of color films. A method of simulating selected combinations of film emulsion layers by printing multispectral images is presented. The simulated photos show that eliminating the blue-sensitive or yellow dye-forming emulsion layer is not the best approach to increasing depth penetration. A more effective method is the use of emulsion layers sensitive to the proper region of the spectrum as determined by the transmission characteristics of the water. Multispectral sensing is useful for research and selection of film emulsion layers, but is not feasible when many photos are required because of the labor necessary for data presentation. The development of color films with the best combination of emulsion layers for water penetration is recommended.

7003RS0001

PIERCE, JACK W., "Tidal Inlets and Washover Fans," *The Journal of Geology*, Vol. 78, No. 2, Mar. 1970, pp. 230-234.

Keywords: *Aerial Photographs, Tidal Inlets, Storm Effects, North Carolina*

Article discusses formation of tidal inlets and washover fans along barrier beaches. It concludes that tidal inlets are opened by wave attack from the lagoon side of the barrier at tidal creeks or channels in the marsh and washover fans are formed by attack from the

seaward side. Study is based on an evaluation of comparative photos of the Core Banks area in North Carolina. Photos illustrate storm-produced tidal inlets and washover fans.

7003RS0002

STAFFORD, DONALD B., and LANGFELDER, L. JAY, "An Aerial Photographic Survey of Coastal Erosion," *Proceedings of the 36th Annual Meeting of the American Society of Photogrammetry*, Washington, D.C., Mar. 1-6, 1970, pp. 533-558.

Keywords: *Aerial Photographs, Beach Erosion, North Carolina*

Paper is slightly different version of Stafford and Langfelder (1971) described in entry no. 7106RS0001.

7004RS0001

WEBER, JOHN D., "Photographic Monitoring of Shoreline Movement," *Shore and Beach*, Vol. 38, No. 1, Apr. 1970, pp. 36-83.

Keywords: *Aerial Photographs, Beach Erosion, Coastal Changes, North Carolina*

Capabilities and limitations of photos in measuring beach erosion is presented. Characteristics of the dune line, high water line, and the waterline for measuring beach erosion on photos are described and problems associated with each line are discussed. Techniques used by the Wilmington District Office to compare periodic photos to monitor beach erosion of the North Carolina Coast are described. Plans for comparing the photo survey with field survey measurements are described. Discussed are the common problems in measuring coastal change on photos. The best conditions for taking photos for erosion surveys are noted. Potentials of black and white infrared film to delineate the waterline are discussed. Precautions to be observed if the photo survey is to produce accurate short-term beach erosion data are given.

7004RS0002

NORRMAN, JOHN O., "Studies of the Coastal Morphology of Surtsey Island," Report No. AFCRL-70-0212, Translation No. 73, Air Force Cambridge Research Laboratories, Office of Aerospace Research, U.S. Air Force, L.G. Hanscom Field, Bedford, Mass., Apr. 1970.

Keywords: *Aerial Photographs, Coastal Changes, Coastal Mapping, Surtsey Island, Iceland*

An English translation of a report by a Swedish scientist assigned the responsibility for coastal morphology research at Surtsey Island, Iceland, formed by volcanic action during November 1963 to June 1967. Because of the dynamic nature of the island building process, high wave energy, depth conditions, and material characteristics that promote rapid development, this was an excellent location for coastal morphology studies. Coastal changes, primarily rapid erosion, are described. Several photos illustrate island features. Report states photos are continually used to monitor retreat of the coastal cliffs and that a topographic map is being prepared by photogrammetry. The text refers to a report by Professor S. Thórarinnsson of Reykjavík, Iceland, which describes the development of Surtsey Island coastline from photos, although complete reference to the report is not given.

7005RS0001

LANGFELDER, LEONARD J., STAFFORD, DONALD B., and AMEIN, MICHAEL, "Coastal Erosion in North Carolina," *Proceedings of the American Society of Civil Engineers*, Journal of the Waterways and Harbors Division, Vol. 96, No. WW2, Paper No. 7306, May 1970, pp. 531-545.

Keywords: *Aerial Photographs, Beach Erosion, North Carolina*

A description of a two-phase approach, using photos and wave refraction techniques, to survey beach erosion along 330 miles of North Carolina coast. Advantages of the photo approach to beach erosion are discussed. The procedure is the measurements between stable reference points, the dune line and high water line on comparative photos in different years. Difference in ground distances obtained by multiplying photo measurements by the photo scale represents the change in location of the dune line and high water line. Annual rates of change are computed by dividing the total changes by the elapsed time interval. A summary of the erosion data is presented.

7006RS0001

FISHER, JOHN J., "Criteria for Recognition of Estuarine Water Pollution by Aerial Remote Sensing," Technical Completion Report, Project No. OWRR:A-031-R1, Department of Geology, University of Rhode Island, Kingston, R.I., June 1970.

Keywords: *Multispectral Photographs, Water Pollution, Estuaries, Narragansett Bay, Rhode Island*

Report describes a study of water quality in estuaries from multispectral photos. Five advantages of remote sensing for water pollution studies are listed. A multispectral camera system of four conventional 35-mm cameras fastened to a frame was developed for the research program. The characteristics and capabilities of the system are described. The study areas were along the west side of Narragansett Bay and at Point Judith Pond. The potential of four film types, conventional panchromatic, black and white infrared, color, and color infrared, was investigated. Results of using the photos for detection and evaluation of estuarine pollution sources are described. The technique to detect small and large pollution sources was important. The color and color infrared films gave the best results. A brief review of related studies is included.

7006RS0002

LEWIS, ANTHONY J., and MacDONALD, HAROLD C., "Significance of Estuarine Meanders Identified from Radar Imagery of Eastern Panama and Northwestern Columbia," *Modern Geology*, Vol. 1, No. 3, June 1970, pp. 187-196.

Keywords: *Radar Imagery, Estuaries, Marshlands, Eastern Panama and Northwestern Columbia*

The use of radar imagery to examine estuarine meanders in Eastern Panama and Northwestern Columbia is described. The basic characteristics and modes of operation of radar imagery are covered. Radar imagery depicts drainage features very clearly, and is excellent for investigating the characteristics of estuarine meanders and other coastal drainage features. Estuarine meanders develop under certain environmental conditions and

their presence can imply the nature of the coast in areas where they form. Estuarine meanders can also indicate the relative importance of fluvial and marine processes. Advantages of radar imagery in terrain studies are discussed.

7008RS0001

HERBICH, JOHN B., and HALES, ZELTON L., "Remote Sensing Techniques Used in Determining Changes in Coastlines," Technical Report RSC-16, Remote Sensing Center, Texas A&M University, College Station, Tex., Aug. 1970.

Keywords: *Aerial Photographs, Coastal Changes, Tidal Inlets, San Luis Pass, Texas*

Report describes a study of coastal changes at San Luis Pass on Galveston Island, Texas, from photos and coastal charts. Vertical and oblique photos and charts were compared to determine changes in the tidal inlet and adjacent beach. The report notes while color photos are easier to interpret, they are not necessary for coastal change studies. Several photos show the San Luis Pass area and data on changes are presented. Report concludes that photos are an adequate sensor for detecting changes due to such long term phenomena as coastal processes or such short term events as storms.

7008RS0002

BURGESS, FRED J., and JAMES, WESLEY P., "Aerial Photographic Tracing of Pulp Mill Effluent in Marine Waters," Water Pollution Control Research Series, 12040EBY08/70, Federal Water Quality Administration, Washington, D.C., Aug. 1970.

Keywords: *Aerial Photographs, Color Aerial Photographs, Water Pollution, Water Currents, Oregon Coast*

Report describes a study of pulp mill effluent dispersion from photos. Three sites along the Oregon and California coasts were investigated. Black and white, black and white infrared, and color or color infrared photos were used. Water current velocity and direction, waste concentrations, toxicity zones, and diffusion coefficients were determined from the photos. Photo density measurements determined waste plume characteristics. A computer program was developed to process the data and plot results of the analysis. Surface water current was the most important variable in shaping the effluent plume. Results of the data are compared with field samplings from a boat.

7009RS0001

HELGESON, GAYLORD A., and ROSS, DONALD S., "Remote Sensor Imaging for Oceanography," *Oceanology International*, Vol. 5, No. 9, Sept. 1970, pp. 20-25.

Keywords: *Color Aerial Photographs, Satellite Photographs, Image Enhancement, Oceanographic Applications*

Article discusses requirements for color and satellite photos in oceanographic applications. The need to select proper techniques to record subsurface features is noted. Sensitivity of emulsion layers of color films and light attenuation characteristics of water are discussed. The authors show that the blue-sensitive emulsion layer should not be eliminated for best results with either aircraft or satellite photos. Most of the article is a discussion of image enhancement by slicing techniques to map shallow areas and sediment flows on satellite photos.

7009RS0002

NICHOLS, MAYNARD M., "Coastal Processes from Space Photography," *Proceedings of the 12th Coastal Engineering Conference*, Vol. 2, Washington, D.C., Sept. 13-18, 1970, pp. 641-649.

Keywords: *Satellite Photographs, Coastal Processes*

Applications of satellite photos to studies of coastal processes are described. Advantages of the high vantage point and broad coverage for examining dynamic, large-scale processes are emphasized. River effluent plumes, coastal drift, suspended sediment concentrations, and other features on satellite photos are discussed and illustrated. The need for and the difficulties in collecting adequate ground data to calibrate the photos are noted. The capability of repeat photos from NASA's ERTS program in 1972 for monitoring the transient coastal processes has possibilities. Limitations of satellite photos for coastal studies are discussed.

7009RS0003

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, "Remote Sensing of Earth Resources—A Literature Survey With Indexes," NASA Special Publication 7036, Office of Technology Utilization, National Aeronautics and Space Administration, Washington, D.C., Sept. 1970.

Keywords: *Aerial Remote Sensors, Photogrammetry, Bibliography*

This is a comprehensive bibliography of remote sensing and photogrammetry in earth resources applications. The literature citations contain a brief summary of unclassified reports and journal articles in the NASA scientific and technical information system from 1962 to 1970. Annotated references include environmental changes and cultural resources, oceanography and marine resources, and hydrology and water management (including estuarine studies). Separate subject, author, contract number, and report number indexes are in the appendixes.

7009RS0004

MUNDAY, JOHN C., JR., et al., "Priority Problems and Data Needs in Coastal Zone Oceanography—Earth Observation Satellite Planning," NASA Contractor Report 111779, Prepared by the Virginia Institute of Marine Science, Gloucester Point, Virginia, for the National Aeronautics and Space Administration, Langley Research Center, Hampton, Va., Sept. 1970, (NTIS Acquisition No. N70-40772).

Keywords: *Satellite Photographs, Aerial Remote Sensors, Coastal Mapping, Coastal Processes, Water Pollution*

Report discusses priority problems and data needs in coastal oceanography and examines the capability of satellite remote sensing to satisfy them. The oceanographic problems are compiled and defined from generally accepted national environmental and coastal zone priorities. The data needs are specified, particularly the variables that can be measured from a satellite. The spatial resolution, temporal characteristics, and the desired spectral range requirements for satellite remote sensors are given. Coastal zone oceanography is emphasized in selection of experiments for an oceanographic satellite and the important variables are specified.

7010RS0001

MAIRS, ROBERT L., "Oceanographic Interpretation of Apollo Photos," *Photogrammetric Engineering*, Vol. 36, No. 10, Oct. 1970, pp. 1045-1058.

Keywords: *Satellite Photographs, Coastal Processes, North Carolina*

Article describes the use of Apollo IX photos to analyze the origin, movement, and dissipation of discolored water plumes along the coast of North Carolina near Cape Hatteras. The plumes discharged from Ocracoke and Hatteras Inlets are concluded to be ebb tide discharges of low density, highly turbid water in which the sediment was derived from the bottom of Pamlico Sound. Historical meteorologic and oceanographic data were used to interpret the photos. Image enhancement, in which blue, green, and red band separations were prepared, was used for interpretation. A significant difference in the turbidity patterns was shown in the wavelength bands. Satellite photos were useful for circulation, flushing, and mixing patterns in coastal areas, particularly with collection of ground and environmental data.

7010RS0002

AUKLAND, J. C., and TREXLER, D. T., "Oil Pollution Detection and Discrimination by Remote Sensing Techniques," Report No. 714104/A/006-1, AD 716349, A Report Prepared for the U.S. Coast Guard by the Microwave Sensor Systems Division, Spectran, Inc., Downey, Calif., Oct. 1970.

Keywords: *Aerial Remote Sensors, Water Pollution, Gulf of Mexico*

Report describes a series of tests in the Gulf of Mexico in April 1970 to evaluate the capability of remote sensors to detect and discriminate oil types on the water surface. The sensors evaluated were two microwave radiometers, an infrared scanner, two 70-mm cameras using color and color infrared film, and a four-lens multispectral camera. A total of 103 oil spills were made at different ship speeds and spill rates using a different oil pollutant. An excellent series of photos show the oil spills. The study concluded that each sensor tested had certain advantages for conditions of time, sea surface roughness, weather, and type of pollutant.

7010RS0003

POLCYN, FABIAN C., BROWN, W. L., and SATTINGER, I. J., "The Measurement of Water Depth by Remote Sensing Techniques," Report 8973-26-F, Infrared and Optics Laboratory, Willow Run Laboratories, University of Michigan, Ann Arbor, Mich., Oct. 1970.

Keywords: *Aerial Photographs, Multispectral Imagery, Water Depths, Wave Patterns*

Report describes three remote sensing techniques in determining water depths. One technique is measuring changes in wave refraction patterns from photos. An optical technique was used to produce Fourier transforms of the wave patterns on photos. The wave direction and wavelength were determined from the transforms. Test results of this technique in Lake Michigan are presented. The second technique was computer processing of multispectral imagery, using the ratio of light intensity reflected from the ocean floor at different wavelength bands to determine and plot a map of water depths. A depth map is shown of a test site near Miami, Florida. The third technique used an optical laser system to

measure the time difference between the laser beam reflection from the water surface and from the bottom. The problems and potential of the laser are described. The best accuracy can be achieved by a combination of the laser and multispectral imagery techniques.

7010RS0004

LLAVERIAS, RITA K., and LOWE, DOROTHY G., "Remote Sensing Bibliography for Earth Resources, 1968," Interagency Report No. 203, U.S. Geological Survey, Washington, D.C., Oct. 1970, (NTIS Acquisition No. PB 195 748).

Keywords: *Aerial Remote Sensors, Bibliography*

This is the third in a series of bibliographies on remote sensing techniques and applications; about 800 references published in 1968 are given. It is subdivided by subject with sections on cartography, geography, geology, hydrology, limnology, marine resources, oceanography, and remote sensors and techniques. Author, corporate author, and subject indexes are included to facilitate use of the bibliography.

7011RS0001

KELLY, MAHLON G., and CASTIGLIONE, LOUIS, "Aerial Photographic Studies of the Coastal Waters of New York and Long Island," Department of Environmental Science, University of Virginia, Charlottesville, Va., and Department of Biology, New York University, Bronx, N.Y., Nov. 1970.

Keywords: *Color Aerial Photographs, Multispectral Photographs, Image Enhancement, Nearshore Ecology, Estuaries, Water Penetration, Long Island, New York*

Report describes a study of photo applications in an investigation of the coastal environment. Studies include water depth penetration, benthic material characteristics, and water body properties. Color, color infrared, and 70-mm multispectral photos taken at different altitudes were examined. Color photos with one stop number overexposure gave better depth penetration and bottom material delineation capability. Six methods of image enhancement were examined and results are described. Photos were used for mapping bottom vegetation in an area of temperature climate and turbid water. Benthic material mapping from photo interpretation was compared with field surveys. Attempts were made to correlate water color with phytoplankton and sediment concentrations.

7012RS0001

JAMES, WESLEY P., and BURGESS, FRED J., "Ocean Outfall Dispersion," *Photogrammetric Engineering*, Vol. 36, No. 12, Dec. 1970, pp. 1241-1250.

Keywords: *Color Aerial Photographs, Water Pollution, Water Currents*

Article describes a procedure to use photos in evaluating waste concentrations, dispersion processes, and current patterns near an outfall discharging wastes in the ocean. Advantages of this procedure as compared to field sampling from a boat are discussed. The theory and procedure for determining waste concentrations (as reflected by a dye tracer) from measurements of image density in three spectral bands on color photos are given. Analysis of time-lapse photos provides a method to examine the changes in effluent plume position and concentration with time. Movement of the effluent plume indicates current patterns. Photo measurement and computation procedures were computerized and plots of the study

results produced. Photo results were compared with conventional boat samplings and there was good correlation. The photo technique and the computer plotting system have potential for a wide range of water dispersion studies.

7012RS0002

KOLIPINSKI, MILTON C., and HIGER, AARON L., "Detection and Identification of Benthic Communities and Shoreline Features in Biscayne Bay Using Multiband Imagery," *Third Annual Earth Resources Program Review*, Vol. 3, Hydrology and Oceanography, Section 47, National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex., Dec. 1-3, 1970, pp. 1-16.

Keywords: *Multispectral Imagery, Nearshore Ecology, Marine Resources, Biscayne Bay, Florida*

Paper describes the use of multispectral imagery and computer processing to map shallow-water vegetation. Mapping is from an analysis of imagery in six spectral bands ranging from 430 to 680 millimicrons. The map of vegetation communities developed from the computer output is color coded for identification of species. A color-coded map of surface water temperature was produced from the multispectral imagery. Spot checks showed excellent correlation between mapped vegetation and observed community types. Automated mapping of benthic vegetation from multispectral imagery is useful for nearshore ecological studies.

7012RS0003

POLCYN, FABIAN C., "Measurement of Water Depth by Multispectral Ratio Techniques," *Third Annual Earth Resources Program Review*, Vol. 3, Hydrology and Oceanography, Section 61, National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex., Dec. 1-3, 1970, pp. 1-11.

Keywords: *Multispectral Imagery, Water Depths, Water Penetration*

Paper describes a technique to determine water depths from multispectral imagery which is based on the difference in the water penetration characteristics of light at different wavelengths. Depth estimates are from the ratio of the signal strength in two channels of multispectral imagery. Computations are printed in a map with computer-coded water depths. Plans to use a laser device for water depth ranging to provide known depths and improve the accuracy of the estimates are described.

7100RS0001

SHEPARD, FRANCIS P., and WANLESS, HAROLD R., *Our Changing Coastlines*, McGraw-Hill, New York, 1971, 579 pp.

Keywords: *Aerial Photographs, Coastal Changes, United States*

A systematic description of, and changes in, the coastline of the United States is presented. Numerous photos show various coastal features. Periodic photos reveal changes in transient coastal landforms and are an outstanding feature of the book. Both erosional and accretional changes are illustrated and discussed. This is an excellent compilation of photos of coastal features and information on the nature of the U.S. coastline.

7100RS0002

COLWELL, ROBERT N., et al., "Monitoring Earth Resources from Aircraft and Spacecraft," NASA Special Publication 275, Scientific and Technical Information Office, National Aeronautics and Space Administration, Washington, D.C., 1971.

Keywords: *Satellite Photographs, Multispectral Photographs, Image Enhancement, Vegetation, Ecology*

Report contains a series of articles written by personnel of the Forestry Remote Sensing Laboratory at the University of California at Berkeley. Apollo IX satellite photos and high altitude multispectral photos are discussed. Articles cover a wide range of topics on remote sensing. One article discusses the additive color image enhancement technique and describes types of equipment for enhancement. Several articles cover applications of remote sensors for vegetation classification and evaluation. Sequential photos for vegetation studies is emphasized. This publications is useful in remote sensing applications for coastal vegetation and ecology studies.

7100RS0003

EASTMAN KODAK CO., "Kodak Data for Aerial Photography," Kodak Publication No. M-29, Eastman Kodak Co., Rochester, N.Y., 1971.

Keywords: *Aerial Photographs, Color Aerial Photographs, Color Infrared Photographs*

This is a compilation of data on the characteristics of Kodak aerial films. Specifications for all Kodak films and the characteristics of filters in taking photos are given; data on processing and printing procedures are included. Film types for mapping, reconnaissance, and duplicating are described. All Kodak black and white, black and white infrared, color, and color infrared films are described. Data on spectral sensitivity of films are valuable.

7100RS0004

KONOVALOVA, I. Z., and LAGUTIN, B. L., "Some Statistical Characteristics of Coastal Currents Based on Aerial Photographs," Translation 486, U.S. Naval Oceanographic Office, Washington, D.C., 1971, (NTIS Acquisition No. AD 722 839).

Keywords: *Aerial Photographs, Water Currents*

This is a translation of a Russian article published in *Trudy, Gosudarstvennyy Okeanograficheskiiy Institut*, Volume 95, 1968, pp. 72-84. Article describes water current studies off the Caucasian coast of the Black Sea and in the Gulf of Riga in the Baltic Sea. Current velocity and direction were determined from measuring movement of floating targets on periodic photos. Floats were dropped on the surface in a pattern to give the desired data. To improve visibility, the floats were covered with a dissolving paint. Current patterns were complex and different than expected. Current velocity increased with distance from the coastline. The current data are described in detail.

7102RS0001

MacDONALD, H. C., LEWIS, A. J., and WING, R. S., "Mapping and Landform Analysis of Coastal Regions With Radar," *Geological Society of America Bulletin*, Vol. 82, No. 2, Feb. 1971, pp. 345-357.

Keywords: *Radar Imagery, Coastal Mapping, Coastlines, Panama*

Article describes the potential applications of side-looking radar in coastal mapping and geomorphology studies. Advantages and limitations of radar imagery in coastal studies are discussed. Advantages of radar imagery are the wide coverage per flight line and the all-weather, day and night capability that is important in coastal areas having cloud cover most of the time. Radar images show a variety of coastal landforms in Panama and include: tidal mudflats, breaking surf, estuarine features, beach features, and the relationship between landforms and vegetation. Limitations are low spatial resolution and lack of water depths, nearshore bottom detail, or longshore sediment transport. Use of radar imagery to compile or update coastal maps is illustrated.

7102RS0002

GERDING, R. B., et al., "Coastal-Zone Requirements for Earth Observatory Satellites A/B," Final Report, TRW Systems Group, Redondo Beach, Calif., National Aeronautics and Space Administration, Langley Research Center, Hampton, Va., Feb. 1971, (NTIS Acquisition No. N71-17262).

Keywords: *Satellite Photographs, Aerial Remote Sensors, Coastal Mapping, Coastal Processes, Water Pollution*

Report describes coastal zone requirements for remote sensors on Earth Observatory Satellites A and B scheduled for launch during 1974-1976. These satellites are the same as Earth Resources Satellites E and F. Estimates of optimum and minimum remote sensor payloads were developed. Types of sensors considered in the satellite missions and the coastal data obtainable are described. Priority coastal zone applications were concluded to be pollution, fisheries, and geography-hydrology-cartography. Remote sensors for these subjects would provide data unobtainable from other satellites.

7104RS0001

ORR, DONALD G., and QUICK, JAMES R., "Construction Materials in Delta Areas," *Photogrammetric Engineering*, Vol. 37, No. 4, Apr. 1971, pp. 337-351.

Keywords: *Aerial Photographs, Color Aerial Photographs, Color Infrared Photographs, Radar Imagery, Infrared Scanner Imagery, Soil Identification, Mississippi River Delta*

Article presents a study of remote sensors in locating construction materials in deltas. Black and white panchromatic, color, and color infrared photos; radar imagery; infrared scanner imagery; and multispectral scanner imagery were evaluated. The Mississippi River Delta was used as a study area and as an analog of the Mekong River Delta in Vietnam. Radar imagery was best for a regional analysis and color infrared photos were best for the detailed analysis. Ranking of remote sensors and their use in the coastal environment is included.

7105RS0001

GLASBY, J. P., and LOWE, D. G., "Remote Sensing Bibliography for Earth Resources, 1969," NTIS Acquisition No. PB 202726, U.S. Geological Survey, Water Resources Division, Washington, D.C., May 1971.

Keywords: *Aerial Remote Sensors, Bibliography, Marine Resources, Oceanographic Applications*

Report is the fourth in a series of bibliographies on remote sensing and lists 612 references published in 1969. The bibliography is subdivided by subject with sections on ecology, geology, geomorphology, hydrography, oceanography, limnology, and marine resources. Author, corporate author, and subject indexes are included to facilitate use of the bibliography.

7106RS0001

STAFFORD, DONALD B., and LANGFELDER, L. JAY, "Air Photo Survey of Coastal Erosion," *Photogrammetric Engineering*, Vol. 37, No. 6, June 1971, pp. 565-575.

Keywords: *Aerial Photographs, Beach Erosion, North Carolina*

Article describes and evaluates a procedure for using photos in a survey of beach erosion in North Carolina. Reference points are selected on photos taken in different years and the distance measured between these points and points located along the dune line and high water line on the transient beach. The measurements are multiplied by the photo scale for ground distances. Difference in the ground distances is the change in beach location over the elapsed time interval. Changes are converted to rates of change by dividing by the time interval. Advantages and limitations of this approach are discussed; illustrations of data obtained in North Carolina are presented.

7106RS0002

BURGESS, FRED J., and JAMES, WESLEY P., "Airphoto Analysis of Ocean Outfall Dispersion," Water Pollution Control Research Series, 16070ENS06/71, U.S. Environmental Protection Agency, Washington, D.C., 1971.

Keywords: *Color Aerial Photographs, Water Pollution, Water Currents, Oregon Coast*

Report describes a comprehensive investigation of ocean outfall dispersion near Newport, Oregon from color photos. Techniques for determining waste concentrations, dispersion coefficients, and water currents from measurements on photos are described. Photos taken during flights over dye patches produced by dropping dye from an aircraft were used in evaluating dispersion characteristics of proposed ocean outfall sites. Results of comparing waste concentrations from photos with conventional boat samplings are presented. A computer program to analyze the photo data and to plot the results is described. Study concluded that photos are an effective and economically feasible method for analysis of ocean waste dispersion. Several oblique photos of the outfall are included. The computer programs are presented in the appendixes.

7107RS0001

BUTLER, WILLIAM E., JR., "Use of Remote Sensing Data Acquisition for Ecological and Planning Studies in the Caribbean," *Paper presented at the Caribbean Engineers Seminar*, July 12-13, 1971, Port-of-Spain, Trinidad, 23 pp.

Keywords: *Color Aerial Photographs, Infrared Imagery, Nearshore Ecology, Tobago*

Paper describes the use of color and color infrared photos and infrared imagery in the analysis of environmental conditions at the southwestern tip of the island of Tobago in the Caribbean. Photos were taken with a 70-mm camera. Coastal features and vegetation identified on the photos are described. Infrared imagery was used to determine water current directions. The photos and infrared imagery will be used in developing environmental baseline data and for planning a large coastal resort complex. Data from remote sensors will ensure in the planning stage that the proposed complex will have a minimum impact on the island ecology. Advantages of remote sensing in planning the location and number of field data collection points are noted.

7108RS0001

BROWN, W. L., POLCYN, F. C., SELLMAN, A. N., and STEWARD, S. R., "Water Depth Measurement by Wave Refraction and Multispectral Techniques," *Infrared and Optics Laboratory, Willow Run Laboratories, University of Michigan, Ann Arbor, Mich., 1971.*

Keywords: *Aerial Photographs, Multispectral Scanner Imagery, Water Depths, Wave Patterns*

Report presents two remote sensing techniques for measuring depths in coastal waters. One technique is based on shallow bottom wave refraction and optical processing of the wave pattern on photos to extract the Fourier transform. The other technique is an analysis of multispectral scanner imagery of reflected radiation of the water surface and the bottom. Both techniques are concluded to be feasible. Procedures for using the techniques and the results at several test sites are presented. The Fourier transform can be used for sea state conditions from photos. Multispectral analysis can be performed by a computer and computer-generated depth charts can be printed. These techniques may not give the desired accuracy in coastal engineering, but they have potential for future applications.

7108RS0002

THOMAS, REUBEN S., "Comparison of the Coastal Engineering Applications of Color and Color Infrared Aerial Photographs," *Unpublished Master of Science Project Report, Department of Civil Engineering, Clemson University, Clemson, S.C., Aug. 1971.*

Keywords: *Color Aerial Photographs, Color Infrared Photographs, Coastal Engineering, Long Island, New York*

Report describes a study of color and color infrared photos to depict coastal features and processes important to coastal engineering. Extensive review of the literature is included. Study was a visual comparison of matching color and color infrared photos of the south shore of Long Island. Report concluded that color and color infrared photos are useful in coastal engineering studies, but color photos are best for underwater features and color infrared photos are better for land features and the land-water interface. Capabilities of both film types to show coastal features is given.

7109RS0001

YOST, EDWARD, and WENDEROTH, SONDRRA, "Coastal and Estuarine Applications of Multispectral Photography," *Proceedings of the American Society of Photogrammetry Fall Convention*, San Francisco, Calif., American Society of Photogrammetry, Falls Church, Va., Sept. 7-11, 1971, pp. 515-530.

Keywords: *Multispectral Photographs, Image Enhancement, Water Penetration*

Paper describes an investigation of water penetration capability of multispectral photos. The primary objective was to examine factors affecting the ability to detect and identify objects in coastal waters. Multispectral photos of underwater targets were made at test sites near Long Island, New York, and Santa Rosa Island, Florida. The spectral band between 493 and 543 nanometers gave the best water penetration when film was exposed properly. The tests showed that the time of day and altitude of the aircraft had no significant effect on the depth penetration if there was no sun glitter on the water surface. The effects of particulate matter in the water on depth penetration was examined and the results given. Multispectral additive color viewing gave better chromatic enhancement of surface and underwater objects than color film. An isoluminous color technique for enhancing subtle spectral differences of submerged features and within water bodies is described.

7110RS0001

STAFFORD, DONALD B., "An Aerial Photographic Technique for Beach Erosion Surveys in North Carolina," Technical Memorandum No. 36, U.S. Army Corps of Engineers, Coastal Engineering Research Center, Washington, D.C., Oct. 1971.

Keywords: *Aerial Photographs, Beach Erosion, North Carolina*

This technical memorandum is an edited and shortened version of previous entry No. 6808RS0001.

7110RS002

SAPP, CECIL D., et al., "Selected Bibliography of the Terrain Sciences, Fifth Edition," Ratheon Company, Autometric Operation, Wayland, Mass., Oct. 1971.

Keywords: *Aerial Remote Sensors, Bibliography, Oceanographic Applications, Soil Identification*

Report is a comprehensive bibliography of remote sensing for terrain scientists. It is subdivided by subject and includes sections on geology, geomorphology, soils, vegetation and land use, hydrology and oceanography, engineering and photogrammetry, color, multi-sensor, and general studies and reference textbooks. An author index has about 1,000 references. This latest edition is an expansion of earlier bibliographies.

7110RS0003

NATIONAL OCEAN SURVEY, "Photographic and Thermal Remote Sensing Survey of Boston Harbor Surface Currents," U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Office of Marine Survey and Maps, Rockville, Md., Oct. 1971.

Keywords: *Color Aerial Photographs, Infrared Imagery, Water Currents, Boston Harbor, Massachusetts*

Report describes the data acquisition phase of a remote sensing program by the National Ocean Survey in surveying surface currents in Boston Harbor. Color photos of floating

targets composed of aluminum powder were used. Target movement during the time interval between repeat flights is measured on the photos to determine current velocity and direction. Photos were taken with color infrared film for increased haze penetration. Infrared imagery of the harbor was taken at different tidal stages to define the thermal characteristics of the surface waters. Surface temperatures will aid in determining current patterns and in water pollution studies.

7200RS0001

CRAVAT, HARLAND R., and GLASER, RAYMOND, "Color Aerial Stereograms of Selected Coastal Areas of the United States," U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Rockville, Md., 1972.

Keywords: *Color Aerial Photographs, Coastlines, Coastal Mapping*

Publication describes a program by the National Ocean Survey (formerly USC&GS) to periodically photograph the coasts of the United States with color and black and white photos. Index of available color photos and information for ordering the photos are included. Some 45 color stereopairs of coastal areas and a stereoscope are also included. A description of the area, pertinent features shown, and technical data for each stereopair is presented. Quality of the color photos is excellent. The stereopairs show coastal landforms, underwater features, coastal vegetation, pollution effluents, storm damage, and land use.

7202RS0001

THOMPSON, DONALD E., "Airborne Remote Sensing—Georgia Tidal Marshes," *Paper Presented at the Seminar on Operational Remote Sensing*, Sponsored by the American Society of Photogrammetry, Houston, Tex., Feb. 1-4, 1972, 19 pp.

Keywords: *Color Infrared Photographs, Infrared Imagery, Marshlands, Vegetation, Estuaries, Sapelo Island, Georgia*

Paper discusses color infrared photos and infrared imagery in investigations of tidal marsh vegetation near Sapelo Island, Georgia. The research was to determine tidal marsh productivity from color infrared photos and field samplings. Photos were taken at four different periods of growth and samples were collected to determine the grass productivity. The vegetation was classified by height and the areal distribution of grasses was determined from color infrared photos. Infrared imagery taken at 1-hour intervals was used to record the progressive flooding of the marsh caused by the rising tide. Remote sensing and primary production estimates from ground measurements are concluded to be a feasible and economical method of determining productivity zones in tidal marshlands.

7203RS0001

BREWER, RONALD K., and HEYWOOD, ALBERT K., "Coastal Boundary Mapping," *Proceedings of the 38th Annual Meeting of the American Society of Photogrammetry*, Washington, D.C., Mar. 12-17, 1972, pp. 182-191.

Keywords: *Aerial Photographs, Color Aerial Photographs, Coastal Mapping, Shoreline Delineation, Florida*

Paper describes a program of coastal boundary mapping by the National Ocean Survey in cooperation with the State of Florida. The program will produce about 450 coastal

boundary photomaps of the Florida coast at a scale of 1:10,000. The maps will define the shoreline at mean low water and mean high water so that boundaries for private, state, and federal ownership can be established. Black and white infrared photos are taken to delineate the shoreline at desired tide levels. Color photos are being used for aerial triangulation to establish horizontal ground control and for photo mosaics. Procedures for compiling the maps and problems in defining the shoreline are given.

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MEASUREMENT OF WATER DEPTH BY MULTISPECTRAL RATIO (TECHNIQUES)
 OIL POLLUTION DETECTION AND DISCRIMINATION BY REMOTE SENSING (TECHNIQUES)

6500RS0002
 600ARS0001
 7107RS0001
 700ARS0002
 701RS0001
 570ARS0004
 681RS0001
 690ARS0005
 630ARS0001
 361RS0001
 6902RS0001
 6907RS0001
 6909RS0003
 5207RS0001
 6712RS0001
 581RS0001
 6906RS0002
 4712RS0001
 6411RS0002
 5903RS0001
 6300RS0002
 6912RS0001
 6802RS0001
 7110RS0003
 5600RS0002
 7004RS0002
 5604RS0002
 4704RS0001
 6207RS0001
 6409RS0001
 6804RS0003
 6612RS0001
 7110RS0003
 7106RS0001
 7006RS0002
 6808RS0001
 5708RS0001
 7009RS0003
 6804RS0001
 6307RS0003
 6309RS0001
 6003RS0002
 5704RS0002
 7000RS0001
 7110RS0001
 7002RS0001
 7110RS0001
 7012RS0003
 7010RS0002

TECHNIQUES (CONTINUED)
 THE MEASUREMENT OF WATER DEPTH BY REMOTE SENSING [TECHNIQUES]
 WATER DEPTH MEASUREMENT BY WAVE REFERENCE MULTISPECTRAL [TECHNIQUES]
 WATER DEPTH DETERMINATION USING REMOTE SENSING [TECHNIQUES]
 COASTAL WATER PENETRATION USING MULTISPECTRAL PHOTOGRAPHY [TECHNIQUES]
 REMOTE SENSING [TECHNIQUES] AS APPLIED TO COASTAL SEDIMENTATION SOUTH TEXAS
 REMOTE-SENSING [TECHNIQUES] USED IN DETERMINING CHANGES IN COASTLINES
 TERRAIN
 DEVELOPMENT OF AERIAL PHOTOGRAPHY FOR [TERRAIN] ANALYSIS
 SELECTED BIBLIOGRAPHY OF THE [TERRAIN] SCIENCES
 TERRESTRIAL
 APPLICATIONS OF [TERRESTRIAL] PHOTOGRAMMETRY FOR DETERMINATION OF SHORE MOVEMENTS
 SOME APPLICATIONS OF [TERRESTRIAL] PHOTOGRAMMETRY TO THE STUDY OF SHORELINES
 TETHERED
 [TETHERED] BALLOON FOR STUDY OF COASTAL DYNAMICS
 TEMINKEL
 DISCUSSION PAPER - WATER DEPTHS FROM AERIAL PHOTOGRAPHS BY G.C. [TEMINKEL]
 THEORETICAL
 RESULTS OF EXACT WAVE MEASUREMENTS (BY STEREOPHOTOGRAMMETRY) WITH SPECIAL REFERENCE TO MORE RECENT
 [THEORETICAL] INVESTIGATIONS
 THERMAL
 PHOTOGRAPHIC AND [THERMAL] REMOTE SENSING SURVEY OF BOSTON HARBOR SURFACE CURRENTS
 TIDAL
 [TIDAL] CURRENT SURVEYS BY PHOTOGRAMMETRIC METHODS
 [TIDAL] CURRENT SURVEYS BY PHOTOGRAMMETRIC METHODS
 PHOTOGRAMMETRIC MEASUREMENT OF [TIDAL] CURRENTS
 BIRTH AND EARLY GROWTH OF A [TIDAL] DELTA
 [TIDAL] INLETS AND WASHOVER-FANS
 MULTIBAND PHOTOS FOR [TIDAL] MARSH
 TIDE
 AIRBORNE REMOTE SENSING - GEORGIA [TIDE] MARSHES
 TIME
 [TIME] LAPSE PHOTOGRAPHY - AN AID TO STUDIES OF THE SHORELINES
 TIMELAPSE
 WATER CURRENT AND MOVEMENT MEASUREMENT BY [TIMELAPSE] AIR PHOTOGRAPHY - AN - EVALUATION
 TONES
 PHOTOGRAPHIC GRAY [TONES] AS AN INDICATION OF THE SIZE OF BEACH MATERIALS
 TOPOGRAPHY
 REFRACTION OF OCEAN WAVES - A PROCESS LINKING UNDERWATER [TOPOGRAPHY] TO BEACH EROSION
 TRACING
 AERIAL PHOTOGRAPHIC [TRACING] OF PULP MILL EFFLUENT IN MARINE WATERS
 TRAFFICABILITY
 A METHOD FOR ESTIMATING BEACH [TRAFFICABILITY] FROM AERIAL PHOTOGRAPHS
 UNDERWATER
 [UNDERWATER] DEPTH DETERMINATION BY AERIAL PHOTOGRAPHY
 REFRACTION OF OCEAN WAVES - A PROCESS LINKING [UNDERWATER] TOPOGRAPHY TO BEACH EROSION
 UNITED-STATES
 COLOR AERIAL STEREOGRAMS OF SELECTED COASTAL AREAS OF THE [UNITED-STATES]
 PHOTOINTERPRETATION OF SHORELINE CHANGES IN SELECTED AREAS ALONG THE ATLANTIC AND GULF COASTS OF THE
 [UNITED-STATES]
 HYDROGRAPHIC APPLICATION OF PHOTOGRAMMETRY IN THE [UNITED-STATES] COAST AND GEODETIC SURVEY
 EFFECTS OF HURRICANES ON PARTS OF THE [UNITED-STATES] COASTLINE AS ILLUSTRATED BY AERIAL PHOTOGRAPHS
 URBAN
 COASTAL AND [URBAN] SURVEYS WITH INFRARED
 USED
 REMOTE-SENSING TECHNIQUES [USED] IN DETERMINING CHANGES IN COASTLINES

7010RS0003
 7108RS0001
 6910RS0004
 6600RS0004
 6900RS0001
 7008RS0001
 5610RS0001
 7110RS0002
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 7008RS0002
 5406RS0003
 4812RS0002
 4701RS0001
 7200RS0001
 6600RS0001
 5604RS0002
 6300RS0001
 7002RS0001
 7008RS0001

VEGETATION	A GUIDE TO PACIFIC LANDFORMS AND [VEGETATION] FOR USE IN PHOTOGRAPHIC INTERPRETATION	4505RS0001
VELOCITIES	COLOR AERIAL PHOTOGRAPHY FOR AQUATIC [VEGETATION] SURVEYS	6804RS0001
VIRGINIA	THE MEASUREMENT OF WATER CURRENT [VELOCITIES] BY PARALLAX METHODS	5203RS0001
VISIBILITY	SHORE CHANGES ON FENWICK AND ASSATEAGUE ISLAND MARYLAND AND [VIRGINIA]	6600RS0002
WASHOVER-FANS	INVESTIGATION OF [VISIBLE] REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES	6707RS0001
WATER	INVESTIGATION OF [VISIBLE] REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES	6803RS0003
	TIDAL INLETS AND [WASHOVER-FANS]	7003RS0001
	THE DETERMINATION OF THE DEPTHS AND EXTINCTION COEFFICIENTS OF SHALLOW [WATER] BY AERIAL PHOTOGRAPHY USING COLOR FILTERS	4701RS0003
	COASTAL [WATER] CLARITY FROM SPACE PHOTOGRAPHS	6807RS0001
	[WATER] CURRENT AND MOVEMENT MEASUREMENT BY TELEBASE AIR PHOTOGRAPHY - AN - EVALUATION	6203RS0001
	PLOTTING OF [WATER] CURRENT PATTERNS BY PHOTOGRAMMETRY	6012RS0001
	THE MEASUREMENT OF [WATER] CURRENT VELOCITIES BY PARALLAX METHODS	5203RS0001
	[WATER] DEPTH AND DISTANCE PENETRATION RATIO TECHNIQUES	7002RS0002
	THE MEASUREMENT OF [WATER] DEPTH BY MULTISPECTRAL TECHNIQUES	7012RS0003
	[WATER] DEPTH DETERMINATIONS USING REMOTE SENSING TECHNIQUES	6910RS0004
	REMOTE SENSING BY AERIAL COLOR PHOTOGRAPHY FOR [WATER] DEPTH PENETRATION AND OCEAN BOTTOM DETAIL	7008RS0001
	DISCUSSION PAPER - [WATER] DEPTHS FROM AERIAL PHOTOGRAPHS BY G.C. TEWINKEL	6407RS0001
	[WATER] DEPTHS FROM AERIAL PHOTOGRAPHS	6311RS0002
	COASTAL [WATER] PENETRATION USING MULTISPECTRAL PHOTOGRAPHIC TECHNIQUES	6804RS0004
	CRITERIA FOR RECOGNITION OF ESTUARINE [WATER] POLLUTION BY AERIAL REMOTE SENSING	7006RS0004
	THE USE OF COLOR AERIAL PHOTOGRAPHY IN [WATER] RESOURCE MANAGEMENT	6906RS0004
	COLOR PHOTOGRAPHS FOR [WATER] RESOURCES STUDIES	6803RS0001
	INFRARED IMAGING FOR [WATER] RESOURCES STUDIES	6901RS0001
	AERIAL PHOTOGRAPHY FOR SHALLOW [WATER] STUDIES ON THE WEST EDGE OF THE BAHAMA BANKS	6817RS0001
	FORMULA FOR CONVERSION OF STEREOSCOPICALLY OBSERVED APPARENT DEPTH OF [WATER] TO TRUE DEPTH NUMERICAL EXAMPLES AND DISCUSSION	6411RS0001
WATERS	AERIAL PHOTOGRAPHIC TRACING OF PULP MILL EFFLUENT IN MARINE [WATERS]	7008RS0002
	AERIAL PHOTOGRAPHIC STUDIES OF THE COASTAL [WATERS] OF NEW-YORK AND LONG-ISLAND	7011RS0001
WAVE	STEREOPHOTOGRAMMETRIC [WAVE] MEASUREMENT	5010RS0001
	RESULTS OF EXACT [WAVE] MEASUREMENTS (BY STEREOPHOTOGRAMMETRY) WITH SPECIAL REFERENCE TO MORE RECENT THEORETICAL INVESTIGATIONS	5200RS0001
	AN AERIAL STUDY OF HAWAIIAN WAVE PATTERNS	6300RS0002
	[WAVE] PATTERNS OFF SOUTHERN CALIFORNIA	5811RS0002
	WATER DEPTH MEASUREMENT BY [WAVE] REFRACTION AND MULTISPECTRAL TECHNIQUES	7108RS0001
	[WAVE] SURFACE CONFIGURATION	6802RS0001
WAVES	A METHOD OF SEPARATING MULTIPLE SYSTEMS OF OCEAN [WAVES] FOR DETAILED STUDY OF DIRECTIONS AND OTHER PROPERTIES	5207RS0001
	MEASUREMENT OF OCEAN [WAVES] IN A SATELLITE PHOTOGRAPH	6910RS0005
	REFRACTION OF OCEAN [WAVES] - A PROCESS LINKING UNDERWATER TOPOGRAPHY TO BEACH EROSION	4701RS0001
ZONE	MAPPING THE COASTAL [ZONE] FOR BOUNDARY DEMARICATION	6910RS0002
	PRIORITY PROBLEMS AND DATA NEEDS IN COASTAL [ZONE] OCEANOGRAPHY - EARTH OBSERVATION SATELLITE PLANNING	7009RS0004

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13. ABSTRACT A bibliography of representative literature covering the applications of aerial remote sensing techniques to coastal engineering. About 200 references published since 1934 are presented. Annotations accompany each bibliographic entry and are a concise and informative summary of the references describing the characteristics of each remote sensor in coastal engineering investigations. Computer indexes of authors, titles and keywords are included.			

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