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16. Abstract

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MAPPING SOUTHERN ATLANTIC COASTAL MARSHLANDS, SOUTH CAROLINA-GEORGIA, USING ERTS-1 IMAGERY

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Abstract

Southeastern coastal marshes are among the most extensive and productive in the United States. A relatively low cost, moderately accurate method is needed to map these areas for management and protection. Ground-based and low altitude aircraft methods for mapping are time-consuming and quite expensive. The launch of NASA's Earth Resources Technology Satellite has provided an opportunity to test the feasibility of mapping wetlands using small scale imagery. The test site selected was an area from the South Carolina border to Saint Catherine's Island, Georgia. Results of the investigation indicate that the following may be ascertained from ERTS imagery: (1) upper wetland boundary; (2) drainage pattern in the wetland; (3) plant communities such as Spartina alterniflora, Spartina patens, Juncus roemerianus; (4) ditching activities associated with agriculture; (5) lagooning for water-side home development. Conclusions are that ERTS will be an excellent tool for many types of coastal wetland mapping.

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Introduction and Characteristics of the Study Area

Eastern coastal areas are receiving increasing pressure from a variety of sources, mainly due to population growth. The northeastern coast is under the most pressure at the present time, but laws regulating development have been passed in several of the states. The southeastern coastline (except Florida) has had less developmental pressure, mainly from agriculture and some industry. Dredge and fill operations have altered some portions of the coastline. The prognosis is for a tremendous increase in pressure in this area during the next decade. Laws regulating development are helpful but usually require costly mapping of coastal resources. A relatively low cost and moderately accurate method for mapping these areas, including wetlands, mud flats, drainage patterns, impact of man and vegetation productivity would be very attractive to states and assure that at least a portion of this valuable ecosystem would be preserved.

Investigators such as Anderson (1) and Reimold (3) have shown the reliability of using aircraft remote sensing techniques to do a variety of wetlands studies, including species mapping and vegetation productivity. With the launch of the NASA Earth Resources Technology Satellite (ERTS-1) in July, 1972, it became possible to investigate the use of small scale imagery for doing large area wetlands ecological studies.

ERTS-1 data provide repetitive synoptic coverage of the earth's surface. It is the first time that information of this nature has been available to investigators on a routine basis. The satellite is in a near polar, sun-synchronous orbit, making about 14 revolutions around the earth each day with complete global coverage every 18 days. The altitude is 912 kilometers with equatorial crossing at about 9:45 local time. ERTS-1 is equipped with two sensing systems. The Return Beam Vidicon (RBV) system is three co-aligned cameras, each viewing the same scene but in different spectral bands. These are 0.475-0.575, 0.580-0.680, and 0.690-0.830 microns. The second is the Multispectral Scanner Subsystem (MSS), which scans the earth, simultaneously detecting energy in four spectral bands: Green Band 4, 0.5-0.6; Red Band 5, 0.6-0.7; I.R. Band 6, 0.7-0.8 and I.R. Band 0.8-1.1 microns. Information is either stored in on board type recorders or transmitted to ground tracking stations. Images, 185 kilometers square of earth surface, are prepared at Goddard Spaceflight Center.

The coastal marshes from North Carolina and southward represent the best development of saline marshes in the United States. Those in South Carolina and Georgia are particularly well developed. Cooper (2) has summarized the current knowledge of eastern coastal areas. Vegetational composition is quite similar along most of the coast but grades to mangrove swamps in Florida. Tidal amplitudes vary from two feet in some portions of North Carolina to eight feet in South Carolina and Georgia.

The two major community types which dominate the marshes of this area are Spartina alterniflora and Juncus roemerianus. These species are restricted to areas with frequent tidal inundation. S. alterniflora occurs as at least two and in some areas three growth forms. This is apparently related to tidal inundation and soil aeration. High growth (to 3 meters) is found along the banks of creeks where the substratum is very soft and tidal inundation is for the longest period of time. The next growth form (to 1 meter) grows at slightly higher elevations in a more firm substrate. The third growth type (less than 1 meter) is at the highest elevation for S. alterniflora in a firm substrate where other species may mix with it occasionally. Juncus roemerianus occurs as small to large zones mostly at the next highest elevation and where the water is somewhat fresher.

Higher, less frequently tidally inundated portions of these marshes contain several species which grow as mixed communities or in relatively small single species zones. These include Spartina patens and Spartina cynosuroides, Distichlis spicata, Baccharis halimifolia and Borrichia frutescens.

Mapping of wetlands has been approached in a variety of ways depending on the investigator and requirements of the project. Ground based ecological studies in wetlands have produced maps of relatively small areas with a high degree of accuracy. These have been valuable in developing remote sensing techniques but the process is too slow and costly for large areas. Low altitude (2,000 meters) aerial photography has been applied in New Jersey to produce wetland maps which meet national map accuracy standards. This is a relatively rapid method, but the cost may be prohibitive for some states. In order to decrease the time and cost involved in wetland mapping, it will be necessary to reduce the accuracy somewhat. It appears from this research that ERTS-1 data may be applied to rapid, relatively low cost wetland mapping on broad regional scales.

Results of Analysis of ERTS Imagery for Wetland Mapping

A. General for whole area

ERTS positive transparencies at a scale of 1:1,000,000 have high resolution and excellent contrast. Unfortunately processing procedures at Goddard Spaceflight Center favor the more highly reflective, upland features. Due to the high moisture content in marshlands, reflectance values are lower and are quite dark on all ERTS MSS bands. Special processing is required to bring out detail in coastal features. Detail in uplands is lost when optimum processing techniques for coastal areas are used.

The marsh-water interface and the upper wetland boundary are clearly seen on MSS bands 6 and 7. Large plant associations or communities can also be detected on either MSS band 7 or on color composites made using the Diazo subtractive color technique. In bands 4 and 5 (visible: green and red), all marsh species have a low overall average reflectance and appear very dark in tone as does the dryland vegetation. As the coastal marshes become fresher, the spectral reflectance of the species composing these marshes is higher and approaches that of dryland vegetation making the boundary less clear. It may be necessary to develop special processing techniques where wetland grades to dryland in order to clearly define this boundary.

B. Specific analysis of the test area

The area for testing the feasibility of mapping coastal wetlands from ERTS-1 was bordered on the south by Saint Catherine's Island, Georgia, and on the north by Charleston, South Carolina. The southern portion of the test site around Ossabaw Island, Georgia, was studied intensively due to the availability of good ERTS imagery.

The vegetation of this area is characteristic of the southern coastline in general. There are large zones of high and low growth *S. alterniflora* and *J. roemerianus*, and smaller zones of *S. cynosuroides*, *B. frutescens* and *S. patens*. There is marshland ditching in Ogeechee River related to agriculture and "lagooning" for water-side homes on the Vernon River. Fig. 1 is a map showing the location of the test area.

Fig. 2 is a 1:250,000 scale reprocessed enlargement of MSS band 7 (No. 1046-15324, Sept. 7, 1972) of the test site. Note good tonal differentiation in the coastal marshland but

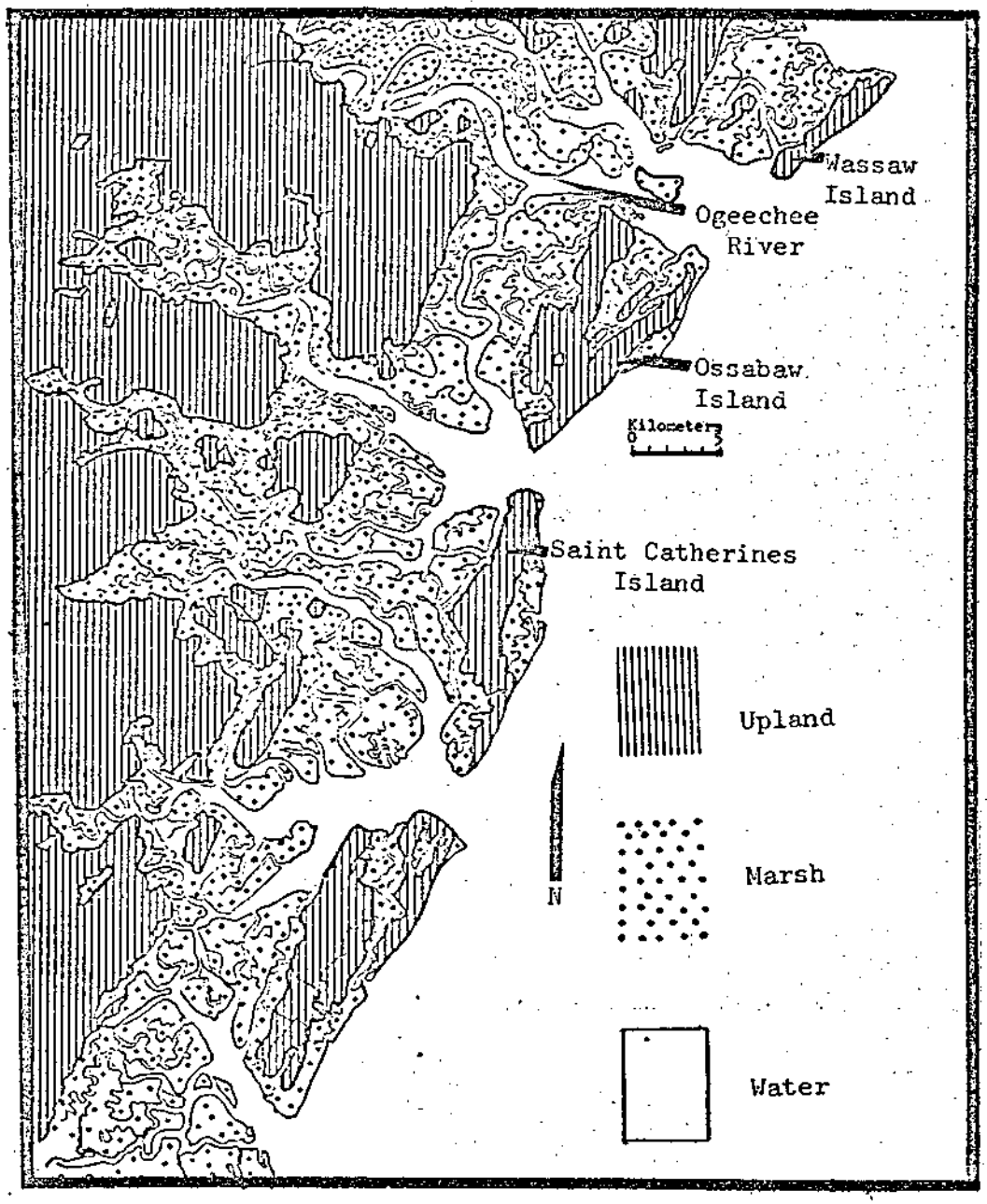

Fig. 1. Map of portion of Georgia coastline showing areas of intensive analysis.

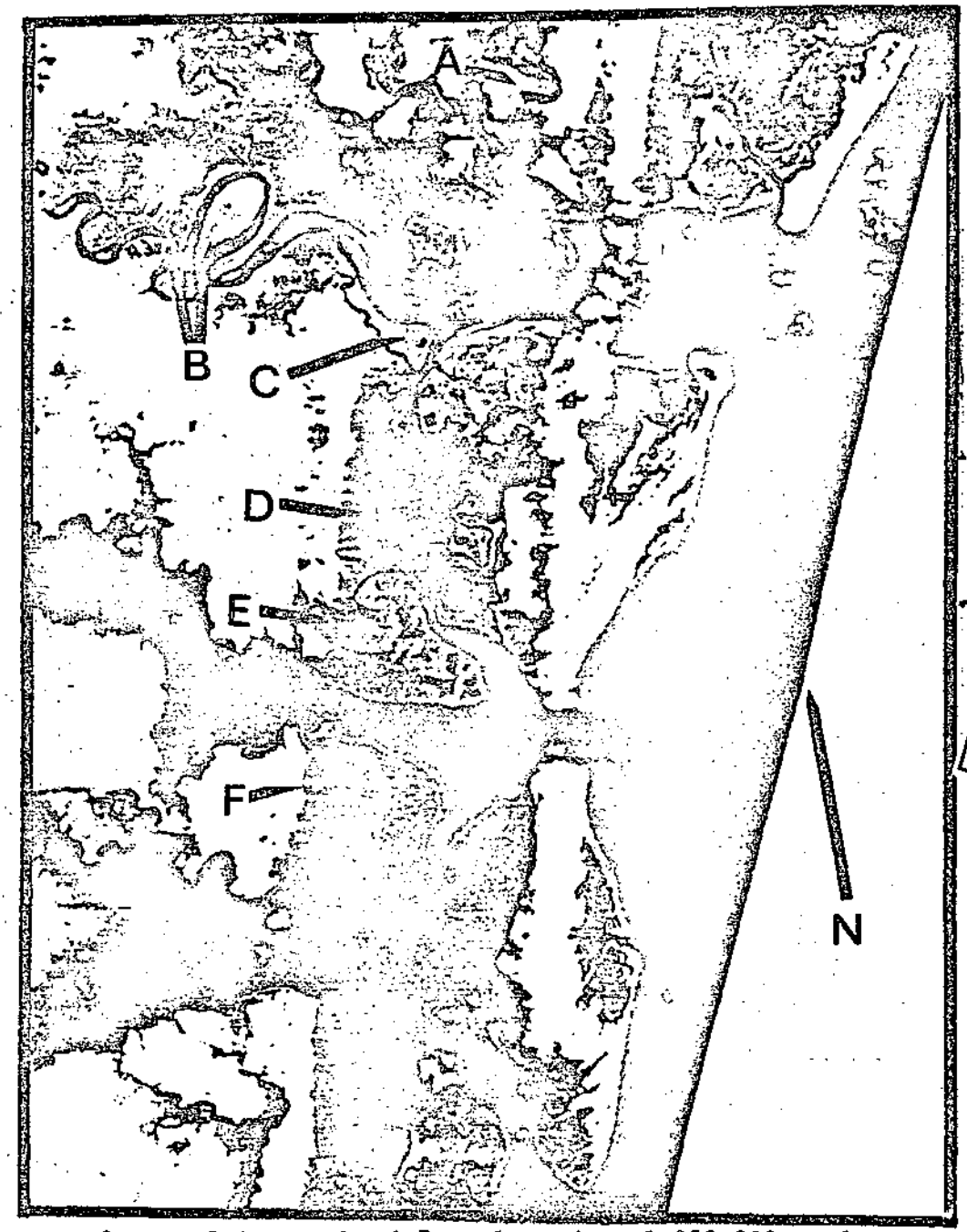

Fig. 2. ERTS image, band 7, enlarged to 1:250,000 scale. A - "lagooning" for water-side homes; B - wetland ditching with Spartina cynosuroides; C - zone of Juncus roemerianus; D - Spartina alterniflora high growth form along creek edges (interior dark areas are low growth form of this species); E - berm with Spartina alterniflora and Borrichia frutescens; F - upland-wetland border.

loss of detail in the upland. The upper wetland boundary is clearly seen in most of the image although patchy clouds may be mistaken for upland or tree islands in the marsh. Lagooning for water-side home development is visible near Burnside, Georgia, on the Vernon River. Of possible greater significance is the marshland ditching visible in the Fort McAllister area of the Ogeechee River. Ditching causes drying out and accelerates vegetational succession to dryland species and is therefore undesirable as currently practiced for mosquito control and agriculture in many areas. It has been assumed that the resolutional limitation of ERTS imagery would not allow definition of ditching practices. At least in this area that assumption was incorrect.

Various vegetational features are also clearly shown. Tonal characteristics of marshland vegetation in Ogeechee River are considerably different from the nearby Medway River. On the ground investigations have shown that Juncus roemerianus is the dominant vegetation in the Red Bird Creek area. The lighter tones of this species contrast nicely with the darker tones of Spartina alterniflora which makes up the bulk of the vegetation in Medway River.

Tonal structure in the Bear River marshes indicate that separation of at least two growth forms of S. alterniflora will be possible. The tall form along the creeks images lighter than the shorter forms. It appears that gross productivity estimates may be made from the imagery. The lightest tones in these marshes at the "loop" in the Ogeechee River and off Kilkenny Creek near Belle Isle are mixed populations of Spartina cynosuroides and Borrichea frutescens.

Conclusions

ERTS-1 imagery is an excellent tool by which large area coastal marshland mapping may be undertaken. If states can sacrifice some accuracy (amount unknown at this time) in placing of boundary lines, the technique may be used to do the following:

(1) Estimate extent of man's impact on marshes by ditching and lagooning.

(2) Place boundaries between wetland and upland and hence estimate amount of coastal marshland remaining in the state.

(3) Distinguish among relatively large zones of various plant species including high and low growth S. alterniflora, J. roemerianus, and S. cynosuroides.

(4) Estimate marsh plant species productivity.

References

[1]Anderson, R. R. and Wobber, F. W., "Wetlands Mapping in New Jersey," Photogrammetric Engineering (in press).

[2]Cooper, A. W., "Salt Marshes," in Coastal Ecological Systems of the United States, Environmental Protection Agency, Washington, D. C.

[3]Reimold, R. J., Gallagher, J. L., and Thompson, D. E., "Coastal Mapping with Remote Sensers," Proceedings of a Symposium on Coastal Mapping, Washington, D.C., American Society of Photogrammetry, pp. 99-112.