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by

Sandra S. Batie and William R. Niedzwiedz

February, 1982

Sea Grant
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ALTERNATIVE MANAGEMENT STRATEGIES FOR
VIRGINIA'S COASTAL WETLANDS

SEA GRANT PROJECT PAPER

VPI-SG-81-16

Departments of Agricultural Economics

Virginia Polytechnic Institute and State University
Blacksburg, Virginia

ABSTRACT

The Virignia Wetlands Act of 1973 was established with limited information regarding previous wetlands conversions, yet this information is useful in developing wetlands management policy. This report summarizes the findings of a study which determined the historical changes in wetlands acres and wetland use from 1949 to 1971 in Virginia Beach and Accomack counties. In Virginia Beach, there was a net change of 882 acres (or 11.7 percent) of saltwater wetlands from 1949-71; there was a 992 acre (or 56.6 percent) reduction in saltwater wetlands exclusive of open saltwater types in this same period. Most of these wetlands were converted to medium and light density residential uses. In contrast, Accomack county experienced relatively few coastal wetlands reductions, converting 825 acres (or .01 percent) of coastal wetlands to developed uses; natural accretion, however, has meant that from 1949-1971 Accomack's salt marshes and mudflats increased by 572 acres (or 1 percent).

Conversion rates of wetlands are highly variable depending on development pressures, and dynamic natural forces also play a major part in determining the amount and location of coastal wetlands. Implications for policy decisions and wetlands management are developed in this report.

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PREFACE

This report is a result of research funded by the National Oceanic and Atmospheric Administration, Office of Sea Grant, Department of Commerce, under grants #04-6-158-44086 and #04-7-158-44086. The U.S. government is authorized to produce and distribute reprints for governmental purposes, not withstanding any copyright notations that may appear hereon.

The results of the study are reported in a series of project papers under the general title: "Alternative Management Strategies for Virginia's Coastal Wetlands" with project paper titles as follows:

	Sea Grant Project Number
1. Alternative Management Strategies for Virginia's Coastal Wetlands: A Program of Study	Not Numbered
2. Economic Values Attributable to Virginia's Coastal Wetlands as Inputs in Oyster Production	VPI-SG-77-04
3. Economic Implications of Environmental Legislation for Wetlands	VPI-AF-77-05
4. Estimating the Economic Value of Natural Coastal Wetlands: A Cautionary Note	VPI-SG-77-06
5. Existing Legal Framework for Management of Virginia Coastal Wetlands	VPI-SG-77-07 (replaced by VPI-SG-79-10)
6. The Development Value of Natural Coastal Wetlands: A Framework for Analysis of Residential Values	VPI-SG-77-08
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ACKNOWLEDGEMENTS

The Department of Agricultural Economics, Virginia Polytechnic Institute and State University, assumes primary responsibility for the analyses and preparation of reports for this project, but many persons have made contributions. Principal investigators were Sandra S. Batie, Burl F. Long and Leonard A. Shabman of the Department of Agricultural Economics. Associate investigators were William E. Cox of the Department of Civil Engineering and Waldon R. Kerns of the Virginia Water Resources Research Center. Additional contributors include Michael Belongia, Michael Bertelsen, Ronald Carriker, William Gibson, Carl Mabbs-Zeno, Raymond Owens, William Park, James R. Wilson and Mark Weitner of the Department of Agricultural Economics.

James R. MacFarland, presently employed with the Federal Coastal Zone Management Office, provided data-gathering assistance as did Susie Wilson and Charles Cooley of Accomack County, Virginia, and Cynthia Bertelsen, Diane Johnson, and Samuel Johnson of Blacksburg, Virginia.

In addition, the cooperation of many state and local agency personnel, as well as Virginia Beach and Accomack County citizens, was important to the completion of this study.

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INTRODUCTION

In April 1972, the General Assembly of Virginia passed the Virginia Wetlands Act (VWA). The VWA is based on the premise that coastal wetlands constitute "... an irreplaceable natural resource which in its natural state is essential to the ecological systems of the tidal rivers, bays and estuaries of the Commonwealth."[1] This premise was supported by both legislators' perceptions and scientific reports that wetlands contribute significantly to marine environmental quality and productivity.[2] Values attributed to marine wetlands were the provision of wildlife food, wildlife habitat, erosion buffers, water quality control, and flood buffers.

The desire for the VWA appears to have stemmed not only from a perception of the ecological services that wetlands provide, but also from a perception that wetlands were being destroyed and that this destruction was undesirable. This is evidenced by statements made at public hearings held in four Virginia localities by the Virginia Wetlands Study Commission prior to the drafting of

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1 VWA, Va. Code Ann., sec. 62.1-13.1 (1973).

2 See George M. Dawes and Claiborne Jones, "Virginia Wetlands Law," Impact, Richmond, Va., The Council on the Environment, (September, 1975), p. 1. See also Silberhorn, Gene M., George M. Dawes, and Thomas A. Barnard, Jr., "Coastal Wetlands of Virginia: Interim Report 3," Guidelines for Activities Affecting Virginia Wetlands. Special Report #46, Virginia Inst. of Marine Sciences, Gloucester Pt., Va., June 1974.

the VWA.[3]

It was clear from these hearings that proponents of the VWA felt that without the protection provided by legislation, development of wetlands would proceed at a rapid rate. One proponent expressed the sentiment that unless protective measures were soon developed:

> "There exists a strong possibility that a unique resource which would be held beyond price or any economic means of reckoning by future generations will be lost to the Commonwealth and its people."[4]

Another opinion, expressed at one hearing by a candidate for the State Senate, was:

> "In the next twenty to thirty years all the wetlands of Virginia would be destroyed unless some legislative action was taken at once."[5]

One study, conducted by Fairfax Settle, estimated that 4,026 acres of Virginia's tidal wetlands (1.2 percent of the total acreage) had been filled or altered by man's activities from 1954 through 1969.[6] Settle projected increased rates of wetlands destruction in the future.

The Virginia Wetlands Act (VWA) was passed following the publication of the Virginia Wetlands Study Commission report. This report discussed the perceived high ecological values for natural wetlands and rapid destruction of

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[3] Carriker, Roy R., "Economic Incentives for Institutional Change: The case of the Virginia Wetlands Act." Unpublished Ph.D., Dept. of Ag. Econ., Va. Tech., Blacksburg, Virginia, November 1976.

[4] October 8, 1971, Statement by Ted Pankowski, Co-Chairman of the Wetlands Committee for the Conservation Council of Virginia, before the Wetlands Study Commission, Arlington County Courthouse. As cited in Carriker, op cit.

[5] October 13, 1971, Minute of the Virginia Wetlands Study Commission, Arlington County Courthouse, p. 6, as cited in Carriker op cit., p. 32.

[6] Settle, Fairfax Healy, Survey and Analysis of Changes Effected by Man on Tidal Wetlands of Virginia 1955-69, unpublished master's thesis, Va. Tech., Dept. of Wildlife Management, December, 1969.

wetlands. The VWA reflected these perceptions in that it declares that policy of the State is "to preserve the wetlands and to prevent their dispoliation and destruction and to accomodate necessary economic development in a manner consistent with wetlands preservation."[7]

The Study

The policy for managing wetlands established in the VWA was based on limited scientific information concerning wetlands' natural values and on Settle's study concerning the rate of wetlands' conversions. Legislating with limited information is not unusual, however. Indeed, in many cases, it is the passage of legislation that focuses the need for additional research to improve public management decisions.

In Virginia and other states who have public policies to manage wetlands, additional information on wetlands' natural values and on historical changes in the use of coastal wetlands can have considerable utility. Research findings on wetlands' natural values are reported elsewhere.[8] This report summarizes findings of a study which determined the historical changes in uses of Virginia wetlands by two county locations. The researchers desired the information in order to:

(a) determine past development trends;

(b) determine natural (not influenced by man) changes in wetlands acreage;

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[7] VWA, Va. Code Ann., Sec. 62.1-13.1 (1973).

[8] See L. A. Shabman and S. S. Batie "Estimating the Economic Value of Coastal Wetlands: Conceptual Issues and Research Needs," pp 3-15. In V. S. Kennedy (ed) Estuarine Perspectives, NY: Academic Press. 1980.

(c) determine number of wetlands acres altered by man relative to the total number of acres; and,

(d) determine the location of and changes in various wetlands types over time.

The Determination of Past Development Trends

One major benefit of determining historical changes in Virginia's wetlands acreage is the determination of past development trends.[9] Past trends of wetlands development can assist in prediction of future development pressures on wetlands as well as providing information with respect to the value of wetlands in development uses. Just as different wetlands have varying degrees of biological quality, they also have varying degrees of potential for development.

The Determination of Natural Changes in Virginia's Wetlands Acreage

Not all changes in wetlands acreage are caused by human actions. The natural forces of winds and water can lead to accretion of wetlands in some areas and destruction of wetlands in others. Natural succession of life-forms also changes wetlands, typically through the following evolution: open water, deep marsh, shallow marsh, shrub swamp, forested wetlands.

The identification of areas of natural accretion and erosion of wetlands, as well as the quantification of the numbers of wetlands acres affected, would assist in both the estimation of wetlands values and in public policy design.

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[9] Development for the purposes of this study is defined as any man-made alteration of a natural coastal wetlands' which was of such magnitude as to significantly alter the natural services of the wetlands. Development activities include actual construction, filling, bulkheading, dredging and/or channelizing of wetlands.

For example, if an area is known to be gaining (losing) an appreciable amount of wetlands acreage over time, activities that alter some acres may be considered less (more) damaging to environmental services of the total wetlands system than if that were not the case. This conclusion might be altered, however, if the newly formed wetlands were not considered as biologically productive as those which were altered.

The Determination of the Number of Wetlands Altered by Man Relative to the Total Number of Acres

In those areas where a considerable proportion of wetlands have been altered by man's activities, the development value of an additional wetlands acre converted to a development use should be relatively less (all other factors constant) than the value of the previously developed acres. Conversely, the development values of the first few wetlands acres converted to development uses in an area where little or no previous alteration of wetlands has taken place should be relatively more valuable (all other factors constant) than the conversion of the next few additional acres.[10] Thus, estimation of development values for future wetlands development requires the determination of the number of wetlands altered by man relative to the total number of acres.

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[10] It is tempting to make the same arguments with respect to the natural values of wetlands -- that is, the loss of a few acres of wetlands, when there are many acres of wetlands present, is of less value to society than where there are few total wetlands acres present. However, it is possible that in order for wetlands to provide natural values, there must be a large number of acres. Thus, the filling of one acre may destroy the ability of others to provide natural services. Whether or not this is the case is not known.

The Determination of the Location of, and Changes in, Various Wetland Types

Wetlands can be classified with respect to biological and hydrolgical characteristics as well as development potential. For example, guidelines have been developed in Virginia by the Virginia Marine Resources Commission on the basis of studies conducted by the Virginia Institute of Marine Science (VIMS). These guidelines classify wetlands by type, set forth the environmental consequences of their alteration and are used to assist localities in regulation of wetlands use. Factors used in the evaluation process consist of vegetation production and detritus availability, waterfowl and wildlife use, erosion buffering, water quality control, and flood buffering. Twelve types of wetlands are evaluated by VIMS scientists in accordance with these factors and grouped into five classifications based on total environmental value. Wetlands, however, do not necessarily remain in the same classification through time. Natural wetlands will go through successional stages of biota types even when undisturbed and are subject to dramatic changes when subject to extreme storm events. Similarily, development potential can also change as various characteristics of nearby economies change. For example, the construction of a new highway may provide access to a previously unavailable waterfront area and result in development pressure on existing wetlands. Conversely, the relocation of a large employer away from a wetlands area to a distant location can reduce development pressures. An appreciation of the dynamic nature of these processes can assist in developing predictions of future wetlands' use conflicts.

Previous Studies

Unfortunately, the previous research of Settle on historical changes of Virginia's tidal wetlands was of little assistance to the researchers in completing the analysis. The methods used by Settle are not clearly identified in his study. It appears that he established the number of wetlands acres existing in 1954 by use of maps, navigation charts and personal interviews. He then questioned field personnel of state and federal conservation agencies and other persons "knowledgeable of wetlands habitats" concerning changes in wetlands known to have occurred since 1954. He visited each identified site and determined the amount of acreage altered. Natural changes in wetlands were not considered. The percentage of 1954 wetlands which were altered from 1954-1969 was calculated to be 1.2 percent (or 4,026 acres) of the estimated 1954 total. Only 2,482 of the altered wetlands acres were classified as coastal saline by Settle. (Settle estimated there were 314,614 acres of wetlands which were tidal). The others are freshwater, and therefore, would not be affected by the Virginia Wetlands Act.

Settle identified channelization as the major contributor to marine wetlands alterations (47 percent) and industrial development as the second major factor (27 percent). Other alterations resulted from residential development (16 percent), roads (4 percent), marinas and docks (5 percent), and other causes (1 percent).

Settle did not report his data by county, rather he reported by major drainage areas. Of the 2,482 acres of marine wetlands identified by Settle as altered, over half, 1,475 acres, were on the Eastern Shore. The remainder were on the Chesapeake Bay Shores (466 acres), James River (475 acres), the Rappahannock River (8 acres), or the York River (58 acres).

Settle's methods for determining actual coastal wetlands changes is questionable. In fact, the method appears to be a "patchwork" of procedures chosen to expedite completion of the study, at the expense of obtaining the most accurate data available. The following reflect questionable elements of Settle's method which could act to bias the estimations of wetlands conversions:

- Base maps used for change analysis reflect representative scales of 1:30,000, 1:40,000, 1:60,000 and 1:80,000. As stipulated by U.S. Map Accuracy Standards, each of the above has a representative accuracy. Settle did not address this inherent problem.
- Documentation of wetlands changes was largely dependent upon personal interviews. Since persons interviewed were required to identify changes that occurred up to 15 years previous to Settle's study, opportunity for recall error was high.
- "Wetland boundaries of change" were ocularly plotted on the above maps during field inspection. Ocular, free-hand boundary delineation is error-prone, particularly on maps of the above scales. Maps of this quality do not display the detail necessary for accurate boundary identification.
- A real measurement of wetlands change was obtained via dot grid. Settle failed to stipulate the density of the grid used, nor did he suggest that different density grids were utilized to offset scale differences of the base maps.
- Aerial measurement of wetlands change for small parcels (less than five acres) was obtained with on-site or ocular estimates. Accurate pacing in wetlands is highly unlikely. More accurate estimations could have

been obtained through careful analysis and comparison of aerial photographs of identical areas at different years.

The apparent inaccuracies in Settle's study are unfortunate since the study has been used to determine the effectiveness of the VWA. A 1974-75, annual report of the Council of the Environment of the Commonwealth of Virginia,[11] stated:

> "It had previously been determined that man's activities were destroying about 450 acres of marsh per year, and that the annual rate of destruction was sharply increasing. The experience of the Marine Resources Commission and the Virginia Institute of Marine Science (VIMS) demonstrates a sharp reversal in this situation since 1972." (p. 21)[12]

The Virginia Institute of Marine Science (VIMS) has developed detailed inventories by county of Virginia's wetlands using aerial and field surveys. While these inventories provide useful information, they do not attempt to provide any historical perspective from which to judge changes prior to the date the inventories were completed.

Also, in 1979, a study by Batie and Wilson[13] tabulated the number of wetlands acres by coastal county in Virginia for the purposes of valuing oyster habitat. Again, however, there was no attempt to ascertain historical changes.

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[11] Council on the Environment Commonwealth of Virginia, Annual Report 1974-75, "The State of Virginia's Environment," 49 pp.

[12] Interestingly, this was an incorrect use of Settle's work. The Council's report cited Settle's data for all wetlands destruction, fresh and marine wetlands for 1965-69 as 450 acres of marsh per year as a basis of comparison of the "effectiveness" of the Wetlands Act. The correct comparison for determining the effectiveness of the Act" using Settle's data, should have been 275 acres of marine wetlands per year.

[13] Batie, S. and J. Wilson. Economic Values Attributable to Virginia's Coastal Wetlands as Inputs in Oyster Production, Southern Journal of Agricultural Economics 10 (1) pp. 111-117, July 1978.

With the possible exception of Settle's research, no study has undertaken an analysis of wetlands changes in Virginia's counties. Furthermore, no study has been specifically designed within Virginia to utilize such information to develop economic values or improve decision-making.

The Case Study Areas

This study utilized aerial photographs to document the natural and man-made historical changes in coastal wetlands. The study focused on two case study areas: Virginia Beach and Accomack Counties. These two case study areas were selected because Virginia Beach is a rapidly urbanizing area with much residential development and Accomack is predominately rural with a few small communities. It was felt that these two areas were representative of the two main classifications of coastal counties: rural and urban. The study measured wetlands changes from 1949 to 1974 in Accomack County and from 1949 to 1971 in Virginia Beach.

Accomack County lies between the Atlantic Ocean and the Chesapeake Bay and North of Northampton County on the Eastern Shore peninsula (Figure 1). County population was 29,700 in 1974, a decrease of 935 since 1960. Accomack, an isolated, highly rural county, covers 486 sq. mi. (364,640 acres) of land. Agriculture and manufacturing are the primary employers of the county, employing 3,871 people in 1970.[14]

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[14] Virginia Dept. of Planning and Budget. Data Summary Accomack County, Nov. 1976.

[15] Virginia Beach is actually an independent city formed by the annexation of Princess Ann County. For ease of references, however, this study will refer to Virginia Beach County.

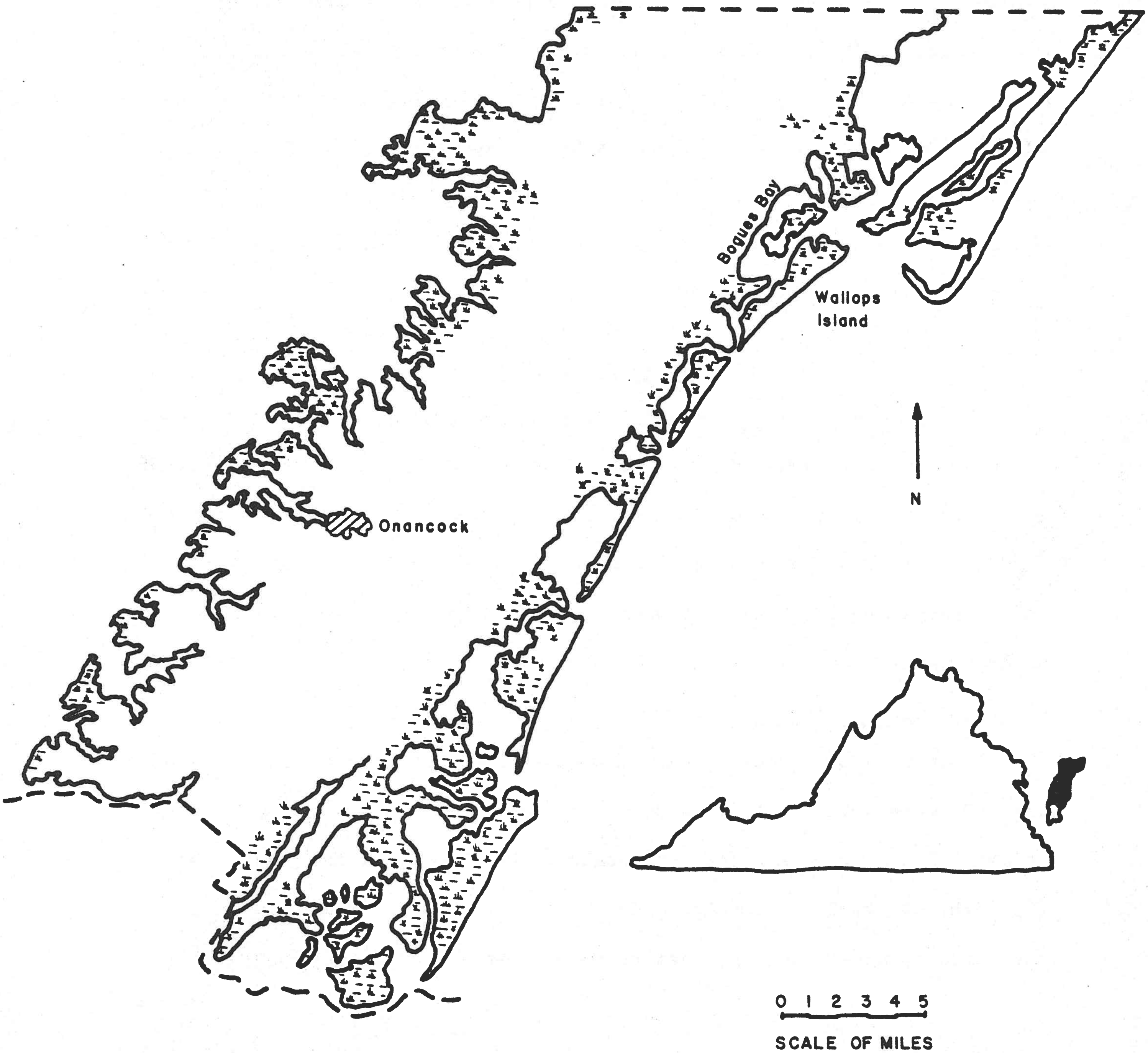

FIGURE 1 ACCOMACK COUNTY STUDY AREA

Virginia Beach[15] serves as the southeastern-most boundary of the Chesapeake Bay. Virginia Beach lies between the Atlantic, the Chesapeake Bay to the north and Norfolk and Chesapeake cities to the west (Figure 2). In many respects, Virginia Beach is the antithesis of Accomack County. Population for Virginia Beach was 184,579 in 1971, representing an increase of 99,361 since 1960. Virginia Beach is highly accessable, being served by interstate 64, and state highways 17, 58, 60, and 160, and is highly urban in character. Major employers in the county in 1971 included wholesale and retail trades and government.[16]

Research Procedures

The study proceeded in several steps; first, a coastal wetlands profile was developed for each county for the 1949 base year; second, an assessment was made for each county of the natural and man-made changes to wetlands acreage over a 20 plus year period within the 1949 base year boundary; and third, measurements of coastal wetlands expansion beyond the 1949 base year boundary were made.

Virginia Beach Study Area

Three sets of standard panchromatic aerial photographs at a scale of 1:20,000 were obtained to provide stereoscopic coverage of the study area.[17] The aerial photographs represent coastal zone conditions as captured on March 29, 1949, May 4, 1958, and April 24, 1971. An Abrams 2X-4X power lens stereoscope, model CB-1 was used to annotate the photographic prints Dot grids

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[16] Virginia Division of State Planning and Community Affairs. Date Summary - City of Virginia Beach. April 1973.

[17] The photographs were obtained from the Aerial Photography Field Office, USDA-ASCS, Salt Lake City, Utah.

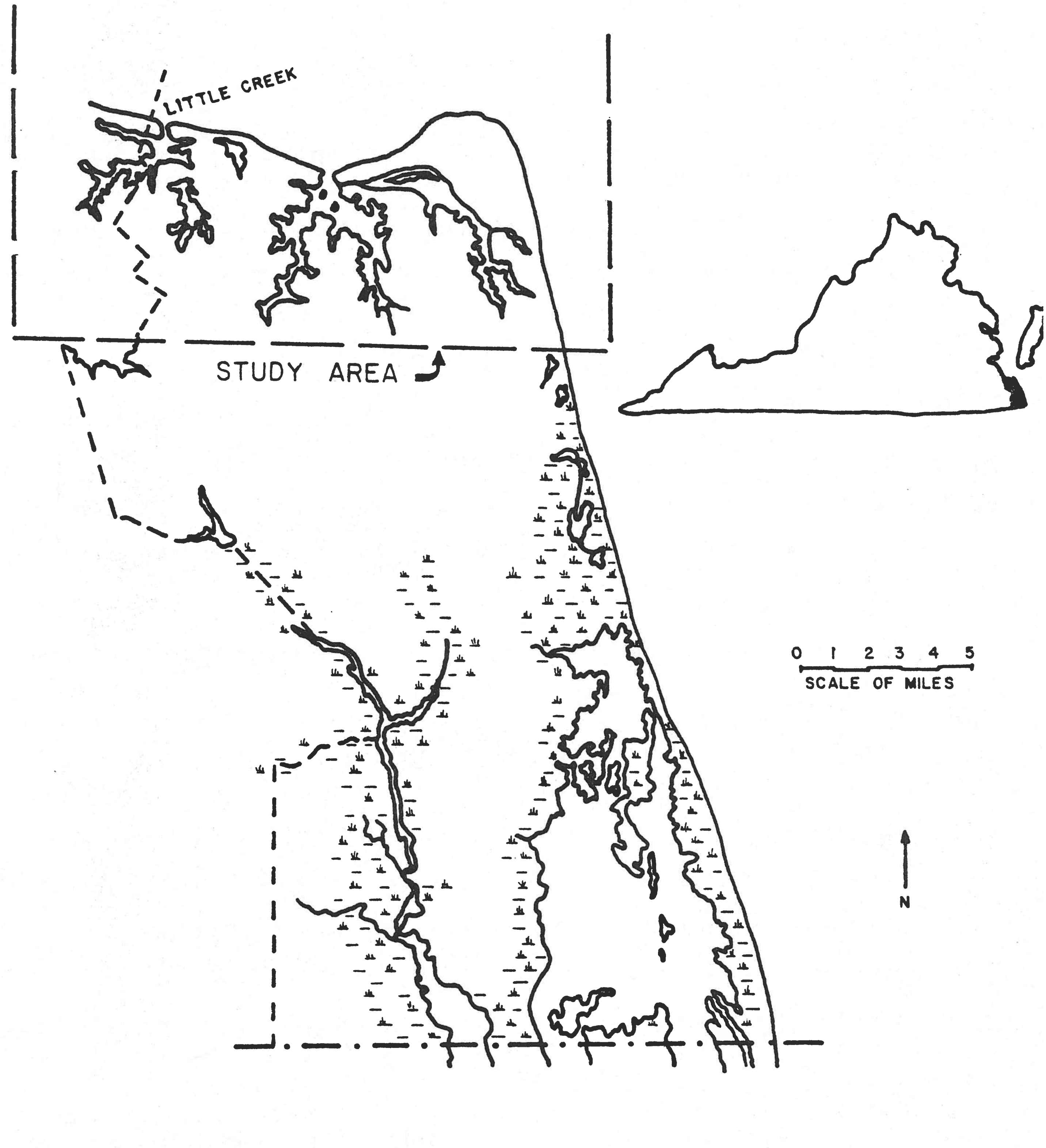

FIGURE 2 VIRGINIA BEACH STUDY AREA

(100 dots per square inch) served to measure area types. Map measures were used to measure distances on maps and photographs.

<u>Accomack Study Area</u>

The above discussion of materials and methods is applicable to the Accomack study area except for the following: one set of 1:20,000 and one set of 1:40,000 scale Black and White panchromatic aerial photographs were obtained to provide temporal stereoscopic coverage of the study area. The aerial photographs used represent coastal zone conditions as captured on March 13, 1949 and October 23, 1974.

<u>Classification System - Virginia Beach Study Area</u>

The classification system represents a modification of the system used in the State of Massachusetts.[18] The system was devised to describe the nature of coastal wetlands, the vegetation on the landscape and land use. The system includes only features that can be interpreted consistently and accurately on 1:20,000 scale panchromatic photographs. The system is separated into three categories: wetlands types, urban land-use types, and agricultural and open land-use types. These are defined in Table 1.

<u>Classification System - Accomack County Study Area</u>

The classification system designed for Virginia Beach coastal wetlands was applied to Accomack County with one modification: wetlands types tidal salt marsh (TSM), irregularly flooded salt marsh (ISM) and ditched salt meadow (DSM) were combined into one salt wetlands type denoted TSM. This modification was necessary to accomodate the smaller scale photography of 1:40,000. Accomack coastal wetlands are extensive and highly complex. It was

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18 MacConnell, W. P. and W. R. Niedzwiedz. 1975. Remote sensing 20 years of change in Berkshire, County, Mass. -- 1951-1971. Mass. Agri. Exp. Sta. Col. Food and Natural Resources. Bul. No. 629. 117 pp.

Table 1. Wetlands Classifications

Wetland Types

General Type:

MF - Mud Flat

Salt Type:

MF - Mud Flat

TSM - is tidal salt marsh which is flooded twice daily. Vegetation is primarily saltmarsh cordgrass.

ISM - is irregularly flooded salt meadow flooded at monthly high tides and during severe storms. Vegetation is primarily salt meadow and black rush.

DSM - is ditched salt meadow which has been ditched for mosquito control or for agricultural purposes. Vegetation is the same as ISM.

W - is open salt water in estuary lakes, rivers, and large streams. Water depth is greater than three feet during the growing season. The boundary of coastal water is located by drawing a line at the river mouth to connect the edges of the coastline.

Brackish Type:

DM - is deep marsh. Water depth ranges from six inches to three feet. Fairly large open water areas are bordered by, or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweek, water shield and pondweeds are also present.

SM - is shallow marsh. Shallow marsh is wetter than meadow, its soil is waterlogged completely and often covered with up to six inches of water during the growing season. Some open water is usually present and the predominant vegetation is emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead. Some grasses and sedges are present.

SS - is shrub swamp. Soil is waterlogged during the growing season and is often covered with as much as six inches of water. Common woody species are alder, buttonbush, dogwood and willow. Sedges are usually present in tussocks.

SF - is seasonally flooded basin or flat. This type occurs principally on stream floodplains, most common plants being grasses and herbaceous species. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season. This type is difficult to recognize on summer aerial photographs because it does not support a distinctive vegetation complex.

Table 1 (continued).

M - is meadow. The soil is waterlogged through most of the growing season and surface water is present only for a short period during the spring. Vegetation is predominantly grasses, rushes and sedges. Rushes, which grow in the wetter parts of many meadows, photograph in dark tones, making this type easy to identify.

FW - is forested wetland. Areas covered with trees that are greater than 20 feet in height. Three crown closure exceeds 30 percent. Soil is moist, often waterlogged during the growing season.

Man-Altered Types:

OS - is channelized open water. The type includes man-made channels constructed to serve as water/boat access-ways to subdivision areas, or future subdivision areas.

MS - is mining spoil wetland. The type represents wetland areas created as a result of man's mining activities below the groundwater line.

DO - is dammed open fresh water. The type represents brackish water areas dammed and possibly dredged that lie within the coastal zone. After dam construction water type is fresh. Such areas appear as small ponds or lakes.

Urban Land-Use Types

URH - is high density urban residential land used for homes which are spaced closely, set back from the street, and arranged in orderly rectangular patterns on lots less than 1/4 acre in size. Nearly all the street frontage for these building lots is in the vincinity of 50 feet and many of the streets are laid out at 200' intervals. There are about eight dwelling units per acre. These are usually located in older urban areas, or are cottages near the ocean, or are mobile home parks.

URM - is medium density residential land used for homes which are spaced closely and arranged in orderly curved or rectangular patterns and set back from the street on lots which are predominantly 1/4 or 1/2 acre in size. Most of the street frontage is 100' in width and there are two to four dwelling units per acre.

URL - is light density residential land with lot sizes from 1/2 acre to one acre in size. Most of the lots are one acre in size and there is one dwelling unit per acre.

UA - are "garden" apartments which are usually located outside the "core" city, are set back from the street, have some "grounds" and may have attached recreational facilities, e.g. swimming pools and tennis courts.

Table 1 (continued).

US - are shopping centers located away from the urban core which are surrounded by large parking lots and may have some landscaping and trees as part of the complex. Theatres are often located in shopping centers to take advantage of the parking.

UH - is highway commercial land used for merchandizing goods and services to the travelling public. Gas stations, motels, restaurants, drive-ins, and stores located in strips along major routes of travel contitute this type.

UP - is public or quasi-public land with "grounds" and green space which contains facilities to serve large numbers of people. Examples are schools, colleges, churches, hospitals, state hospitals and prisons.

UTW - are docks, warehouses and related land-based storage facilitites for water transportation and commercial fishing. Liquid storage facilities like tank farms may be part of this type.

UTA - are airports with landing strips, hangers, parking areas and related facilities. Small airfields without paved runways, hangers or other specialized facilities are not typed as airports.

UTT - are terminal freight and storage facilities for truck freight including liquid storage facilities. Bus terminals are included in this type. Transportation facilities which are part of an industrial complex are included as part of the Industrial type.

HW - is divided highway with 200 feet or more of right-of-way width.

FB - is filter bed. This land and associated buildings are used for treating liquids containing organic or chemical matter.

RM - are margins or boatyards.

RSB - is saltwater sandy beach. This type includes bathhouses, parking and related facilities.

RG - are golf courses. This type includes the club house and associated recreation facilities.

<u>Agricultural - Open Land-Use Types</u>

T - is tilled or tillable crop land which is or has recently been intensively farmed. Boundaries on the ground are usually sharply defined and well maintained because the land is valuable. Land supporting farm buildings is included as part of this type.

P - is pasture or wild hay land which is not suitable for tillage due to steepness of slope, poor drainage, stoniness, or lack of fertility. This land has less sharply defined boundaries than tilled (T) and often has occasionally scattered shade trees for the grazing animals.

Table 1 (continued).

AF - is abandoned field which is reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30 percent. If three crown cover were greater than 30 percent, the land would be classified as forest. This land is highly productive of wildlife. Most of this land was pasture or wild hay land before abandonment.

O - is open land. Open undeveloped land lying idle in the midst of urbanized areas or adjacent to them.

S - if open sand area which may support scattered herbaccous vegetation. Sandy beaches are a separate outdoor recreation type.

SG - is sand or gravel. This land is used for the extraction of sand or gravel.

FI - is fill area. Deposition of waste materials, sand, gravel, or a combination of materials into wetland areas.

decided that additional classification of these complex wetlands (which are similar in their capacity to support man-made development) was not necessary in light of the objectives of the research.

Interpretation and Annotation of Aerial Photographs

Virginia Beach Study Area

The temporal nature of this research required an application of the classification system to three sets of aerial photographs. To establish a base condition for Virginia Beach coastal wetlands, the wetlands subcategory (see Table 1) of the classification system was applied to the 1949 photography. Beginning at Little Creek on the Chesapeake Bay (Figure 2) coastal wetlands were identified and annotated with wetlands type symbols indicative of their state. Interpretation and annotation was conducted while viewing stereopairs of portions of the study area.

Wetlands classification is a function of photographic format, scale, tone, texture, size, shape and location of the subject(s). As examples: on the photographs used, ditched salt meadows (DSM) appear as mottled areas located close to open-water, and display clearly defined linear man-made ditch networks; channelized open-water areas (OS) appear as dark-toned, vegetation-free water courses with regular banks. These areas are usually adjacent to residential areas (to serve as boat access-ways to the bay waters) or to agricultural areas that are subject to developmental pressures. Wetlands interpretation and annotation proceeded along the saltwater and land interface until a point of "no saltwater influence" was established. A boundary line was placed where saltwater influence was not apparent on the aerial photographs. Placement of this boundary line is a function of type location and most importantly, the types(s) of vegetation present.

Some caution must be expressed concerning tidal elevation during aerial film exposure and its effect on wetlands boundary identification. Film exposed during high tides will capture less wetlands information than will film exposed during low tides. Wetlands type measurements most affected by tidal elevation are open salt water (W) and mudflats (MF).

This interpretive process was applied in a systematic manner until all of the study area included on the 1949 photographs was delineated. The Back Bay area of the county (Figure 2) was not included in the study. This area is located south of the main development pressures of the urban area of the county and, therefore, it was felt the northern part of the county would better represent an "urban" situation. To insure interpretive consistency and accuracy, "ground truth" or correct classification, was established early in the study with on-site field inspection. The smallest interpretable unit was two acres.

Documenting historical change with aerial photography requires a comparison of the same area(s) as captured on film on different dates. To access coastal zone change in the Virginia Beach study area, the 1949 wetlands boundary (interior-most line) was transferred to the 1958 and 1971 photo sets. Conventional aerial photographs normally possess horizontal scale inaccuracies. Because each set of aerial photographs is flown at one scale registered to a particular datum plane, any change in elevation above or below that plane will cause an error in scale. As one might expect, errors of scale are greatest in high-relief areas. Virginia Beach coastal wetlands and adjacent lands offer little elevational change. Few study areas are higher than ten feet above mean sea level. As a result, scale anomalies between the three sets of photos were within one percent and direct boundary transfer was accomplished without difficulties using a high-intensity light table. Wetlands boundaries were annotated.

Wetlands and land-use interpretation proceeded on the 1958 and 1971 photographs. All areas within the transferred 1949 boundary were annotated. Any expansion of coastal wetlands beyond (landward) the transferred 1949 boundary was annotated.

The above interpretive process applies also to the 1949 and 1974 aerial photographs covering the Accomack County study area. Due to photo-scale differences between the 1949 and 1974 photographs, boundary transfer was conducted using small-grid ocular techniques.

Measurement of wetlands and land-use was made directly on the annotated photographs. A dot grid with 100 dots per square inch was used; each dot represented .637 acres (1.57 ha.) at a scale of 1:20,000 and 2.55 acres (6.30 ha.) at 1:40,000. Tabulations were separated by year according to wetlands, urban, and agricultural types within the 1949 base-year boundary.

Tabulations

Tabulations for Virginia Beach represent a 100 percent sample of the study area. Tabulations for Accomack County represent a 33 percent sample of the study area. Three sample sites within Accomack were chosen for aerial analysis. Two sample sites are located on the county's north and southeastern Atlantic shore, the third site is located on the county's central western Chesapeake shore. Total Accomack coastal wetlands acreage was determined via interpretation and measurement on aerial photomosaics. A partial sample of Accomack County was used for two reasons; a preliminary aerial survey indicated that change of coastal wetlands was minimal, and the large area of the county precluded a total sample.

Results

Virginia Beach Study Area

1949 -- The Virginia Beach coastal wetlands totaled 9,184 acres for the 1949 base-year (Table 2). Of this total, 1,753 acres were in three saltwater wetlands types: tidal (TSM), irregularly flooded (ISM) and ditched (DSM) salt marsh types; 5,804 acres were open salt water; 1,587 acres were in brackish-water wetlands types (DM, SM, SS, FW, M, and SF); and 40 acres were in man-manipulated wetlands (DO, OS, and MW).

1958 -- In 1958 the total of the three salt marsh types (ISM, DSM, TSM) dropped to 1,142 acres, open salt water represented 5,833 acres and brackish-water wetlands types accounted for 1,108 acres. Man-manipulated wetlands accounted for 672 acres or 7.3 percent of the 1949 total. Tables 3 and 4 show that 429 acres of wetlands (1949 base) were developed for urban-associated (306 acres) plus agricultural-open uses (123 acres) by 1958.

The 1958 figures reflecting wetlands developed or expanded beyond the 1949 wetlands boundary, totaled 243 acres (Table 5). Of this total, 179 acres were man-manipulated, including 68 acres of dammed open water (DO), 73 acres of channelized wetlands (OS), 37 acres of mining-spoil wetlands (MW) and three acres developed for recreational beach (RSB). The above reflect the shallow depth of the ground water and the apparent positive economic returns of developing wetlands for recreation based uses and for dredge disposal.

1971 -- Virginia Beach wetlands totaled 8,364 acres in 1971 (Table 2), reflecting a drop of 820 acres or 8.9 percent since 1949. Of the above total, 761 acres were classified into the saltmarsh types (ISM, DSM, TSM), 5,789 acres in the open salt water type (W), 829 acres in the brackish-water types, and 985 acres in man-manipulated wetlands types.

Table 2: Net Historical Change of Virginia Beach Coastal Wetlands Types (acres).

	Saltwater Wetlands					Brackish Wetlands							Man Altered				
Year	ISM	DSM	TSM	W	total salt	DM	SM	SS	FW	SF	M	total brackish	DO	OS	MW	total man-altered	total wetlands types
1949	696	845	212	5804	7557	-	215	272	1085	-	15	1587	20	10	10	40	9184
1958	544	431	167	5833	6975	13	59	205	727	88	16	1108	168	421	86	672	8755
1971	369	209	183	5789	6550	3	50	116	508	107	45	829	233	671	82	985	8364
1949-1971	-327	-636	-29	-15	-1007	+3	-165	-156	-577	+107	+30	-758	+213	+661	+72	+945	-820

Of the 820 acres of wetlands that have changed into other uses since 1949, 687 acres and 133 acres were in urban associated or acricultural-open uses (Tables 3 and 4); there was also an expansion of 436 acres of wetlands beyond the 1949 base (Table 5). Land uses with an urban association (Table 3) included 232 acres of medium density residential uses (URM), 252 acres of light density residential uses (URL), 12 acres of shopping center area (US), 10 acres of public land (UP), 49 acres of water transportation facility (UTW), 31 acres of highway (HW), 21 acres of marina (RM), and 48 acres of golf course area (RG).

Of the 133 acres of agricultural and open land (Table 4) converted from wetlands since 1949, only 12 acres were devoted to agricultural uses (T, P, AF, O) while 21 acres were classified as sand (S), 50 acres as gravel mining area (SG), and 50 acres as filled-in wetlands (FI).

The 436 acres of wetlands expanded were in the form of dammed open water (DO), channelized wetlands (OS), and mining spoil wetlands (MW). Natural wetlands types identified beyond the 1949 boundary include 11 acres of irregularly flooded salt meadows (ISM), 11 acres of shrub swamp (SS), 21 acres of forested wetlands (FW) and 114 acres of open salt water (W).

Thus, in Virginia Beach a net change of all types of coastal wetlands acreage (including expansion from the 1949 borders) was a decrease of 384 acres from the original 1949 total of 9,184. If only saltwater wetlands (ISM, DSM, TSM, W) are considered, however, the change is a decrease of 882 acres (minus 1007 acres (from Table 2) plus 125 acres expansion (from Table 5) from the 1949 total of 7557 acres. This is a percentage change of 11.7 percent. The predominant cause for changes was urban associated -- medium and light density residential uses (URM and URL) -- which accounted for the majority of wetlands conversions.

Table 3: Net Historical Development of Virginia Beach Coastal Wetlands into Urban Types (acres).

	URH	URM	URL	UA	US	UH	UP	UTW	UTA	UTT	HW	FB	RM	RSB	RG	total urban types
1958	1	30	173	1	2	1	8	31	-	-	19	-	1	6	33	306
1971	1	232	252	7	12	4	10	49	4	3	31	13	21	-	48	687
1949-1971	+1	+232	+252	+7	+12	+4	+10	+49	+4	+3	+31	+13	+21	-	+48	+687

Table 4: Net Historical Change of Virginia Beach Coastal Wetlands into Agricultural and Open Land Use Types (acres).

	T	P	AF	O	S	SG	FI	Total ag-open
1958	5	6	6	22	63	10	11	123
1971	4	-	4	4	21	50	50	133
1949-1971	+4	-	+4	+4	+21	+50	+50	+133

Table 5: Net Expansion of Virginia Beach Coastal Wetlands Beyond 1949 Base Year (acres).

	Saltwater Wetlands					Brackish Wetlands							Man Altered						
Year	ISM	DSM	TSM	W	total salt	DM	SM	SS	FW	SF	M	total brackish	DO	OS	MW	RSB	RM	total man altered	total all
1949 base	696	845	212	5804	7557	-	215	272	1085	-	15	1587	20	10	10	-	-	40	9184
1958 expansion	5	-	1	31	37	-	1	12	11	-	3	27	68	73	35	3	-	179	243
1971 expansion	11	-	-	114	125	-	4	11	21	2	8	46	99	137	28	-	1	265	436

Further refinement of the data to exclude the open saltwater type (W)* yields interesting results regarding the loss of wetlands types ISM, DSM, TSM (saltwater wetlands) and DM, SM, SS, FW, SF, M (brackish wetlands). Saltwater wetlands exclusive of open saltwater types declined from 1,753 acres in 1949 to 761 acres in 1971. This represents a loss of 56.6 percent. Similarily, brackish water types declined from 1,587 to 829 acres for the same period, representing a loss of 47.8 percent. Total saltwater and brackish water wetlands types (including expanded acres of these types) declined by 1,693 acres (or by 49.3 percent) from 1949 to 1971. A large majority of the losses were due to urban and mining filing operations (see Tables 3 and 4).

Accomack County Study Area

1949 -- In 1949, Accomack County coastal wetlands comprised 81,217 acres of area (Table 6). Of the total, 68,694 acres were classified as tidal salt marsh (TSM), 4,094 acres mud flat (MF), 4,723 acres shrub swamp (SS), 3,075 acres forested wetlands (FW), 554 acres meadow (M), and 77 acres man-made wetlands (MW).

1974 -- In 1974, minor changes were noted in the configuration of Accomack County coastal wetlands. Tidal salt marsh (TSM) and mud flat (MF) areas accounted for 71,233 acres and 2,127 acres, respectively. The total was an increase of 572 acres from the 1949 base of salt water marsh plus mudflats. Brackish-water wetlands consisting of shrub swamp (SS), forested wetlands (FW) and meadow (M), however, declined by 1,320 acres or 15.8 percent of the 1949 base of 8,352 acres. Urban associated uses totaled 825 acres: 113 acres of which were identified as dammed open water (DO), 24 acres as channelized for

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*This saltwater type (W) is least accommodating to development because of the serious constraints present. It was felt, therefore, that the large numbers of acres of (W) "masked" impacts to other wetlands types.

Table 6: Net Historical Change of Accomack County Coastal Wetlands Types (acres).

		TSM	MF	SS	FW	M	MW	DO	OS	URS	TOTAL
Area (Acres)	1949	68694	4094	4723	3075	554	77				81217
	1974	71233	2127	1904	4678	450		113	24	688	81217

TSM - Salt Marsh

subdivision boat access, and 688 acres of 1949 base-year wetlands were developed as light density residential land (URL). No wetlands were observed on the 1974 photos that fell outside of the 1949 base-year boundary.

Thus, Accomack County has experienced few changes in wetlands relative to the urbanizing area of Virginia Beach. In contrast to the 11.7 percent decline in saltwater wetlands types (ISM, DSM, TSM, W) in Virginia Beach from 1949 to 1971, Accomack County's salt marshes and mudflats increased by 1 percent or 572 acres. The major development uses of altered wetlands were light density residential land.

Implications

Development pressures on Virginia Beach's wetlands prior to the existence of the Virginia Wetlands Act were substantially different from those of Accomack. Development uses in Virginia Beach included residential, industrial, agricultural, marina, port, highway, and recreation uses which resulted in a reduction of acres of saltwater wetlands (or 761 acres). If one were to classify wetlands with respect to development potential, it is apparent that much of the studied Virginia Beach wetlands were in the high potential category. In contrast, while Accomack had a conversion of 825 wetlands acres to urban uses, this accounted for only .01 percent of the total wetlands acreage; and these reductions were largely for residential homesites and water access for residential homesites.

Whether or not these rates of wetlands conversion were "too fast" and thereby added justification for the Virginia Wetlands Act, is a matter of opinion. It does appear, however, that the concerns that "in the next twenty or thirty years all the wetlands in Virginia will be destroyed" if not protected by legislation were not founded in fact. Even though Virginia Beach experienced considerable development of its saltwater and brackish wetlands types since 1949, this was not true of Accomack. In order for all of Accomack's 81,217 acres of wetlands to be destroyed in 30 years would have required an 80 fold increase in the previous two decades yearly average of 34 acres per year.

Dynamic natural forces also play a major part in determining the location and configuration of Accomack's wetlands as salt marsh types (TSM) plus mudflats (MF) actually increased on the period of study. Tidal saltmarsh area (TSM) increased by 2,539 acres while mudflat (MF) decreased by 1,967 acres, shrub swamp (SS) decreased by 2,819 acres and meadow (M) decreased by 104 acres. Forested wetlands (FW) increased by 1,603 acres for the period studied. These figures parallel a natural trend common in wetlands succession.

The implication of these development trends for management strategies are not totally evident because of the lack of data as to the value of wetlands acreage for its biological services. Is one acre of wetlands in isolation as valuable as one acre of wetland adjacent to many more acres of wetlands for its ecological services? The scientific evidence is inconclusive. Thus, it is uncertain as to whether meticulous protection of an isolated acre in Virginia Beach is more or less valuable than the protection of an acre of wetlands surrounded by wetlands in Accomack.

While the determination of value of wetlands ecological services awaits further research, the value of wetlands in development can be estimated. These estimates, when combined with information concerning the amount of wetlands available and past development trends, can provide information useful for managing wetlands. Researchers have attempted to estimate development values for some wetlands the Virginia Beach and Accomack County areas. The procedures used are reported elsewhere,[19] and only the results are reported as an illustration of the usefulness of the estimates of wetlands acreage historical trends.

In Virginia Beach, Virginia, development values for residential lots on altered wetlands acres are not remarkably high. Development values varied according to location and type of development. For purposes of illustration, a three-fourths acre site with 150 feet of frontage on an open bay would have a development value of $14,000. Development value for water access through a private marina and for vacation home sites on wetlands in rural Accomack County, Virginia, were calculated for the situation when no fastland alternative site was available. Development values for a marina were $5.8 million per acre for five acres of wetlands. However, if a fastland alternative site was available (i.e. dry dock with water access), there were no positive returns to marina development in wetlands areas. Development values for second home developments was estimated to be $40,000 an acre.

The relationship between the values in the urbanizing Virginia Beach and the rural Accomack County can be explained with the hypothesized relationships illustrated in Figure 4. The relationships illustrated in Figure 3 shows hypothetical values for wetlands in development used for various amounts of wetlands acreage converted for an urban county (U), and a rural county (R). In the urban county, the hypothetical development value for an additional acre of wetlands converted to a development use when 99 percent of the previous

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19 Shabman, L. A., Batie, S. S. and Mabbs-Zeno, C. C., 1980 "The Economics of Wetlands Preservation in Virginia", J. Northeast Agric. Econ. Council 101-116 and Shabman, L. A. and Bertelsen, M.A. 1979, "The Use of Development Estimates for Coastal Wetland and Permit Decisions" Land Economics, 55:213-222.

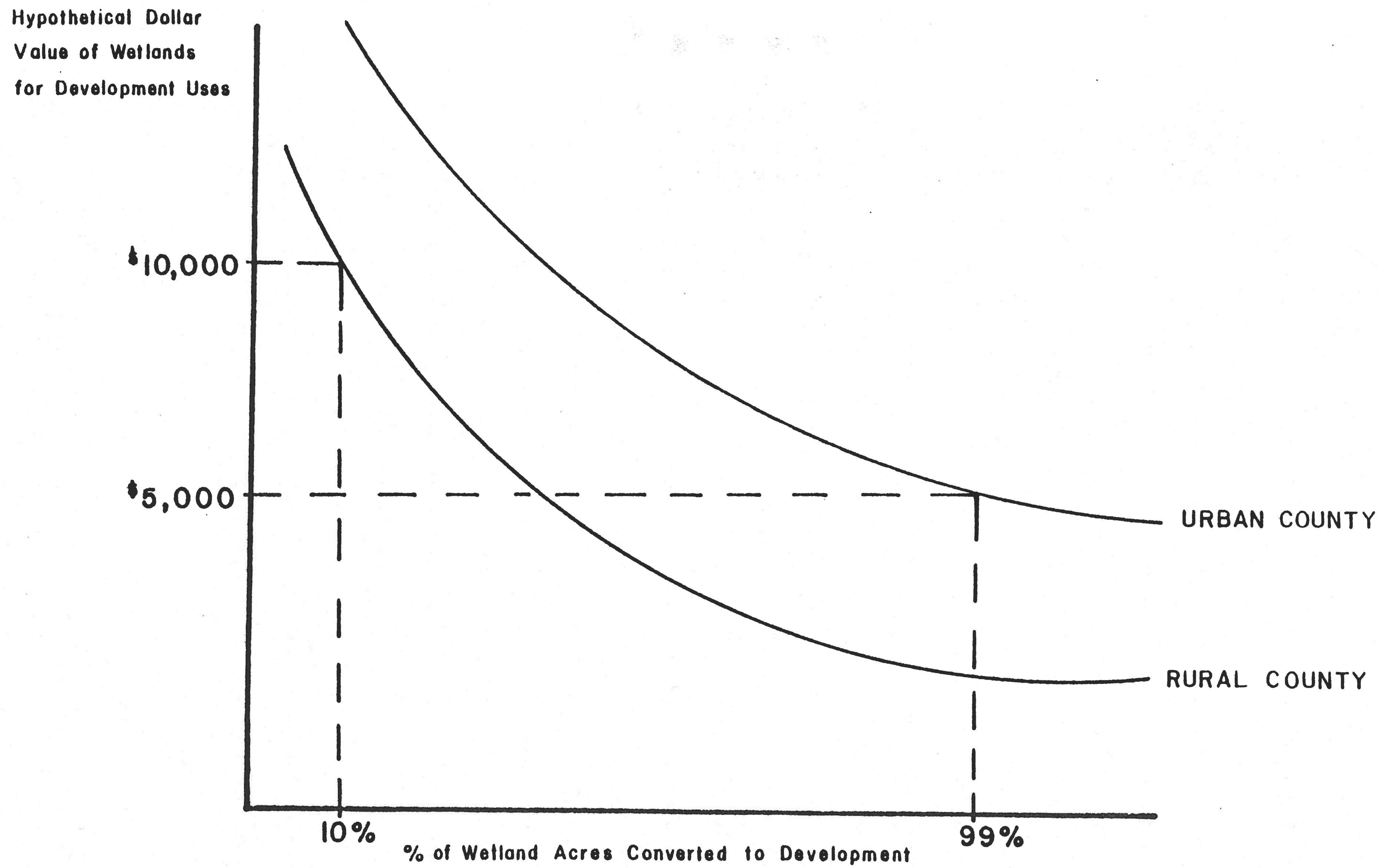

FIGURE 3 HYPOTHETICAL RELATIONSHIPS BETWEEN NUMBER OF WETLANDS CONVERTED

base of wetlands acres has already been converted is $5,000. This compares with $10,000 value of another acre added to an acre where only 10 percent of the existing base of wetlands in the rural county have previously been converted. These hypothesized relationships hold despite the fact that the total value of wetlands acreage conversions can be greater in the urban county for the same percentage of converted wetlands (curve U is above curve R).

In Virginia Beach, where substantial wetlands development has already taken place and where there are substitutes for obtaining water access other than wetlands development, the development values are relatively low. In Accomack County, wetlands managers may decide to accept some wetlands development since almost all of the county's shoreline is wetlands and few, if any, comparable fastland alternatives exist. However, the value of developing additional acres for marinas will fall sharply as additional marinas are built. These tentative findings suggest that the provision of water access to a large group of lot owners (or the general public) by development of small areas of wetlands in a region with many wetlands (such as Accomack) may have a high social value, especially in areas where water access is limited. Conversely, when the development values foregone by protecting wetlands in an area with few remaining wetlands (such as Virginia Beach) are low, a stronger argument for protection can be made.

Because effective wetlands management requires timely, relevant and accurate data reflecting current and historical conditions of the coastal wetlands, as well as improved understanding of the role of wetlands in the natural and economic systems, the research community should continue to improve the appropriate information bases.

While the photogrammetric and interpretive methods utilized in the report are not unique, the results of the analysis have provided new and valuable information on historical changes for use in an economic analysis of coastal wetlands development and coastal wetlands changes. There is reason to be optimistic that with continue cooperative effort between the various disciplines, there will be more information of increased usefulness for improved wetlands management.