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Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Tributaries—1984

Chesapeake Bay Program

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by

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SECTION 1

INTRODUCTION

Communities of submerged aquatic vegetation (SAV) are an integral part of the Chesapeake Bay ecosystem. They provide an important habitat for many species which use SAV either as a food source or as protection from predators, e.g. a nursery. They reduce currents and baffle waves, allowing for deposition of suspended material. In addition, they bind sediments with their roots and rhizomes to prevent erosion of the underlying material. They are important in nutrient cycling both through the absorption and release of nitrogen and phosphorus (Thayer, et. al, 1975; Kemp, et. al., 1984; Orth, et. al., 1984; Ward, et. al., 1984).

Interest in Chesapeake Bay SAV communities by scientists, resource managers and the public has been very high because of the significant reductions of SAV in many areas compared to luxurious stands that once prevailed less than 20 years ago (Orth and Moore, 1981, 1983, 1984). The recently completed Chesapeake Bay Program, funded by the U.S. Environmental Protection Agency (EPA), focused research on SAV in the areas of distribution and abundance, role and value, and factors that may have caused the decline of SAV (U.S. EPA Synthesis Report, 1982). The research phase of the Chesapeake Bay Program was completed in 1983 and the implementation phase is currently in progress.

An early but important consideration in the distribution aspects was how to determine the abundance of SAV effectively on a baywide basis. Aerial photography was chosen as the most cost effective and efficient method of acquiring quantitative information. In 1978 all the shallow water areas of the bay were flown with medium scale photography (scale 1:24,000). This mapping study resulted in the publication of a series of topographic quadrangles depicting the presence of SAV beds throughout the Chesapeake Bay region (Orth, et al., 1979; Anderson and Macomber, 1980). During subsequent years, selected areas of the bay were photographed and/or mapped for SAV but no complete baywide survey has been conducted since 1978.

Between 1978 and 1984, field surveys in different sections of the bay or rivers were conducted by the U.S. Geological Survey (USGS), Maryland Department of Natural Resources (Md.DNR), Northern Virginia Community College (NVCC) and the Virginia Institute of Marine Science (VIMS), to monitor the presence and/or absence of SAV in these particular areas. In addition, researchers at the Harford Community College and the University of Maryland's Horn Point Laboratories (UMdHPL) had been monitoring SAV populations in their respective study areas. Studies in the Choptank River by the UMdHPL have shown a decline in SAV since 1980. However, some surveys found SAV to be increasing in distribution and abundance in certain sections, especially in the Potomac River and Susquehanna Flats. Surveys first by the USGS and then by NVCC showed not only increases in natural species such as wild celery (Vallisneria americana) and sago pondweed (Potamogeton pectinatus) but also significant populations of two species never previously recorded in this area, water stargrass (Heteranthera dubia) and Hydrilla (Hydrilla verticillata). The latter species was of particular concern because of its potential rapid growth rate and its ability to spread and outcompete more desirable species of SAV.

During 1984, SAV beds in the bay were photographed and mapped under grants by the USEPA and the National Oceanographic and Atmospheric Administration (NOAA) to VIMS and EPA's Environmental Photographic Interpretation Center (EPIC). In addition, ground surveys for SAV were conducted in the Potomac River by the USGS and NVCC and in the entire

Maryland section of the bay by Md.DNR. This report draws upon not only information provided by the aerial photography but also data from the surveys conducted in the Potomac River (Allaire, et al., 1985; Carter, et al., 1985a; Rybicki, et al., 1985) and the multi-station survey conducted annually by the Md.DNR. Field observations made in the Susquehanna River and Flats (Stan Kollar, personal communication) and the Choptank River (Robert Twilley, personal communication) were used to corroborate and fill in areas missed by the aerial photography. Unlike the 1978 studies, this represents a unique effort to combine all the information into one baywide report of the 1984 status of SAV.

SECTION 2

SAV SPECIES

Ten species of submerged vegetation are abundant in the bay. Zostera marina (eelgrass) is dominant in the lower reaches. Myriophyllum spicatum (water milfoil), Potamogeton pectinatus (sago pondweed), P. perfoliatus (redhead grass), Zannichelia palustris (horned pondweed), Vallisneria americana (wild celery), Elodea canadensis (common elodea), Ceratophyllum demersum (coontail) and Najas quadalupensis (southern naiad) are less tolerant of high salinities and are found in the middle and upper reaches of the bay (Stevenson and Confer, 1978; Orth, et al., 1979; Orth and Moore, 1981, 1983). Ruppia maritima (widgeongrass) is tolerant of a wide range of salinities and is found from the bay mouth to the Susquehanna Flats. Approximately ten other species are found less commonly and are present primarily in the middle and upper reaches of the bay and the rivers (Appendix A). One species presently found in the Potomac River, Hydrilla verticillata (Hydrilla), has the potential for becoming one of the dominant species found here (Allaire, et al., 1985; Rybicki, et al., 1985).

SECTION 3

METHODS

Aerial Photography

Aerial photography was the principal method used to assess the distribution of SAV in the Chesapeake Bay and its tributaries in the 1984 study. Pre-determined flight lines for photography of areas that either had SAV or could potentially have SAV (that is all areas where water depths were less than 2 m at mean low water) were drawn on 1:25,0000 scale USGS maps to ensure both complete coverage of SAV beds and inclusion of land features as control points for mapping accuracy (Fig. 1). Some areas were not included because of the known lack of SAV in those areas.

The general guidelines used for mission planning and execution are given in Table 1. These guidelines address tidal stage, plant growth, sun elevation, water transparency and atmospheric transparency, turbidity, wind, sensor operation and plotting and allowed for acquisition of photographs under near optimal conditions. The guidelines are critical because significant distortion of any one item could significantly decrease the ability to detect the SAV or to interpret the photography properly as to the presence or absence of SAV.

The camera used for aerial photography of SAV in Virginia was a Fairchild CA-8 cartographic camera with a 152 mm (6 1/2 inch) focal length Bausch and Lomb Metrogon lens. Film was Kodak 24 cm (9 1/2 inch) square positive Aerochrome MS type 2448. The camera was mounted in a camera port in the bottom fuselage of the VIMS single engine, fixed high wing De Havilland Beaver aircraft gelatine. A wratten 1A haze filter was used inside the cone of the camera to reduce the degrading effect of atmospheric haze on image quality. Flights were conducted at an altitude of

Figure 1. Flight lines used for acquisition of aerial photographs of SAV in 1984 for Virginia and Maryland (lines connecting gray squares represent flight lines used in this survey).

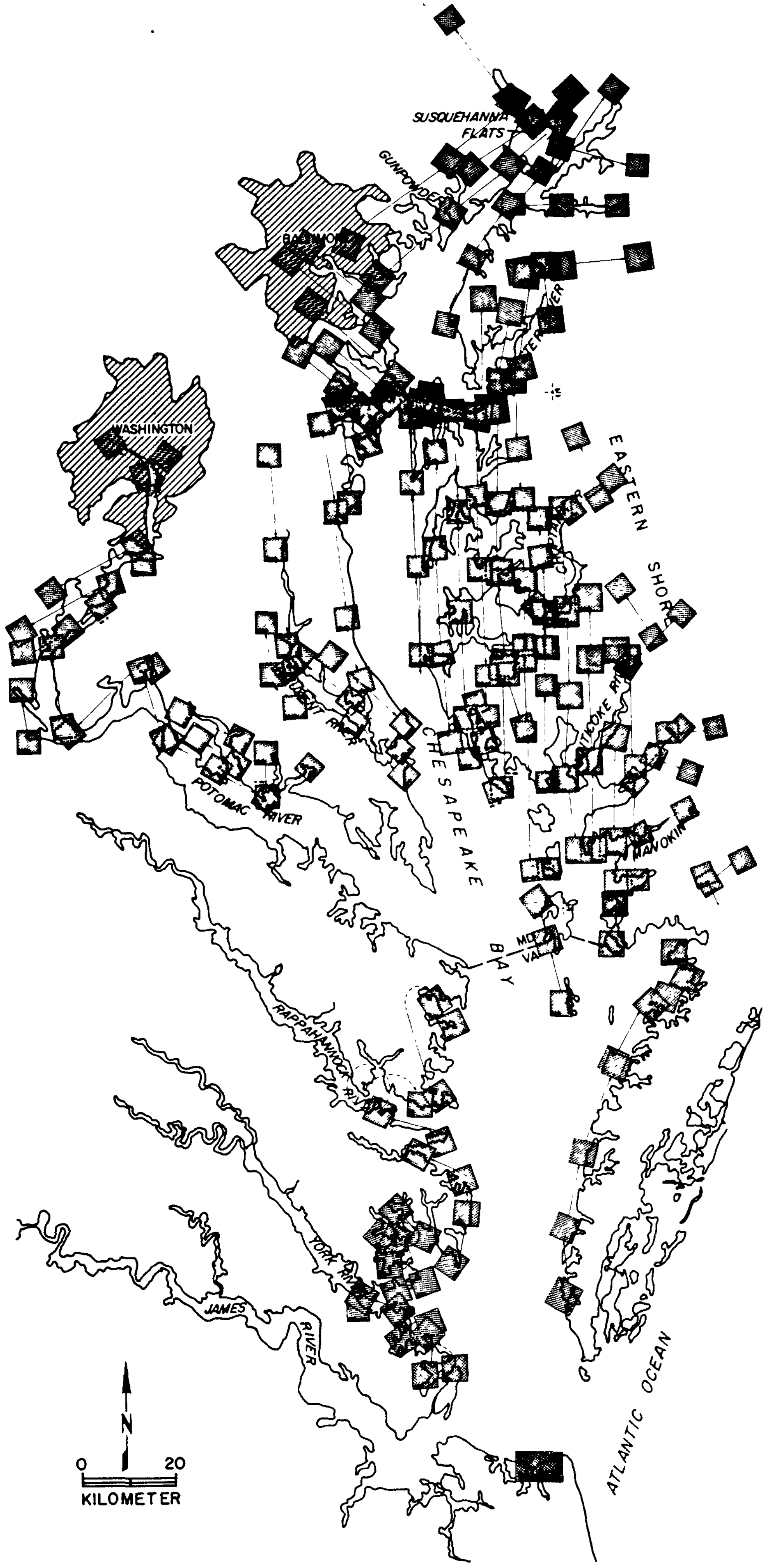

SUSQUEHANNA
FLATS
WASHINGTON
EASTERN
SHORE
CHESAPEAKE
BAY
POTOMAC RIVER
RAPPAHANNOCK RIV
YORK RIV
JAMES
RIVER
ATLANTIC OCEAN
N
0
20
KILOMETER

TABLE 1. GUIDELINES FOLLOWED DURING ACQUISITION OF AERIAL PHOTOGRAPHS.

1. Tidal Stage - Photography was acquired at low tide, +/- 0-1.5 ft., as predicted by the National Ocean Survey tables.

2. Plant Growth - Imagery was acquired when growth stages ensured maximum delineation of SAV, and when phenologic stage overlap was greatest.

3. Sun Angle - Photography was acquired when surface reflection from sun glint did not cover more than 30 percent of frame. Sun angle was generally between 20° and 40° to minimize water surface glitter. At least 60 percent line overlap and 20 percent side lap was used to minimize image degradation due to sun glint.

4. Turbidity - Photography was acquired when clarity of water ensured complete delineation of grass beds.

5. Wind - Photography was acquired during periods of no or low wind. Off-shore winds were preferred over on-shore winds when wind conditions could not be avoided.

6. Atmospherics - Photography was acquired during periods of no or low haze and/or clouds below aircraft. There could be no more than scattered or thin broken clouds, or thin overcast above aircraft, to ensure maximum SAV to bottom contrast.

7. Sensor Operation - Photography was acquired in the vertical mode with less than 5 degrees tilt. Scale/altitude/film/focal length combination permitted resolution and identification of one square meter area of SAV (surface).

8. Plotting - Each flight line included sufficient identifiable land area to assure accurate plotting of grass beds.

approximately 12,000 ft yielding a scale of 1:24,000 for the photograph, approximating that of a standard U.S. topographic quadrangle.

The SAV photography for the Maryland waters was obtained by Aero Eco under contract to the Bionetics Corporation (onsite contractor for EPA/EPIC). The camera used by Aero Eco was a Zeiss Jena LMK 15/2323 with a 153 mm (6.02 inch) focal length Zeiss Jena Lamegon PI/C lens. The film used was Kodak 24 cm (9 1/2 inch) square positive Aerochrome MS type 2448. The camera was mounted in the bottom fuselage of Aero Eco's Partenavia P68 Observer, a twin engine high wing reconnaissance aircraft. An antivignetting filter was also used. The photography was also acquired at an approximate altitude of 12,000 feet.

Several problems were encountered during the acquisition of the 1984 aerial photography. Weather patterns consisting of high percentage of cloud cover and haze appeared to be greater than in past years. This effectively reduced the time available to collect the SAV imagery. Poor weather conditions in certain restricted areas, e.g., Dahlgren, Patuxent NAS or around Smith Island, compounded the problem since access to the airspace over these areas was limited to certain hours of each day or certain days only. Both camera and film processing malfunctions, which resulted in the loss of all or portions of some of the flight lines, occurred in 1984, but, where, possible, were supplemented with similar aerial photography acquired in 1983. These problems are further addressed in the next section.

<u>Mapping Process</u>

Fig. 2 gives the location of the topographic quadrangles in the study area. This area includes all regions with a potential for SAV growth. The quadrangles are sequentially numbered to allow for more efficient access to

Figure 2. Location of topographic quadrangles in the Chesapeake Bay and tributaries for determining distribution of SAV.

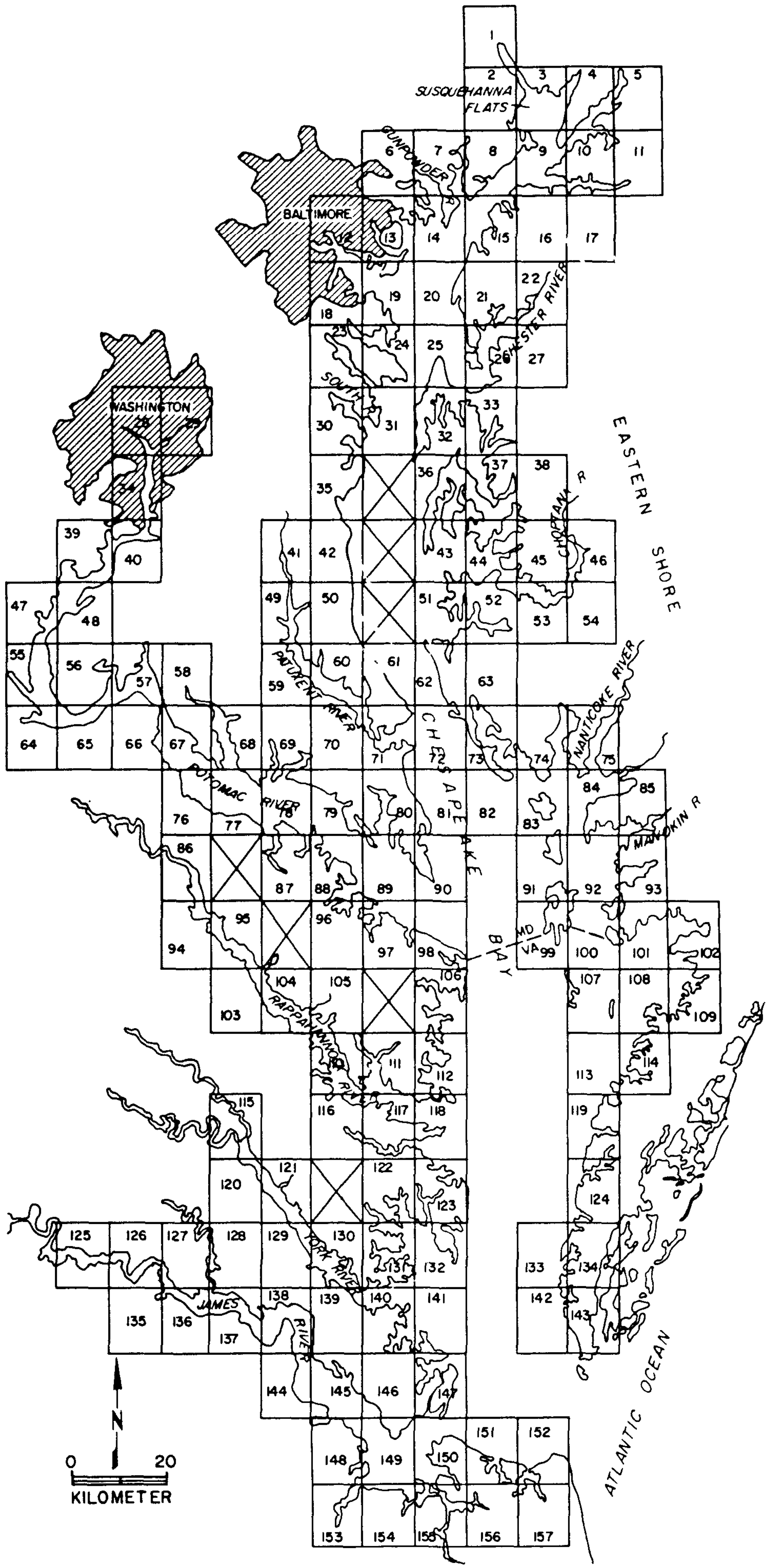

SUSQUEHANNA FLATS
GUNPOWDER R
BALTIMORE
CHESTER RIVER
SOUTH R
WASHINGTON
EASTERN SHORE
CHOPTANK R
PATUXENT RIVER
NANTICOKE RIVER
POTOMAC RIVER
MANOKIN R
CHESAPEAKE BAY
MD
VA
RAPPAHANNOCK R
YORK RIVER
JAMES RIVER
ATLANTIC OCEAN
N
0
20
KILOMETER

TABLE 2. LIST OF USGS 7.5-MINUTE QUADRANGLES IN CHESAPEAKE BAY SAV STUDY AREA AND CORRESPONDING CODE NUMBERS (SEE FIG. 2 FOR LOCATION OF QUADRANGLES. THOSE TOPOGRAPHIC QUADRANGLES WITH SAV BEDS CAN BE FOUND IN APPENDIX B).

---

1. Conowingo Dam, Md.-Pa.
2. Aberdeen, Md.
3. Havre de Grace, Md.
4. North East, Md.
5. Elkton, Md.
6. White Marsh, Md.
7. Edgewood, Md.
8. Perryman, Md.
9. Spesutie, Md.
10. Earleville, Md.
11. Cecilton, Md.
12. Baltimore East, Md.
13. Middle River, Md.
14. Gunpowder Neck, Md.
15. Hanesville, Md.
16. Betterton, Md.
17. Galena, Md.
18. Curtis Bay, Md.
19. Sparrows Point, Md.
20. Swan Point, Md.
21. Rock Hall, Md.
22. Chestertown, Md.
23. Round Bay, Md.
24. Gibson Island, Md.
25. Love Point, Md.
26. Langford Creek, Md.
27. Centreville, Md.
28. Washington West, Md.-DC-Va.
29. Washington East, DC-Md.
30. South River, Md.
31. Annapolis, Md.
32. Kent Island, Md.
33. Queenstown, Md.
34. Alexandria, Va.-Md.
35. Deale, Md.
36. Claiborne, Md.
37. St. Michaels, Md.
38. Easton, Md.
39. Fort Belvoir, Va.-Md.
40. Mt. Vernon, Va.-Md.
41. Lower Marlboro, Md.
42. North Beach, Md.
43. Tilghman, Md.
44. Oxford, Md.
45. Trappe, Md.
46. Preston, Md.
47. Quantico, Va.-Md.
48. Indian Head, Va.-Md.
49. Benedict, Md.
50. Prince Frederick, Md.
51. Sharps Island, Md.
52. Church Creek, Md.
53. Cambridge, Md.
54. East New Market, Md.
55. Widewater, Va.-Md.
56. Nanjemoy, Md.
57. Mathias Point, Md.-Va.
58. Popes Creek, Md.
59. Mechanicsville, Md.
60. Broomes Island, Md.
61. Cove Point, Md.
62. Taylors Island, Md.
63. Golden Hill, Md.
64. Passapatanzy, Md.-Va.
65. King George, Va.-Md.
66. Dahlgren, Va.-Md.
67. Colonial Beach North, Va.-Md.
68. Rock Point, Md.
69. Leonardtown, Md.
70. Hollywood, Md.
71. Solomons Island, Md.
72. Barren Island, Md.
73. Honga, Md.
74. Wingate, Md.
75. Nanticoke, Md.
76. Colonial Beach South, Va.-Md.

continued

TABLE 2. (continued)

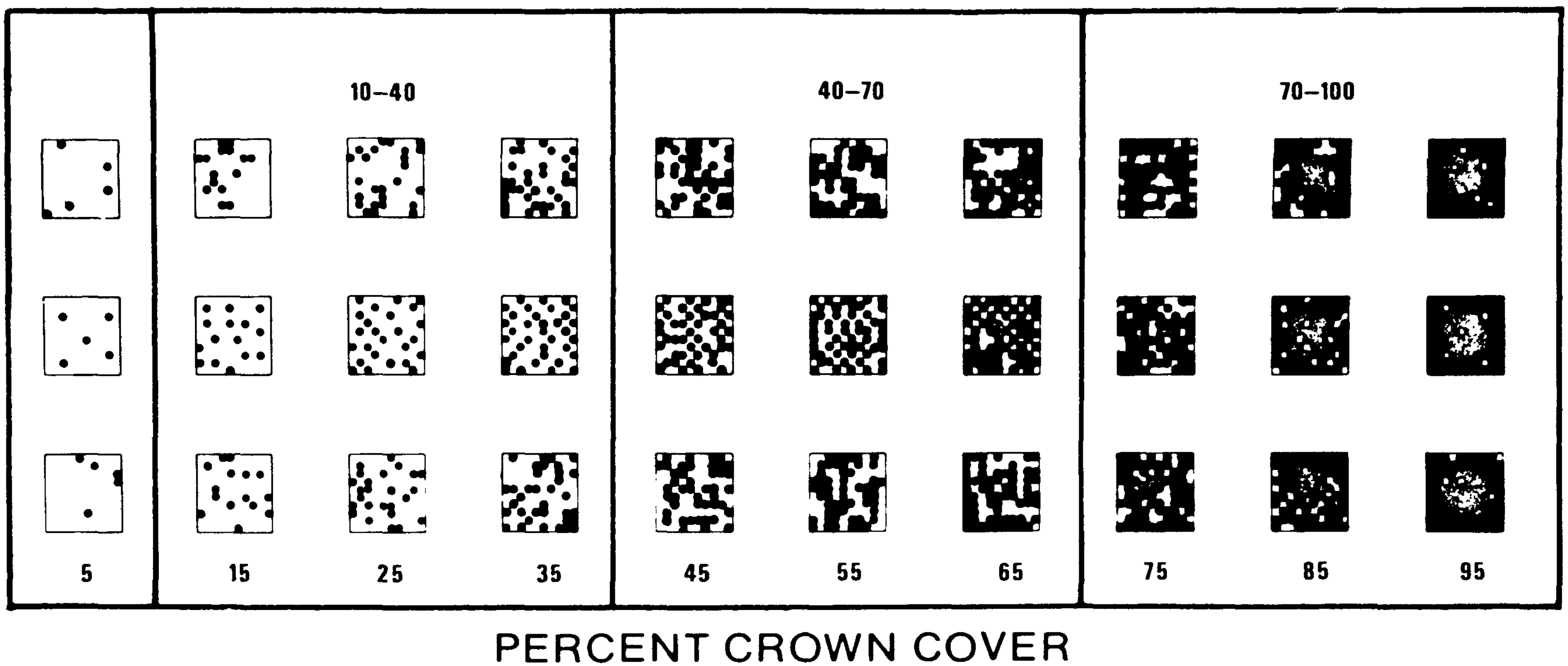
77. Stratford Hall, Va.-Md.	118. Deltaville, Va.
78. St. Clements Island, Va.-Md.	119. Jamesville, Va.
79. Piney Point, Va. Md.	120. Toano, Va.
80. St. Marys City, Md.	121. Gressitt, Va.
81. Point No Point, Md.	122. Ware Neck, Va.
82. Richland Point, Md.	123. Mathews, Va.
83. Bloodsworth Island, Md.	124. Franktown, Va.
84. Deal Island, Md.	125. Westover, Va.
85. Monie, Md.	126. Charles City, Va.
86. Champlain, Va.	127. Brandon, Va.
87. Machodoc, Va.	128. Norge, Va.
88. Kinsale, Va.-Md.	129. Williamsburg, Va.
89. St. George Island, Va.-Md.	130. Clay Bank, Va.
90. Point Lookout, Md.	131. Achilles, Va.
91. Kedges Straits, Md.	132. New Point Comfort, Va.
92. Terrapin Sand Point, Md.	133. Cape Charles, Va.
93. Marion, Md.	134. Cheriton, Va.
94. Mount Landing, Va.	135. Savedge, Va.
95. Tappahannock, Va.	136. Claremont, Va.
96. Lottsburg, Va.	137. Surry, Va.
97. Heathsville, Va.-Md.	138. Hog Island, Va.
98. Burgess, Va.-Md.	139. Yorktown, Va.
99. Ewell, Va.-Md.	140. Poquoson West, Va.
100. Great Fox Island, Va.-Md.	141. Poquoson East, Va.
101. Crisfield, Va.-Md.	142. Elliotts Creek, Va.
102. Saxis, Va.-Md.	143. Townsend, Va.
103. Dunnsville, Va.	144. Bacons Castle, Va.
104. Morattico, Va.	145. Mulberry Island, Va.
105. Lively, Va.	146. Newport News North, Va.
106. Reedville, Va.	147. Hampton, Va.
107. Tangier Island, Va.	148. Benns Church, Va.
108. Chesconessex, Va.	149. Newport News South, Va.
109. Parksley, Va.	150. Norfolk North, Va.
110. Urbanna, Va.	151. Little Creek, Va.
111. Irvington, Va.	152. Cape Henry, Va.
112. Fleets Bay, Va.	153. Chuckatuck, Va.
113. Nandua Creek	154. Bowers Hill, Va.
114. Pungoteague, Va.	155. Norfolk South, Va.
115. West Point, Va.	156. Kempsville, Va.
116. Saluda, Va.	157. Princess Anne, Va.
117. Wilton, Va.	

the data. Table 2 gives the corresponding names of the 157 quadrangles shown in Fig. 2.

SAV beds were identified on the photographs using all available information, including knowledge of aquatic grass signatures on the film, areas of grass coverage from previous flights, ground information, and aerial visual surveys. Mylar topographic quadrangles (1:24,000) were used in the mapping process. Delineation of SAV bed boundaries was facilitated by superimposing on a light table the appropriate mylar quadrangle with the transparent photograph. SAV boundaries were delineated on the mylar map with a pencil. Where minor scale differences were evident between the photograph and quadrangle or where significant shoreline erosion or accretion had occurred since production of the map, a best fit was obtained, or shoreline changes were noted on the quadrangle. Areas of SAV beds were derived from the 1:24,000 scale topographic quadrangle. Measurements were made on a Numonics Graphics Calculator, model 1224 for the lower bay. EPIC utilized a Calma Graphic Interactive Image Analysis System based on a Data General Eclipse S230 minicomputer for upper bay areas. Each SAV bed was digitized three times and the area reported as the average of the three. Each of the three measurements was generally within 5% of the mean.

In addition to the boundaries of the SAV bed, an estimate of percent cover within each bed was made visually in comparison with an enlarged Crown Density Scale, similar to those developed for estimating of forest tree crown cover from aerial photography (Fig. 3). Bed density was classified into one of four categories based on a subjective comparison with the density scale. These were: 1. very sparse; <10%, 2. sparse, 10 to 40%; 3. moderate, 40 to 70%; or 4. dense, 70-100%. Either the entire bed, or subsections within the bed, were assigned a number (1 to 4) corresponding to

Figure 3. Crown density scale used for determining density of SAV beds: very sparse (1), 0-10%; sparse (2), 10-40%; moderate (3), 40-70%; dense (4), 70-100%.



10–40
40–70
70–100
5
15
25
35
45
55
65
75
85
95
PERCENT CROWN COVER

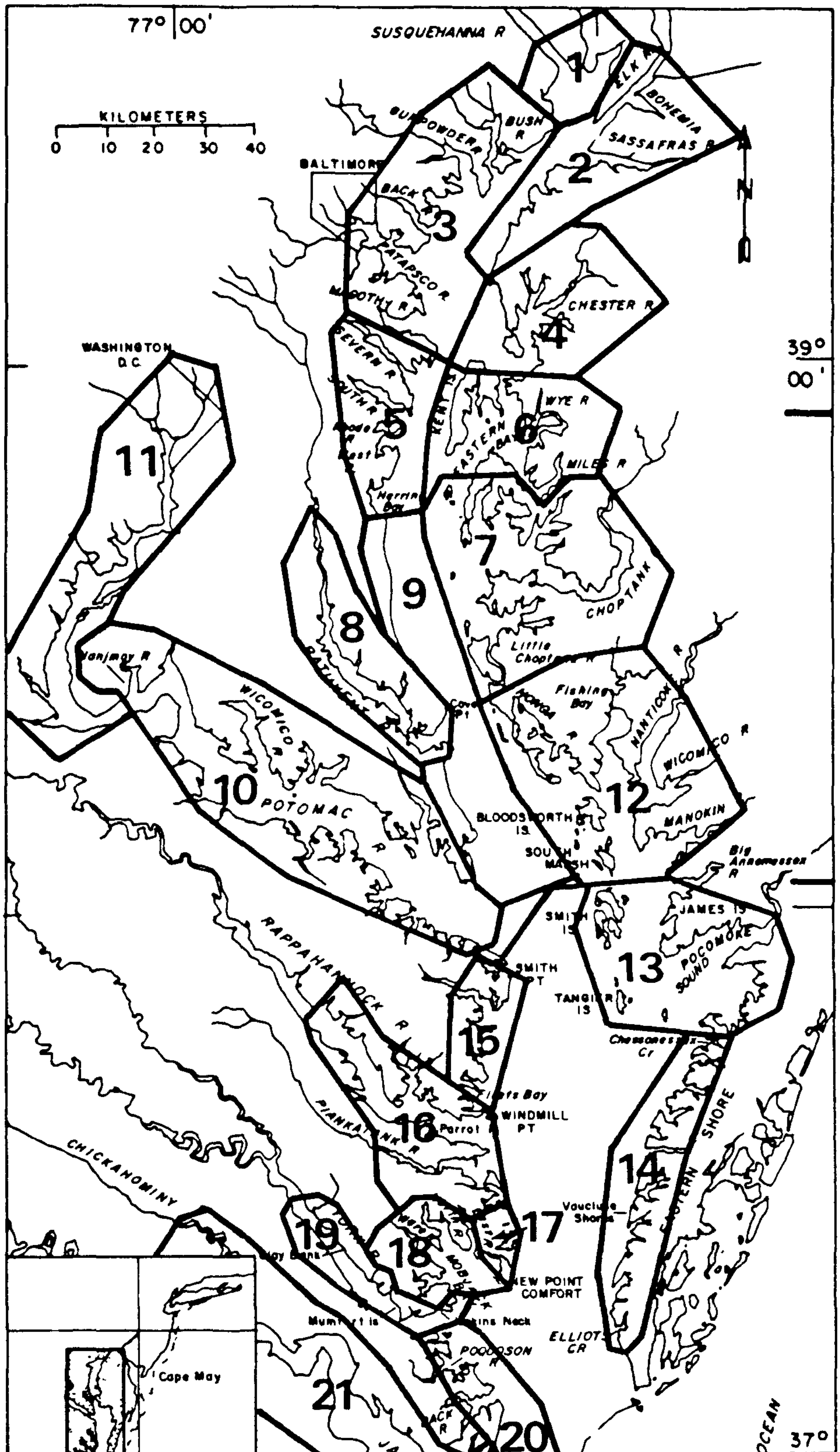
the above density categories. In addition to the density scale, each distinct SAV unit was given a letter designation for proper identification for future comparisons.

In order to reduce interobserver variability in both the mapping and digitizing process, steps were taken to insure quality assurance. Sections from several areas in both Maryland and Virginia containing SAV were independently mapped and assigned a density classification. Results were compared for compatability of mapping effort. In addition, mapped sections were independently digitized for similar comparisons.

The discussion of the distribution of SAV has been organized into three zones as established by Orth and Moore (1982). The area between the mouth of the bay to a line stretching from the mouth of the Potomac River at Smith Point in Virginia to just above Smith Island and extending across to the north shore at the mouth of the Big Annemessex River is referred to as the Lower Bay zone (Fig. 4). The area between the north shore of the Big Annemessex River and the south shore of the Potomac River to the Chesapeake Bay bridge at Kent Island is referred to as the Middle Bay zone. The area between the Chesapeake Bay bridge and the Susquehanna Flats is referred to as the Upper Bay zone. The salinity within each zone roughly coincides with the major salinity zones of estuaries; polyhaline (18-25°/oo), Lower zone; mesohaline (5-18°/oo), Middle zone; oligohaline (0.5-5°/oo), Upper zone. Although the major rivers and smaller tributaries of the bay have their own salinity regimes, the distributions of SAV in each river are discussed within the zone where it connects to the bay proper.

In addition, twenty one major sections of the bay are identified for more detailed discussion of SAV distribution (Orth and Moore, 1982) (Fig. 4, Table 3). These sections denote relatively distinct parts of the bay that

Figure 4. Location of upper, middle and lower zones of the Chesapeake Bay and the 21 major sections used for delineation of SAV distribution patterns (see Table 3 and text for exact boundaries).



UPPER
MIDDLE
LOWER
77° 00'
39° 00'
37° 00'
KILOMETERS
0 10 20 30 40
N
SUSQUEHANNA R
BUSH R
ELK R
BOHEMIA R
SASSAFRAS R
BALTIMORE
BACK R
PATAPSCO R
MAGOTHY R
CHESTER R
SEVERN R
SOUTH R
WYE R
MILES R
WASHINGTON D.C.
CHOPTANK
Little Choptank R
PATUXENT R
Fishing Bay
NANTICOKE R
WICOMICO R
MANOKIN
Big Annemessex R
BLOODSWORTH IS.
SOUTH MARSH
SMITH IS.
JAMES IS.
POCOMOKE SOUND
TANGIER IS.
SMITH PT
POTOMAC R
RAPPAHANNOCK R
PIANKATANK R
WINDMILL PT
CHICKAHOMINY
NEW POINT COMFORT
EASTERN SHORE
ELLIOT CR
POQUOSON R
JAMES R
ATLANTIC OCEAN
Cape May
Cape Henry
Cape Hatteras
1
2
3
4
5
6
7
8
9
10
11
12
13
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16
17
18
19
20
21

TABLE 3. AREA DESCRIPTION FOR EACH OF 21 MAJOR SECTIONS IN THE CHESAPEAKE BAY HAVING SAV.

Section 1. Susquehanna Flats - all areas between and including Spesutie Island and Turkey Point at the mouth of the Elk River to include the Northeast River.

Section 2. Upper Eastern Shore - all areas in the Elk, Bohemia and Sassafras Rivers and SAV in areas on the eastern shore above the Swan Point quadrangle.

Section 3. Upper Western Shore - all areas south of Spesutie Island and north of the bay bridge to include the Bush, Gunpowder, Middle, Patapsco and Magothy Rivers.

Section 4. Chester River - includes all of the Chester River, Eastern Neck, areas north of the bay bridge on Kent Island and south of Swan Point but to include SAV on the Swan Pt. quadrangle.

Section 5. Central Western Shore - all areas south of the bay bridge and north of Holland Point on Herring Bay to include the Severn, South and West Rivers and Herring Bay.

Section 6. Eastern Bay - all areas south of the bay bridge on Kent Island and north of Tilghman Island from Green Marsh Point to include the Wye, East and Miles Rivers, Crab Alley Bay, Prospect Bay and Poplar, Jefferson and Coaches Islands.

Section 7. Choptank River - all areas south of Tilghman Island from Green Marsh Point and north of Taylor Island to include the Choptank and Little Rivers.

Section 8. Patuxent River - all areas in the Patuxent River.

Section 9. Middle Western Shore - all areas south of Holland Point at Herring Bay and north of Point Lookout on the Potomac River but not the mouth of the Patuxent River.

Section 10. Lower Potomac River - all areas between the mouth of the Potomac River to just above the 301 bridge at Nanjemoy Creek.

Section 11. Upper Potomac River - all areas above Nanjemoy Creek to Washington D.C.

Section 12. Middle Eastern Shore - all areas south of Taylor Island and north of but not including the Big Annemessex River to include the Honga, Nanticoke, Wicomico and Manokin Rivers, Fishing Bay, Bloodsworth and South Marsh Islands.

continued

TABLE 3. (continued)

Section 13.	Tangier Island Complex - all areas south of and including the Big Annemessex River and north of but including the northern shore of Chesconessex Creek to include Smith and Tangier Islands, Little Anemessex River and Pocomoke Sound.
Section 14.	Lower Eastern Shore - all areas south of but including the southern shore of Chesconessex Creek and north of Elliots Creek to include Cherrystone Inlet, Hungars, Nassawadox, Occohannock, Nandua, Pungoteague and Onancock Creeks.
Section 15.	Reedville - includes the area between Windmill Point on the Rappahannock River and Smith Point at the mouth of the Potomac River.
Section 16.	Rappahannock River Complex - includes the entire Rappahannock River, Piankatank River and Milford Haven area.
Section 17.	New Point Comfort Region - includes the area fronting the bay from the lighthouse at New Point Comfort north to, but not including, the bay entrance to Milford Haven.
Section 18.	Mobjack Bay Complex - includes the East, North, Ware and Severn Rivers, the north shore of the Mobjack Bay from New Pt. Comfort lighthouse to the North River, and the area around Guinea Neck to include all the SAV around the Guinea Marsh area from the New Point Comfort quadrangle.
Section 19.	York River - all areas along the north shore from Clay Bank to the Guinea Marsh area and includes SAV from the Achilles quadrangle facing the York River and along the south shore to Goodwin Island.
Section 20.	Lower Western Shore - includes all areas south of Goodwin Island to Broad Bay off Lynnhaven Inlet, excluding the James River.
Section 21.	James River - all SAV in the James River including the Chickahominy River.

are readily identifiable from a map. Sections 1 through 4 are located in the Upper Bay zone. Sections 5 through 12 are located in the Middle Bay zone, and sections 13 through 21 are located in the Lower Bay zone. One additional section was added to the original 20 sections denoted by Orth and Moore (1982) to account for a resurgence of SAV in the tidal freshwater and transition zone of the Potomac River. This section had little SAV in 1978.

Orth, et al. (1979) chose six sites in the Lower Bay zone to determine changes in SAV distribution starting in 1937. These sites are Mumfort Island and Jenkins Neck in the York River, East River in the Mobjack Bay, Parrott Island in the Rappahannock River, Fleets Bay located between Windmill Point on the Rappahannock River and Smith Point on the Potomac River and Vaucluse Shores located on the bayside of the eastern shore just above Cape Charles (see Orth, et al. (1979) for further details of these historical sites). Detailed mapping of each historical site was completed in this study similar to the earlier work to provide a 1984 update.

For those areas currently known to contain some SAV where aerial photography could not be obtained in 1984 the quadrangles were noted and determination of SAV abundance from that area was made utilizing low level aerial reconnaissance, aerial photography of these areas in 1983 or 1984 from other sources, anecdotal information or other field surveys indicating the presence of SAV in 1984. In these particular situations, distribution of SAV will be assumed to match what was found in 1978.

<u>Ground Truth and Other Data Bases</u>

For those areas in Virginia where aerial photographic evidence of SAV beds was inconclusive, photoverification was accomplished by ground truthing these sites. This was done principally by small boats and divers snorkeling over the area indicated from the photograph. Since SAV beds in this region contain primarily only one or two species that vary little from year to year, a great deal of ground truth information could be extrapolated from earlier studies (Orth, et al., 1979, 1982; Orth and Moore, 1982).

In Maryland, ground truth data were provided principally from three SAV surveys conducted in 1984, from an SAV transplanting project and an ongoing SAV research project. Two field surveys were conducted in the Potomac River. The first survey was conducted along the transition zone by the NVCC (Allaire, et al., 1985). The area covered consisted of 150 miles of shoreline from Quantico Creek and Chicamuxen Creek in the north to the 301 bridge in the south (Fig. 5). The second survey was conducted by the USGS (Carter, et al., 1985a; Rybicki, et al., 1985) and included the area from the Chain Bridge at Washington, D.C. to the Wicomico River just below the 301 bridge (Fig. 6). Earlier surveys of the Potomac River by the USGS included sections of the river south of the Wicomico River to the mouth of the Potomac River (Carter, et al., 1985b; Haramis and Carter, 1983). Methods used in these two surveys were similar: either sampling along pre determined transects or marked grids using modified oyster tongs to estimate species presence and their standing crop. Visual observations were also used for species identification. Additional information of these surveys is available in the above-mentioned reports.

The third survey is the annual large scale multi-station survey conducted by the Md.DNR. This survey, conducted from June through August, samples 600+ randomly selected stations in certain areas of the bay from the Susquehanna Flats to Smith Island. At each station, samples are also collected with modified oyster tongs and species presence or absence, as well as standing crop, recorded.

Figure 5. Location diagram and USGS 1:24,000 quadrangle index for NVCC Potomac River SAV shoreline study. Numbers under quadrangle name indicate number of vegetated grids and the total number of grids located in that quadrangle (from Allaire, et al., 1985).

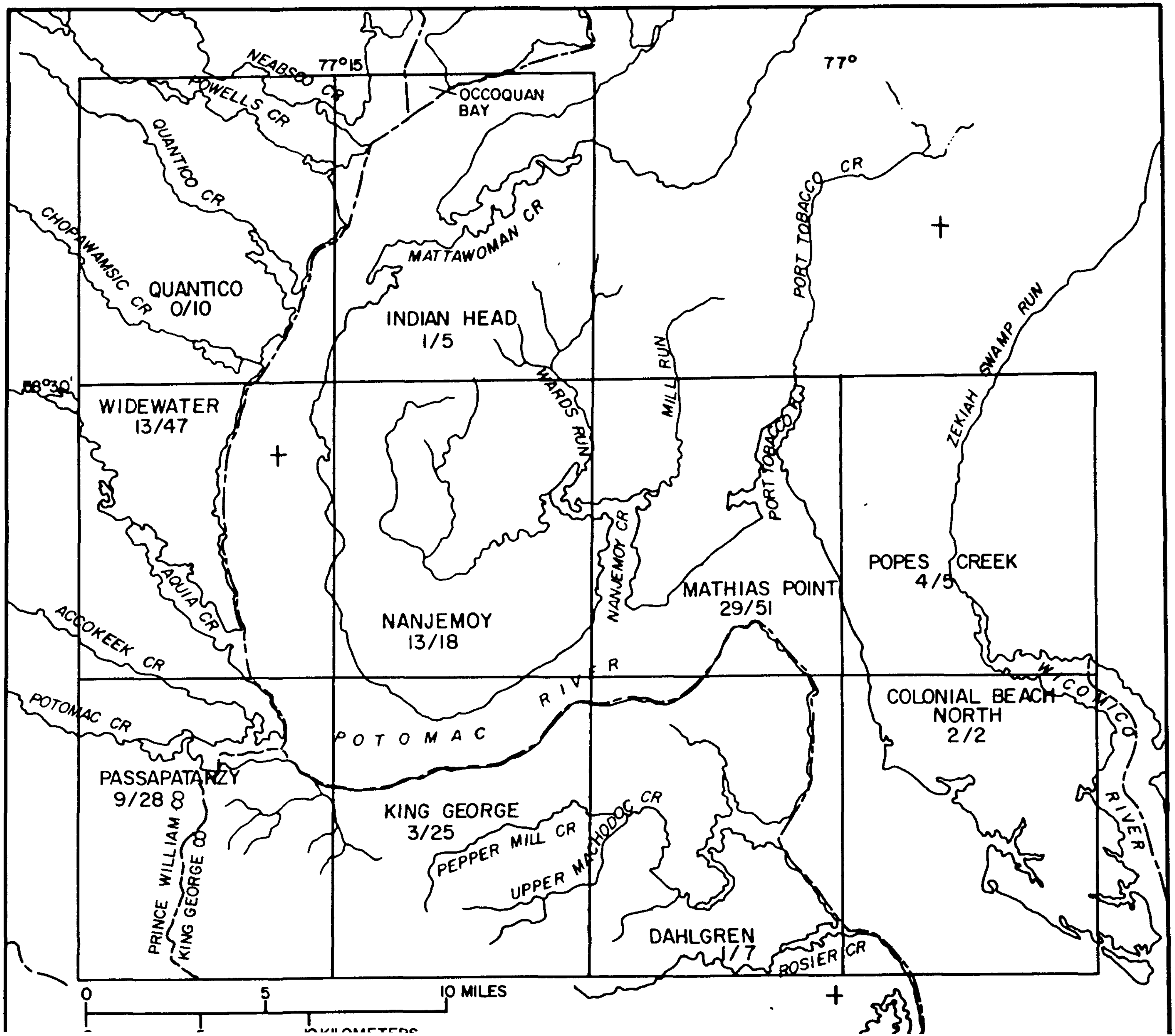
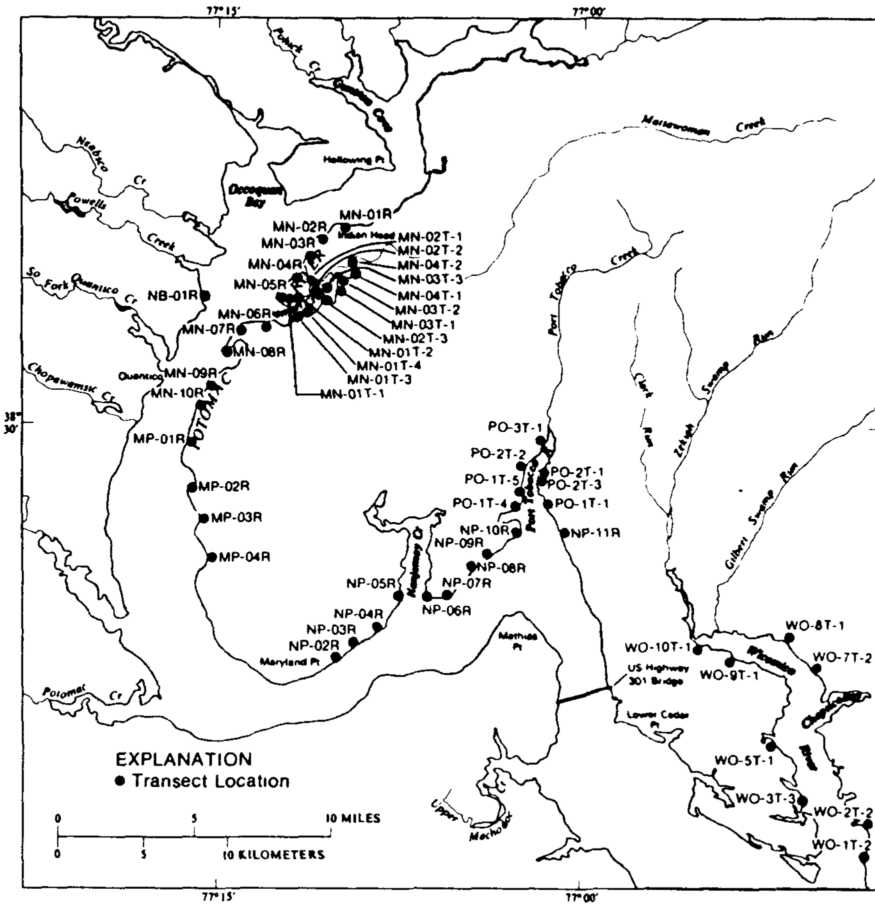
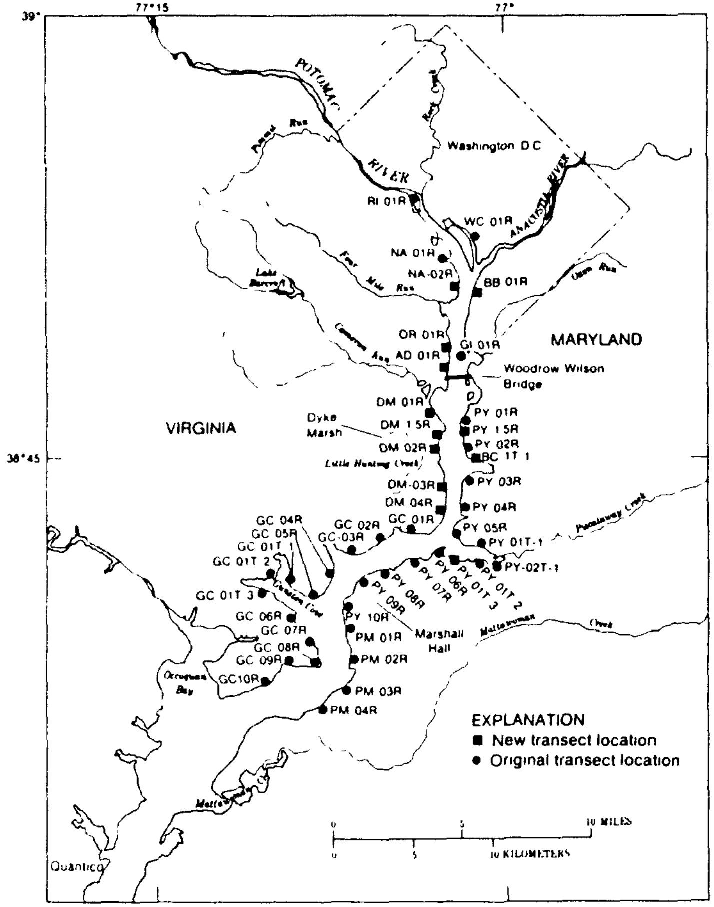

77°15
77°
38°30'
OCCOQUAN BAY
NEABSCO CR
POWELLS CR
QUANTICO CR
CHOPAWAMSIC CR
QUANTICO 0/10
MATTAWOMAN CR
INDIAN HEAD 1/5
PORT TOBACCO CR
ZEKIAH SWAMP RUN
WARDS RUN
MILL RUN
WIDEWATER 13/47
NANJEMOY 13/18
NANJEMOY CR
PORT TOBACCO R
MATHIAS POINT 29/51
POPES CREEK 4/5
AQUIA CR
ACCOKEEK CR
POTOMAC CR
POTOMAC RIVER
WICOMICO RIVER
COLONIAL BEACH NORTH 2/2
PASSAPATANZY 9/28
KING GEORGE 3/25
PEPPER MILL CR
UPPER MACHODOC CR
PRINCE WILLIAM
KING GEORGE
DAHLGREN 1/7
ROSIER CR
0
5
10 MILES

Figure 6. Location of vegetation sampling transects in the tidal and transition portion of the Potomac River used by the U. S. Geological Survey for determining SAV distribution patterns (from Carter, et al., 1985a).



77°15'
77°00'
38° 30'
POTOMAC
Occoquan Bay
Port Tobacco Creek
Mattawoman Creek
Wicomico River
Quantico
Maryland Pt
Mathias Pt
US Highway 301 Bridge
Lower Cedar Pt
MN-01R
MN-02R
MN-03R
MN-04R
MN-05R
MN-06R
MN-07R
MN-08R
MN-09R
MN-10R
MN-02T-1
MN-02T-2
MN-04T-2
MN-03T-3
MN-04T-1
MN-03T-2
MN-03T-1
MN-02T-3
MN-01T-2
MN-01T-4
MN-01T-3
MN-01T-1
NB-01R
MP-01R
MP-02R
MP-03R
MP-04R
NP-02R
NP-03R
NP-04R
NP-05R
NP-06R
NP-07R
NP-08R
NP-09R
NP-10R
NP-11R
PO-3T-1
PO-2T-2
PO-1T-5
PO-1T-4
PO-2T-1
PO-2T-3
PO-1T-1
WO-10T-1
WO-9T-1
WO-8T-1
WO-7T-2
WO-5T-1
WO-3T-3
WO-2T-2
WO-1T-2
EXPLANATION
● Transect Location
0 5 10 MILES
0 5 10 KILOMETERS



39°
77°15
77°
38°45
POTOMAC RIVER
ANACOSTIA RIVER
Washington D C
MARYLAND
VIRGINIA
Woodrow Wilson Bridge
Dyke Marsh
Marshall Hall
Quantico
RI 01R
WC 01R
NA 01R
NA-02R
BB 01R
OR 01R
AD 01R
GI 01R
DM 01R
DM 1 5R
DM 02R
DM-03R
DM 04R
PY 01R
PY 1 5R
PY 02R
BC 1T 1
PY 03R
PY 04R
PY 05R
PY 01T-1
PY-02T-1
PY 01T 2
PY 01T 3
PY 06R
PY 07R
PY 08R
PY 09R
PY 10R
PM 01R
PM 02R
PM 03R
PM 04R
GC 01R
GC 02R
GC-03R
GC 04R
GC 05R
GC 01T 1
GC 01T 2
GC 01T 3
GC 06R
GC 07R
GC 08R
GC 09R
GC10R
EXPLANATION
■ New transect location
● Original transect location
0 5 10 MILES
0 5 10 KILOMETERS

The SAV transplanting project is being conducted on the Susquehanna Flats by Stan Kollar of Harford Community College. Information provided by his work is in the form of species presence by percentage, primarily by visual estimates.

An SAV research group at UMdHPL headed by Mike Kemp also provided ground truth data. Robert Twilley of their group annotated maps of their six study sites on the Choptank River, indicating status of SAV from 1980 to 1984 at each site. No information on percent cover was available.

In addition to 1984 collateral data, a visual aerial survey of the Susquehanna River, the Northeast River and the upper Bush River was conducted in 1982 by Dr. Richard Anderson, under contract to Martin Marietta. SAV data were annotated onto USGS 7.5-minute quadrangles from low level (300-500 feet) observations. Species information was provided, but no percent cover values were obtained.

SECTION 4

RESULTS AND DISCUSSION

The results of the 1984 SAV aerial and ground surveys of the entire bay and its tributaries showed the presence of extensive stands of vegetation in a number of locations throughout the bay as well as the continued absence of SAV beds in areas where they were once abundant.

Table 4 presents hectares of SAV for those quadrangles where vegetation was observed in 1984 and 1978. Table 5 presents the total hectares of SAV for each of the 21 sections and the 3 zones for both 1984 and 1978. Table 6 presents the total square meters of SAV in those topographic quadrangles found in each of the 21 sections. Table 7 presents the square meters of SAV in each of the four density classes (1-4) for those quadrangles having SAV only.

Given the constraints of the 1984 data set (see methods and succeeding sections where problems occurred), it was estimated that there were 15,400 hectares of SAV in 1984 compared to 16,637 found in 1978. Increases of SAV were observed in the following sections: Susquehanna Flats, Upper Eastern Shore, Upper Potomac River, Tangier Island Complex, Lower Eastern Shore, New Point Comfort, Lower Western Shore and York River. Decreases were observed in the Upper Western Shore, Chester River, Central Western Shore, Eastern Bay, Choptank River, Patuxent River, Middle Western Shore, Lower Potomac River, Middle Eastern Shore, Reedville, Rappahannock River, Mobjack Bay and James River sections. The Lower Bay zone showed an 18% increase in SAV abundance from 1978 to 1984 with 9400 hectares mapped in 1978 and 11,116 hectares mapped in 1984. The Middle Bay zone showed a reduction in SAV of 77% in this time period (4,446 to 984 hectares) while SAV in the Upper Bay zone increased 13% (792 to 3168 hectares).

TABLE 4. TOTAL AREA OF SAV IN HECTARES BY TOPOGRAPHIC QUADRANGLES FOR 1978 AND 1984.

	QUANDRANGLE	1978	1984
1.	Conowingo Dam, Md.-Pa.	-	-
2.	Aberdeen, Md.	-	0
3.	Havre de Grace, Md.	803.67	1741.85
4.	North East, Md.	5.62	13.31
5.	Elkton, Md.	.75	0
6.	White Marsh, Md.	-	0
7.	Edgewood, Md.	10.48	49.81+
8.	Perryman, Md.	-	2.01
9.	Spesutie, Md.	.84	411.38
10.	Earleville, Md.	4.67	3.47
11.	Cecilton, Md.	-	0
12.	Baltimore East, Md.	-	0
13.	Middle River, Md.	90.06	0
14.	Gunpowder Neck, Md.	200.71	183.99+
15.	Hanesville, Md.	9.31	5.48
16.	Betterton, Md.	6.40	5.74
17.	Galena, Md.	1.46	11.88
18.	Curtis Bay, Md.	33.40	0
19.	Sparrows Pt., Md.	10.52	0
20.	Swan Point, Md.	29.86	18.65
21.	Rock Hall, Md.	127.25	30.13
22.	Chestertown, Md.	12.31	0
23.	Round Bay, Md.	137.15	0
24.	Gibson Island, Md.	139.45	7.61
25.	Love Point, Md.	11.81	0
26.	Langford Creek, Md.	1255.20	599.72
27.	Centreville, Md.	38.75	0
28.	Washington West, Md.-DC-Va.	-	0++
29.	Washington East, DC-Md.	-	0
30.	South River, Md.	15.14	0
31.	Annapolis, Md.	27.15	0
32.	Kent Island, Md.	513.68	26.28
33.	Queenstown, Md.	492.10	89.45
34.	Alexandria, Va.-Md.	-	160.40
35.	Deale, Md.	61.51	0
36.	Claiborne, Md.	421.08	52.25
37.	St. Michaels, Md.	366.09	11.14
38.	Easton, Md.	1.19	0
39.	Fort Belvoir, Va.-Md.	-	.91
40.	Mt. Vernon, Va.-Md.	-	420.34
41.	Lower Marlboro, Md.	-	0
42.	North Beach, Md.	-	0

continued

TABLE 4. (continued)

43.	Tilghman, Md.	478.15	6.87
44.	Oxford, Md.	562.96	23.25
45.	Trappe, Md.	64.75	0
46.	Preston, Md.	-	0
47.	Quantico, Va.-Md.	-	0
48.	Indian Head, Va.-Md.	-	0++
49.	Benedict, Md.	1.58	0
50.	Prince Frederick, Md.	-	0
51.	Sharps Island, Md.	377.08	4.42
52.	Church Creek, Md.	208.94	9.00
53.	Cambridge, Md.	48.96	0
54.	East New Market, Md.	-	0
55.	Widewater, Va.-Md.	-	4.59
56.	Nanjemoy, Md.	28.03	30.92
57.	Machias Pt., Md.-Va.	194.12	121.11
58.	Popes Creek, Md.	-	0
59.	Mechanicsville, Md.	13.62	0
60.	Broomes Island, Md.	4.94	4.37
61.	Cove Pt., Md.	2.97	3.75
62.	Taylors Island, Md.	-	8.55
63.	Golden Hill, Md.	-	.42
64.	Passapatanzy, Md.-Va.	-	0
65.	King George, Va.-Md.	2.25	13.44
66.	Dahlgren, Va.-Md.	8.32	2.67
67.	Colonial Beach North, Va.-Md.	87.44	25.63
68.	Rock Pt., Md.	22.85	0
69.	Leonardtown, Md.	2.44	0
70.	Hollywood, Md.	-	0
71.	Solomons Island, Md.	10.54	.76
72.	Barren Island, Md.	-	0
73.	Honga, Md.	126.94	5.05
74.	Wingate, Md.	2.64	8.81
75.	Nanticoke, Md.	-	0
76.	Colonial Beach South, Va.-Md.	61.95	11.26
77.	Stratford Hall, Va.-Md.	5.53	2.16
78.	St. Clements Island, Va.-Md.	.13	0
79.	Piney Point, Va.-Md.	-	-
80.	St. Marys City, Md.	-	-
81.	Point-No-Point, Md.	-	-
82.	Richland Pt., Md.	.73	.38
83.	Bloodsworth Island, Md.	66.07	18.29
84.	Deal Island, Md.	3.01	0
85.	Monie, Md.	9.15	0
86.	Champlain, Va.	-	-
87.	Machodoc, Va.	-	-
88.	Kinsale, Va.-Md.	-	-

continued

TABLE 4. (continued)

89.	St. George Island, Va.-Md.	-	-
90.	Point Lookout, Md.	-	-
91.	Kedges Straits, Md.	156.09	366.42
92.	Terrapin Sand Point, Md.	314.48	187.00
93.	Marion, Md.	289.33	0
94.	Mount Landing, Va.	-	-
95.	Tappahannock, Va.	-	-
96.	Lottsburg, Va.	-	-
97.	Heathsville, Va.-Md.	-	-
98.	Burgess, Va.-Md.	-	-
99.	Ewell, Va.-Md.	1483.30	2308.58
100.	Great Fox Island, Va.-Md.	540.65	807.81
101.	Crisfield, Va.-Md.	7.48	113.01
102.	Saxis, Va.-Md.	-	-
103.	Dunnsville, Va.	-	-
104.	Morattico, Va.	-	-
105.	Lively, Va.	-	-
106.	Reedville, Va.	230.40	108.56
107.	Tangier Island, Va.	405.06	614.44
108.	Chesconessex, Va.	482.54	808.61
109.	Parksley, Va.	80.35	264.80
110.	Urbanna, Va.	-	-
111.	Irvington, Va.	5.31	9.33
112.	Fleets Bay, Va.	133.23	155.45
113.	Nandua Creek, Va.	184.86	345.10
114.	Pungoteague, Va.	401.63	716.76
115.	West Point, Va.	-	-
116.	Saluda, Va.	-	-
117.	Wilton, Va.	10.43	0
118.	Deltaville, Va.	59.43	6.62
119.	Jamesville, Va.	406.04	367.36
120.	Toano, Va.	-	-
121.	Gressitt, Va.	-	-
122.	Ware Neck, Va.	256.00	203.15
123.	Mathews, Va.	63.88	30.32
124.	Franktown, Va.	504.49	395.26
125.	Westover, Va.	-	-
126.	Charles City, Va.	-	-
127.	Brandon, Va.	-	-
128.	Norge, Va.	46.48	46.48**
129.	Williamsburg, Va.	-	-
130.	Clay Bank, Va.	-	-
131.	Achilles, Va.	797.92	741.50
132.	New Point Comfort, Va.	1096.31	1092.71
133.	Cape Charles, Va.	321.42	308.32
134.	Cheriton, Va.	85.20	55.99

continued

TABLE 4. (continued)

135.	Savedge, Va.	-	-
136.	Claremont, Va.	-	-
137.	Surry, Va.	-	-
138.	Hog Island, Va.	-	-
139.	Yorktown, Va.	1.92	0.23
140.	Poquoson West, Va.	210.44	216.93
141.	Poquoson East, Va.	516.63	687.16
142.	Elliots Creek, Va.	44.58	14.48
143.	Townsend, Va.	42.70	4.80
144.	Bacons Castle, Va.	-	-
145.	Mulberry Island, Va.	-	-
146.	Newport News North, Va.	-	-
147.	Hampton, Va.	218.25	233.15
148.	Benns Church, Va.	-	-
149.	Newport News South, Va.	1.87	0
150.	Norfolk North, Va.	-	-
151.	Little Creek, Va.	-	0
152.	Cape Henry, Va.	*	37.87
153.	Chuckatuck, Va.	-	-
154.	Bowers Hill, Va.	-	-
155.	Norfolk South, Va.	-	-
156.	Kempsville, Va.	-	-
157.	Princess Anne, Va.	-	-
	TOTAL	16,636.39	15,399.70

NOTES:
- \- indicates quadrangle not photographed and assumed to have no SAV
- 0 indicates quadrangle photographed and no SAV noted
- * area not flown in 1978 but most likely had SAV in 1978 based on data collected in subsequent years
- ** area not photographed in 1984. Area known to still have SAV. We made the assumption that the 1984 distribution would be similar to the 1978 distribution.
- + Information on SAV distribution taken from 1983 aerial photographs provided by Willie Burton of Martin Marietta Corp.
- ++ Presence of SAV beds not detected from 1984 aerial photography. Information provided by Virginia Carter of the USGS for the 1984 Potomac River Shoreline Survey indicated presence of SAV.

TABLE 5. NUMBERS OF HECTARES OF BOTTOM COVERED WITH SUBMERGED AQUATIC VEGETATION IN 1978 AND 1984 FOR DIFFERENT SECTIONS WITHIN THE THREE ZONES IN THE CHESAPEAKE BAY (DATA FOR 1978 FROM ORTH, et al., 1979 AND ANDERSON AND MACOMBER, 1980.

Section	1978		1984	
	Hectares	Zone	Hectares	Zone
1. Susquehanna Flats	804+		2150	
2. Upper Eastern Shore	29	Upper	43	Upper
3. Upper Western Shore	484	2792	244	3168
4. Chester River	1475	hectares	731	hectares
5. Central Western Shore	241		0	
6. Eastern Bay	1800		66	
7. Choptank River	1740	Middle	82	Middle
8. Patuxent River	34	4446	9	984
9. Middle Western Shore	11	hectares	0	hectares
10. Lower Potomac River	410		194	
11. Upper Potomac River	0*		600	
12. Middle Eastern Shore	210		33	
13. Tangier Island Complex	3759		5447	
14. Lower Eastern Shore	1991		2232	
15. Reedville	364		264	
16. Rappahannock River Complex	93	Lower	23	Lower
17. New Point Comfort Region	271	9399	299	11,248
18. Mobjack Bay Complex	1785	hectares	1550	hectares
19. York River	157		238	
20. Lower Western Shore	925		1149	
21. James River	54		46	
TOTAL	16,637		15,400	

+1978 data for Susquehanna Flats remapped and digitized to allow for greater compatability to 1984 data.

*No aerial photography was taken of this area in 1978 and that the absence of SAV is based on ground survey observations by the USGS.

TABLE 6. NUMBER OF SQUARE METERS OF SAV IN EACH QUADRANGLE CONTAINED WITHIN THE 21 SECTIONS FOR 1984

SECTION	QUADRANGLE	AREA
Susquehanna Flats - 1	Conowingo Dam (1)	0
	Aberdeen (2)	0
	Havre de Grace (3)	17,418,496
	North East (4)	0
	Perryman (8)	0
	Spesutie (9)	4,082,974
		21,501,470 sq.m = 2150.15 hectares = 5310.86 acres
Upper Eastern Shore - 2	North East (4)	133,146
	Elkton (5)	0
	Perryman (8)	0
	Spesutie (9)	22,526
	Earleville (10)	34,703
	Cecilton (11)	0
	Gunpowder Neck (14)	0
	Hanesville (15)	54,798
	Betterton (16)	57,422
	Galena (17)	118,828
	Swan Point (20)	0
	Rock Hall (21)	10,002
		431,425 sq.m = 43.14 hectares 106.56 acres
Upper Western Shore - 3	White Marsh (6)	0
	Edgewood (7)	498,100
	Perryman (8)	20,136
	Spesutie (9)	8,325
	Baltimore East (12)	0
	Middle River (13)	0
	Gunpowder Neck (14)	1,839,900
	Hanesville (15)	0
	Curtis Bay (18)	0
	Sparrows Point (19)	0
	Round Bay (23)	0
	Gibson Island (24)	76,075
		2,442,536 sq.m = 244.25 hectares 603.31 acres

continued

TABLE 6. (continued)

Chester River - 4	Swan Point (20)	186,456
	Rock Hall (21)	291,300
	Chestertown (22)	0
	Love Point (25)	0
	Langford Creek (26)	5,997,246
	Centreville (27)	0
	Kent Island (32)	77,356
	Queenstown (33)	756,388
		7,308,746 sq.m = 730.87 hectares 1805.25 acres
Central Western Shore - 5	Round Bay (23)	0
	Gibson Island (24)	0
	South River (30)	0
	Annapolis (31)	0
	Deale (35)	0
	North Beach (42)	0
		0
Eastern Bay - 6	Love Point (25)	0
	Annapolis (31)	0
	Kent Island (32)	185,439
	Queenstown (33)	138,088
	Claiborne (36)	222,031
	St. Michaels (37)	111,365
	Easton (38)	0
		656,923 sq.m = 65.69 hectares = 162.25 acres
Choptank River - 7	Claiborne (36)	300,482
	St. Michaels (37)	0
	Easton (38)	0
	Tilghman (43)	68,699
	Oxford (44)	232,542
	Trappe (45)	0
	Preston (46)	0
	Sharps Island (51)	44,176
	Church Creek (52)	90,017
	Cambridge (53)	0
	East New Market (54)	0
	Taylors Island (62)	85,512
		821,428 sq.m = 82.14 hectares 202.89 acres

continued

TABLE 6. (continued)

Patuxent River - 8	Lower Marlboro (41)	0
	Benedict (49)	0
	Mechanicsville (59)	0
	Broomes Island (60)	43,692
	Cove Point (61)	37,518
	Hollywood (70)	0
	Solomons Island (71)	7,616
		88,826 sq.m = 8.88 hectares 21.93 acres
Middle Western Shore - 9	North Beach (42)	0
	Prince Frederick (50)	0
	Broomes Island (60)	0
	Cove Point (61)	0
	Solomons Island (71)	0
	St. Marys City (80)	np
	Point No Point (81)	np
	Point Lookout (90)	np
		0
Lower Potomac River - 10	Nanjemoy (56)	309,243
	Mathias Point (57)	1,211,162
	Popes Creek (58)	0
	Dahlgren (66)	26,712
	Colonial Beach North (67)	256,316
	Rock Point (68)	0
	Leonardtown (69)	0
	Colonial Beach South (76)	112,561
	Stratford Hall (77)	21,600
	St. Clements Island (78)	0
	Piney Point (79)	np
	St. Marys City (80)	np
	Machodoc (87)	0
	Kinsale (88)	0
	St. George Island (89)	np
	Point Lookout (90)	np
	Lottsburg (96)	np
	Heathsville (97)	np
	Burgess (98)	np
		1,937,594 sq.m = 193.76 hectares 478.59 acres

continued

TABLE 6. (continued)

Upper Potomac River - 11	Washington West (28)	0
	Washington East (29)	0
	Alexandria (34)	1,603,981
	Fort Belvoir (39)	9,072
	Mt. Vernon (40)	4,203,406
	Quantico (47)	0
	Indian Head (48)	0
	Widewater (55)	45,864
	Passapatanzy (64)	0
	King George (65)	134,413
		5,996,736 sq.m = 599.67 hectares 1481.19 acres
Middle Eastern Shore - 12	Taylors Island (62)	0
	Golden Hill (63)	4,218
	Barren Island (72)	0
	Honga (73)	50,478
	Wingate (74)	88,146
	Nanticoke (75)	0
	Richland Point (82)	3,840
	Bloodsworth Island (83)	182,910
	Deal Island (84)	0
	Monie (85)	0
	Kedges Straits (91)	0
	Terrapin Sand Point (92)	0
	Marion (93)	0
		329,592 sq.m = 32.96 hectares 81.41 acres
Tangier Island Complex - 13	Chesconessex (108)	7,846,491
	Parksley (109)	2,648,039
	Tangier Island (107)	6,144,418
	Ewell (99)	23,085,834
	Great Fox Island(100)	8,078,128
	Kedges Straits (91)	3,664,153
	Terrapin Sand Point (92)	1,869,984
	Crisfield (101)	1,130,088
	Marion (93)	0
	Saxis (102)	0
		54,467,135 sq.m = 5,446.71 hectares = 13,453.37 acres

continued

TABLE 6. (continued)

Lower Eastern Shore - 14	Elliots Creek (142)	144,822
	Townsend (143)	48,042
	Cape Charles (133)	3,083,185
	Cheriton (134)	559,874
	Franktown (124)	3,952,565
	Jamesville (119)	3,673,577
	Nandua Creek (113)	3,451,033
	Pungoteague (114)	7,167,565
	Chesconessex (108)	239,628
		22,320,291 sq.m = 2,232.03 hectares = 5,513.11 acres
Reedville - 15	Fleets Bay (112)	1,554,487
	Reedville (106)	1,085,642
	Burgess (98)	0
		2,640,129 sq.m = 264.01 hectares= 652.10 acres
Rappahannock River Complex - 16	Mathews (123)	72,588
	Wilton (117)	0
	Deltaville (118)	66,241
	Irvington (111)	93,276
	Urbanna (110)	0
	Champlain (86)	0
	Mount Landing (94)	0
	Tappahannock (95)	0
	Dunnsville (103)	0
	Morattico (104)	0
	Lively (105)	0
	Saluda (116)	0
		232,105 sq.m = 23.21 hectares = 57.33 acres
New Point Comfort Region - 17	Mathews (123)	0
	New Point Comfort (132)	2,985,042
		2,985,042 sq.m = 298.50 hectares = 737.30 acres

continued

TABLE 6. (continued)

Mobjack Bay Complex - 18	Achilles (131)	5,297,298
	New Point Comfort (132)	7,942,019
	Ware Neck (112)	2,031,475
	Mathews (123)	230,562
		15,501,354 sq.m = 1,550.14 hectares = 3,828.82 acres
York River - 19	Poquoson West (140)	257,028
	Yorktown (139)	2,340
	Clay Bank (130)	0
	Achilles (131)	2,117,660
	West Point (115)	0
	Toano (120)	0
	Gressitt (121)	0
	Williamsburg (129)	0
		2,377,046 sq.m = 237.70 hectares = 587.12 acres
Lower Western Shore - 20	Cape Henry (152)	378,714
	Hampton (147)	2,331,495
	Poquoson East (141)	6,871,628
	Poquoson West (140)	1,912,278
	Norfolk North (150)	0
	Little Creek (151)	0
	Kempsville (156)	0
	Princess Anne (157)	0
		11,494,115 sq.m = 1,149.41 hectares = 2,839.04 acres
James River - 21	Hampton (147)	0
	Newport News South (149)	0
	Norge (128)	464,766
	Savedge (135)	0
	Claremont (136)	0
	Surry (135)	0
	Hog Island (138)	0
	Yorktown (139)	0
	Bacons Castle (144)	0
	Mulberry Island (145)	0

continued

TABLE 7. NUMBER OF SQUARE METERS OF SAV IN EACH OF THE DENSITY CLASSES FOR ONLY THOSE QUADRANGLES CONTAINING SAV IN 1984.

Quadrangle	No.	Density 1	Density 2	Density 3	Density 4	Total Sq m	Total Hectares	Total Acres
Havre de Grace	3	16,457,549	490,635	206,630	263,772	17,418,586	1741.86	4302.39
North East	4	78,096	55,050	0	0	133,146	13.31	32.86
Edgewood	7	212,672	83,846	171,943	29,676	498,137	49.81	123.04
Perryman	8	0	7,842	12,294	0	20,136	2.01	4.96
Spesutie	9	4,082,974	6,144	0	24,709	4,113,827	411.38	1016.11
Earleville	10	0	16,227	2,579	15,897	34,703	3.47	8.57
Gunpowder Neck	14	384,413	374,696	685,668	395 101	1,839,878	83.99	454.45
Hanesville	15	0	0	54,798	0	54,798	5.48	13.54
Belterton	16	0	16,768	40,654	0	57,422	5.74	14.18
Galena	17	0	0	61,558	57,270	118,828	11.88	29.34
Swan Point	20	22,686	19,164	59,124	85,482	186,456	18.65	46.01
Rock Hall	21	106,626	6,594	15,852	172,230	301,302	30.13	74.42
Gibson Island	24	0	40,604	31,666	3,805	76,075	7.61	18.80
Langford Creek	26	3,240	959,910	1,322,466	3,711,630	5,997,246	599.72	1481.31
Kent Island	32	0	25,000	91,716	146,079	262,795	26.28	64.91
Queenstown	33	30,686	74,634	677,455	111,701	894,476	89.45	220.94
Alexandria	34	266,938	866,632	91,545	378,866	1,603,981	160.40	396.19
Claiborne	36	12,658	176,275	331,762	1,818	522,513	52.25	129.06
St. Michaels	37	0	16,471	94,894	0	111,365	11.14	27.52
Fort Belvoir	39	9,072	0	0	0	9,072	.91	2.25
Mt. Vernon	40	214,950	1,932,984	904,756	1,150,716	4,203,406	420.34	1038.24
Tilghman	43	0	8,790	25,545	34,364	68,699	6.87	16.97
Oxford	44	44,116	82,949	94,921	10,556	232,542	23.25	57.43
Sharps Island	51	2,653	18,492	18,430	4,601	44,176	4.42	10.92
Church Creek	52	0	24,648	31,502	35,267	91,417	9.14	22.58
Widewater	55	6,168	28,146	6,726	4,824	45,864	4.59	11.34
Nanjemoy	56	23,012	123,935	162,296	0	309,243	30.92	76.37
Mathias Point	57	117,762	252,165	503,748	337,487	1,211,162	121.12	299.16
Broomes Island	60	0	0	0	43,692	43,692	4.37	10.79
Cove Point	61	0	6,312	14,424	16,782	37,518	3.75	9.26

continued

TABLE 7. (continued)

Quadrangle	No.	Density 1	Density 2	Density 3	Density 4	Total Sq m	Total Hectares	Total Acres
Taylors Island	62	34,758	16,428	20,178	14,148	85,512	8.55	21.12
Golden Hill	63	0	0	4,218	0	4,218	.42	1.04
King George	65	15,780	53,431	65,202	0	134,413	13.44	33.10
Dahlgren	66	26,712	0	0	0	26,712	2.67	6.59
Colonial Beach North	67	0	69,535	171,254	15,527	256,316	25.63	63.31
Solomons Island	71	0	0	7,616	0	7,616	.76	1.88
Honga	73	0	36,642	13,836	0	50,478	5.05	12.47
Wingate	74	0	8,718	79,428	0	88,146	8.81	21.76
Colonial Beach South	76	0	0	64,436	48,125	112,561	11.26	27.81
Stratford Hall	77	0	0	21,600	0	21,600	2.16	5.34
Richland Point	82	0	0	3,840	0	3,840	.38	.94
Bloodsworth Is.	83	38,868	141,936	2,106	0	182,910	18.29	45.18
Kedges Straits	91	59,376	397,620	680,736	2,526,421	3,664,153	366.42	905.05
Terrapin Sand Pt.	92	81,834	145,296	1,327,392	315,462	1,869,984	187.00	461.89
Ewell	99	24,408	2,078,240	7,276,464	13,706,722	23,085,834	2,308.58	5,702.19
Great Fox Island	100	356,088	368,928	1,863,902	5,489,210	8,078,128	807.81	1,995.29
Crisfield	101	0	351,174	414,324	364,590	1,130,088	113.01	279.13
Reedville	106	280,356	634,067	167,067	4,134	1,085,642	108.56	268.14
Tangier Island	107	178,710	549,738	1,820,094	3,595,876	6,144,418	614.44	1,517.67
Chesconessex	108	777,781	2,481,026	2,980,668	1,846,674	8,086,149	808.61	1,997.28
Parksley	109	0	353,484	2,034,690	259,865	2,648,039	264.80	654.06
Irvington	111	0	93,276	0	0	93,276	9.33	23.05
Fleets Bay	112	251,178	1,160,654	128,099	14,555	1,554,487	155.45	383.96
Nandua Creek	113	1,434,216	912,985	513,756	590,076	3,451,033	345.10	852.40
Pungoteague	114	456,450	3,072,667	1,187,760	2,450,688	7,167,565	716.76	1,770.39

continued

TABLE 7. (continued)

Quadrangle	No.	Density 1	Density 2	Density 3	Density 4	Total Sq m	Total Hectares	Total Acres
Deltaville	118	5,298	42,745	18,198	0	66,241	6.62	16.35
Jamesville	119	0	1,915,436	749,871	1,008,270	3,673,577	367.36	907.37
Ware Neck	122	496,445	739,836	706,736	88,458	2,031,475	203.15	501.78
Mathews	123	0	15,552	222,540	65,058	303,150	30.32	74.89
Franktown	124	61,830	649,415	1,190,676	2,050,644	3,952,565	395.26	976.28
Achilles	131	145,608	912,584	4,910,598	1,446,168	7,414,958	741.50	1,831.51
New Point Comfort	132	699,361	2,397,546	2,455,134	5,375,020	10,927,061	1,092.71	2,698.99
Cape Charles	133	132,174	1,313,101	960,288	677,622	3,083,185	308.32	761.50
Cheriton	134	0	40,722	49,518	469,634	559,874	55.99	148.17
Yorktown	139	0	2,340	0	0	2,340	0.23	0.57
Poquoson West	140	485,766	627,408	525,870	530,262	2,169,306	216.93	535.82
Poquoson East	141	365,772	824,124	3,258,523	2,423,209	6,871,628	687.16	1,697.99
Elliots Creek	142	144,822	0	0	0	144,822	14.48	35.77
Townsend	143	0	0	0	48,042	48,042	4.80	11.86
Hampton	147	154,596	302,478	323,216	1,551,205	2,331,495	233.15	575.88
Cape Henry	152	25,440	32,004	277,698	43,572	378,714	37.87	93.54

In order to facilitate the discussion of the distribution of SAV in the bay, each of the 21 sections in the 3 major zones will be discussed separately.

1. SUSQUEHANNA FLATS

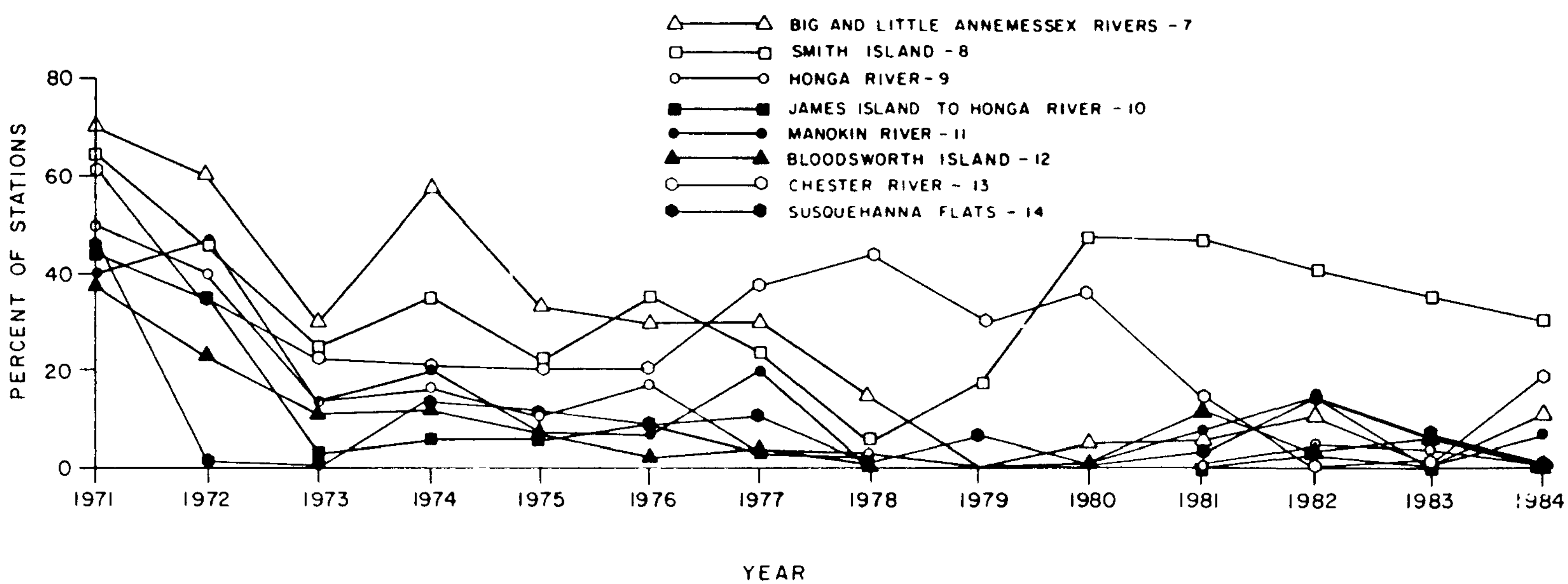
The distribution of SAV in this section for 1984 was based primarily on species presence and abundance from Dr. Stan Kollar because of the loss of imagery of the Flats area. SAV beds on the Flats for 1978 were remapped to allow for greater comparability to the 1984 data. Instead of mapping each small bed, the entire area was remapped as distinct units and given a density classification. Thus, instead of 110 hectares being reported on 1978, the remapping of these data yielded 804 hectares in a density 1 classification. In 1984, the Flats contained sparse patches of SAV throughout the region which were mapped as one unit and then classified as a density of 1 (very sparse). Thus, the 1984 survey showed 2,150 hectares in this section compared to 804 in 1978 (Tables 4-7). The information provided by Kollar indicates a large increase, albeit only in small patches on the Susquehanna Flats, from 1978 to 1984. Seven species of SAV were found in 1984, with milfoil, the most abundant, being found in patches throughout the Flats. Wild celery was the second most important species in this section. Both species were noted in 1978 with milfoil also being the most common. Both Hydrilla and water stargrass were noted in 1984 in small isolated pockets but not in 1978.

The Md.DNR survey sampled 37 stations in 1984 and found no vegetation in any of these stations (Table 8, Fig. 7). No stations were located in the Susquehanna River where SAV occurs along the shoreline just north of the Interstate 95 bridge. The survey did find some vegetation from 1981 to 1983

TABLE 8. FREQUENCY OF STATIONS WITH ROOTED SUBMERGED AQUATIC VEGETATION ON THE CHESAPEAKE BAY SYSTEM, 1971-84

RIVER SYSTEM	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Elk & Bohemia Rivers	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sassafras	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	10.0
Howell-Swan Points	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chester River	61.1	36.1	26.5	23.5	25.0	25.7	38.9	44.4	33.3	38.9	13.9	0.0	1.1	19.4
Love-Kent Points	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern Bay	34.0	46.5	34.0	36.2	21.7	42.2	28.3	26.1	17.3	34.8	4.4	4.3	17.4	6.5
Choptank River	35.0	39.7	19.3	27.6	1.7	39.0	25.8	28.3	26.7	25.0	1.7	6.7	5.0	1.7
Little Choptank River	21.0	21.0	0.0	0.0	0.0	15.8	5.3	5.3	5.3	0.0	0.0	0.0	0.0	0.0
James-Barren Islands	44.1	35.3	2.9	5.9	8.8	2.9	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0
Honga River	50.0	40.0	13.3	16.7	10.3	17.2	3.3	3.3	0.0	0.0	0.0	3.3	3.3	0.0
Fishing Bay	8.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nanticoke-Wicomico River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manokin River	40.0	46.7	13.3	20.0	7.1	6.7	20.0	0.0	0.0	0.0	6.7	13.3	0.0	6.7
Little & Big Annemessex R.	70.0	60.0	30.0	57.9	33.3	30.0	30.0	15.0	0.0	5.0	5.0	10.0	0.0	10.0
Pocomoke Sound	18.2	10.0	4.8	0.0	15.0	9.1	10.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0
Bloodsworth-Sound Marsh Is.	37.5	22.7	10.9	11.6	7.0	2.2	4.4	0.0	0.0	2.2	11.1	2.2	4.3	0.0
Smith Island	64.7	45.5	25.0	35.3	22.2	35.3	23.5	5.8	17.6	47.1	47.1	41.2	35.3	29.4
Total Eastern Shore	36.4	28.5	13.3	18.0	9.7	17.7	13.9	11.6	9.0	12.4	5.4	4.5	5.6	4.5
Susquehanna Flats	44.4	2.7	0.0	13.5	11.1	8.1	11.1	2.7	8.1	0.0	2.7	13.5	5.4	0.0
Gunpowder-Bush Rivers	11.1	0.0	0.0	0.0	0.0	0.0	11.1	0.0	11.1	22.2	11.1	11.1	11.1	0.0
Back-Middle Rivers	13.6	4.6	4.6	4.6	9.1	4.6	9.1	4.5	4.5	9.1	4.5	0.0	19.0	17.6
Patapsco River	0.0	5.0	4.8	9.5	0.0	9.5	14.2	9.5	9.5	0.0	9.5	0.0	4.8	0.0
Magothy River	33.3	0.0	16.7	16.7	0.0	16.7	25.0	8.3	16.7	16.7	8.3	0.0	0.0	16.7
Severn River	40.0	20.0	26.7	26.7	0.0	46.2	20.0	26.7	20.0	13.3	6.6	0.0	6.7	0.0
South-West-Rhode River	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Curtis-Cove Points	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0
Patuxent River	2.0	4.3	0.0	4.0	0.0	2.1	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0
Total Western Shore	6.8	4.2	4.1	8.3	5.0	8.4	8.8	5.0	7.2	4.0	3.7	3.6	4.6	2.7
Percent of stations vegetated	28.5	21.0	10.5	14.9	8.7	14.9	12.4	9.5	8.4	9.7	4.9	4.2	5.3	4.0
Number of areas with no SAV recorded	5.0	9.0	12.0	9.0	11.0	8.0	8.0	12.0	13.0	16.0	12.0	16.0	15.0	17.0

Figure 7. Trends of occurrence of submerged vegetation at eight of the 26 areas surveyed by the Maryland Department of Natural Resources, 1971-1984.


BIG AND LITTLE ANNEMESSEX RIVERS - 7
SMITH ISLAND - 8
HONGA RIVER - 9
JAMES ISLAND TO HONGA RIVER - 10
MANOKIN RIVER - 11
BLOODSWORTH ISLAND - 12
CHESTER RIVER - 13
SUSQUEHANNA FLATS - 14
PERCENT OF STATIONS
0
20
40
60
80
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
YEAR

but the very sparse nature of SAV on the Flats probably resulted in the SAV not being sampled in 1984.

It appears from the SAV survey conducted in 1982 by Dr. Richard Anderson, ground observations by Stan Kollar in 1984 and the 1984 aerial survey, that SAV is expanding both in the Susquehanna River and the Flats.

2. UPPER EASTERN SHORE

Small, scattered SAV beds were found in this section in the Elk and Sassafras Rivers in 1984. A total of 43 hectares were mapped in 1984 compared to 29 hectares in 1978 (Tables 4-7) with 30% of the SAV found in the Elk River of the North East quadrangle. Seven of the 12 quadrangles had SAV in 1984 compared to 8 in 1978. The small beds found in the Elkton and Swan Point quadrangles in 1978 were not observed in 1984 while the SAV beds in the North East quadrangle in 1984 were not present in 1978. Fifteen stations were sampled in the Elk and Bohemia Rivers by the Md.DNR in 1984 with no vegetation recorded at any of the stations (Table 8). Several of the stations were located in deep water just off SAV beds evident on the photography. SAV was found in one of ten stations in the Sassafras River by this survey. The SAV was milfoil and was noted to be abundant throughout Lloyd Creek where SAV had been observed in the photographs in 1978. Five stations on Stillpond had no SAV in the Md.DNR survey although SAV was observed on the aerial photography in 1984 and 1978 in this area on both the Hanesville and Betterton quadrangles. Seven additional stations were sampled in the Howell and Swan Point system and no SAV were found.

3. UPPER WESTERN SHORE

The 1978 aerial survey indicated there were 484 hectares of SAV. In 1984, several flight lines were lost here due to a malfunction in the film processing. As a consequence, SAV beds for 1984 were poorly represented in the Middle, Gunpowder and Bush Rivers where large beds were found in 1978. However, aerial photography of the Gunpowder River was available for 1983 from Martin Marietta which showed SAV beds in areas similar to 1978. Thus, SAV information for 1984 was assumed to be similar to 1983. The Middle River was not flown in 1983 and it could be assumed there was SAV in this river similar to the 1978 distribution. The available 1983-84 photography showed 244 hectares of SAV in this section. Thus, the distribution of SAV in 1984 shown here is probably less than what was actually present.

The Md.DNR survey showed vegetation at 3 of 27 stations in the Gunpowder, Bush, Back and Middle Rivers (Table 8). The three stations that had SAV were in the Middle River and contained wild celery, milfoil and Chara sp. In the Magothy River, two of 12 stations had SAV (only horned pondweed) while no SAV was found in 23 stations in the Patapsco River.

4. CHESTER RIVFR

In 1978, the Chester River section contained a diverse assemblage of 7 species of SAV encompassing 1,475 hectares. These species included milfoil, redhead grass, wild celery, horned pondweed, widgeongrass and Naiad species. Eighty-five percent of the SAV in 1978 was in the Langford quadrangle with the grasses occurring along both shorelines of the lower Chester River. In 1984, 731 hectares of SAV were recorded with 82% found in the Chester River, Langford quadrangle. There was a decrease of 655 hectares in the Langford quadrangle from 1978 to 1984. No SAV was mapped for the East and West Forks of Langford Creek in 1984 because of a film processing malfunction. There were 97 hectares found in this area in 1978. There were SAV beds in this area in 1984, as the Md.DNR survey recorded redhead grass, milfoil and sago pondweed.

The Md.DNR survey found 19.4% of their 35 stations in the Chester River vegetated in 1984 compared to 1% in 1983 and 0% in 1982 (Table 8, Fig. 7). However, this was still lower than the 44% of the stations vegetated in the 1978 photo survey. Notes taken during the 1984 Md.DNR survey indicated large beds of SAV inshore from many of the actual sampling stations as well as much drift SAV.

5. CENTRAL WESTERN SHORE

No SAV's were noted in this section in 1984, compared with 241 hectares found in 1978 (Tables 4-7). Aerial coverage of this section in 1984 was complete. Fifty-seven percent of the vegetation in 1978 in this section was present in the Severn River with smaller amounts found in the South and Rhode Rivers. Seven species were present: milfoil, wild celery, redhead grass, sago pondweed, horned pondweed, widgeongrass and Najas sp.

The Md.DNR survey found no SAV in 1984 in the Severn, South, West and Rhode River systems (Table 8). Twenty-seven percent of the stations in the Severn River were vegetated in 1978. This declined to 0% in 1982. Some vegetation was found in 1983 but declined to 0% again in 1984. Since 1971 the Md.DNR survey has never found SAV in the South-West-Rhode Rivers.

6. EASTERN BAY

In 1984, only 66 hectares of SAV were noted in the aerial photography for the section. This was a significant decrease from the 1,800 hectares of SAV recorded in 1978, which was the most abundant section that year (Tables 4-7). Diverse beds of milfoil, redhead grass, sago pondweed, elodea, horned pondweed and widgeongrass were found along the shores of Eastern Bay in 1978 but these were considerably reduced by 1984.

The Md.DNR found no vegetation at 8 stations in the Love-Kent Points systems and SAV at only 3 of 46 stations in the Eastern Bay system in 1984 (Table 8). In 1978, 26.1% of the stations were vegetated. This percentage has vacillated between 1978 and 1984, increasing to 34.8% in 1980 and then declining to the 6.5% in 1984. The only species found by the survey in 1984 was widgeongrass.

7. CHOPTANK RIVER

In 1984, only 82 hectares of SAV were noted in the aerial photography compared with 1740 hectares in 1978. Five species were observed in 1978: milfoil, sago pondweed, redhead grass, common elodea and horned pondweed. Large decreases of SAV were noted from 1978 to 1984 in the Claiborne, Oxford, Sharps Island and Church Creek quadrangles. In 1984, 65% of the SAV was found in two quadrangles, Claiborne and Oxford.

The Md.DNR survey found SAV in only 1 of 60 sampled stations in the Choptank River and no SAV in 19 stations in the Little Choptank River (Table 8). The only species found in 1984 was widgeongrass. In 1978, 28.3% of the stations in the Choptank River were vegetated which declined to lower levels after 1980. No vegetation has been found in the Little Choptank River since 1979. The qualitative surveys of the UMdHPL found SAV at only 2 of their 6 monitoring stations in 1984. In 1980, the year they began monitoring all six stations were vegetated. .The most dramatic loss of SAV occurred at Benoni Point (Oxford quadrangle), Dickinson Bay (Trappe quadrangle), and Todd's Cove (Church Creek quadrangle) during the 1981-82 growing season.

8. PATUXENT RIVER

In 1984, 9 hectares of SAV were observed from the photography, compared with 34 hectares in 1978 (Tables 4-7). SAV occurred in the Broomes Island, Cove Point and Solomons Island quadrangles in 1984. Two species, widgeongrass and horned pondweed, were found in 1978. The Md.DNR survey found no SAV in 43 stations and have not recorded any since 1979 when 2% of the stations were vegetated, the same percentage as 1978 (Table 8).

9. MIDDLE WESTERN SHORE

No SAV was recorded in this section in 1984 compared to 11 hectares found in 1978 (Tables 4-7). The Md.DNR survey found no SAV in 8 sampled stations in Curtis - Cove Points system (Table 8). This area is a very exposed region and would not be expected to support significant stands of SAV.

10. LOWER POTOMAC RIVER

The Potomac River received more coverage, both from ground and aerial surveys, than any other part of the bay. Ground surveys by the Md.DNR, NVCC, and USGS and the 1984 aerial survey provided excellent coverage of the distribution of SAV's this year. However, several problems were encountered with the aerial survey. Five quadrangles were not covered with photography because of airspace restrictions by the Patuxent NAS: Piney Point, St. Marys City, Point No Point, St. George Island and Point Lookout. The 1978 aerial survey found no SAV's in these quadrangles. However, Carter, et al (1985) did find three or four species growing in the St. Marys River during their 1978-81 survey. Another complication was the timing of the flights for the Potomac River in 1984. Very poor atmospheric conditions delayed the flying of the Potomac River flight lines until early November when some of the SAV had declin . This resulted in less coverage than that expected during the growing eason.

In 1984, the rial survey noted 194 hectares of SAV compared to 410 hectares found in 78 (Tables 4-7). SAV was found in the Nanjemoy, Mathias Point, Dahlgren, C onial Beach North, Colonial Beach South and Stratford Hall quadrangles i 1984, similar to what was observed in 1978. Most of the SAV in 1984 was in he Mathias Point quadrangle (63%) as was the case in 1978 (48%).

The Md.DNR su ey sampled 88 stations in the lower section and found vegetation in only ne, near Blossom Point at the mouth of Nanjemoy Creek. Wild celery and wi eongrass were the only two species observed.

The USGS samp d only the freshwater tidal and transition zone down to the Wicomico River in 1983 and 1984) (Fig. 6). Table 9 lists the species found in the vege ted transects. Wild celery, milfoil, redhead grass, sago pondweed, and idgeongrass were among the species found in this section. A compar on with earlier data collected from 1978-1981 indicated more vegetated sta ons and grabs were found on sampled transects in 1984 than in 1981 (Tabl 10).

The NVCC surv also sampled in the transition zone (Fig. 5) in 1984 and found 9 specie in this section (Table 11). These were the same species found by the USGS rvey. The distribution of the species found by NVCC is given in Figs. 8-1 Wild celery was by far the most abundant species found by the NVCC survey nd often was found in 100% coverage.

It is apparen from the data collected by the USGS and NVCC that SAV was more abundant an indicated in the aerial survey. Thus, the smaller amount of SAV foun in 1984 is most probably due to the timing of the aerial

TABLE 9. SPECIES OF SUBMERSED AQUATIC PLANTS FOUND ON VEGETATED TRANSECTS IN THE TIDAL POTOMAC RIVER AND TRANSITION ZONE, 1984.

n.d. is no data available

Transect	Species[1/] Spring	Fall
OR-1R	Hydr, Vall, P. pect, Zann	Heter
AD-1R	Hydr, P. cris	Hydr
DM-1R	Hydr	Cerat, Hydr
DM-2R	Hydr	Cerat, Hydr
DM-3R	Hydr	Cerat, Hydr, Nitella
DM-4R	Hydr, P. pect Vall, Zann	Cerat, Heter, Hydr, Myrio, Nitella, Vall
GC-1R	Cerat	Heter, Hydr, Myrio
GC-2R		Myrio, Vall
GC-4R		Vall
WC-1R	Vall, Zann	Vall
BC-1T-1	Cerat, Heter, Hydr, Myrio, Najas g., P. cris	n.d.
PY-1R	P. pect, Vall	Myrio
PY-1.5R	Myrio, Najas m.	n.d.
PY-2R	Myrio, Najas m.	Cerat, Heter, Hydr, Myrio, Najas g., Vall
PY-3R		Hydr, Myrio Najas g.
PY-4R		Najas g.
PY-5R		Heter
PY-7R	Myrio	Heter, Hydr, Myrio, Najas g., Najas m., Vall
PY-8R	Vall, Zann	Cerat, Heter, Hydr, Myrio Najas g., Vall, Zann
PY-1T-1		Myrio,
PY-1T-3	Cerat	n.d.
PY-2T-1	Hydr	Cerat, Hydr, Myrio
MN-9R	Cerat, P. pect	Vall
MN-10R	P. pect, Vall, Zann	Vall

continued

TABLE 9. (continued)

Transect	Species[1/] Spring	Fall
MN-4T-1	Cerat	Cerat, Myrio
MN-4T-2	Vall	Najas g., P. pus, Vall
MP-3R	Vall	n.d.
MP-4R	Myrio, Najas g., Vall, Zann	n.d.
NP-2R	n.d.	Vall
NP-3R	n.d.	Vall
NP-4R	n.d.	P. perf, Vall
NP-5R	n.d.	Vall
NP-6R	n.d.	Cerat, P. pect, P. perf, Vall
NP-7R	n.d.	Vall
NP-8R	n.d.	Vall
NP-9R	n.d.	P. perf, Vall
NP-10R	n.d.	Myrio, P. perf, Vall
NP-11R	n.d.	Vall
NY-3T-3	n.d.	Cerat, Myrio, P. pus
PO-1T-5	n.d.	Myrio, Vall
PO-2T-1	n.d.	Vall
PO-2T-2	n.d.	Vall
PO-2T-3	n.d.	Vall
PO-3T-1	n.d.	Myrio, Vall
WO-5T-1	n.d.	P. perf, Rupp
WO-8T-1	n.d.	Najas g., Rupp

1/Cerat = Ceratophyllum demersum, Heter = Heteranthera dubia, Hydr = Hydrilla verticillata, Myrio = Myriophyllum spicatum, Najas g = Najas guadalupensis, Najas m = Najas minor Nitella = Nitella flexilis, P. cris = Potamogeton crispus, P. pect = Potamogeton pectinatus, P. pus = Potamogeton pusillus, Vall = Vallisneria americana, Zann = Zannichellia palustris P. perf = Potamogeton perfoliatus, Rupp = Ruppia maritima

TABLE 10. RELATIVE OCCURRENCE OF VEGETATED TRANSECTS, STATIONS AND GRABS FOR THE TIDAL POTOMAC RIVER AND ESTUARY, 1978-81 AND 1984.

Relative occurrence as number vegetated/total number

Site	Vegetated transects Date	Vegetated transects Date	Site	Vegetated transects Date	Vegetated transects Date
Tidal river					
Washington Channel	Fall 1981	Fall 1984	Pomonkey Creek	Spring 1981	Fall 1984
transects	1/1	1/1		0/4	0/4
stations	2/4	3/4		0/20	0/20
grabs	6/12	7/12		0/60	0/60
Mattawoman/ Piscataway Creeks	Summer 1978	Fall 1984	MN-4T-2	Fall 1981	Fall 1984
transects	1/34	12/34		1/1	1/1
stations	1/160	46/197		3/4	1/5
grabs	3/480	84/491		7/12	3/15
Gunston Cove	Fall 1979	Fall 1984			
transects	0/13	3/13			
stations	0/65	14/77			
grabs	0/195	17/231			
Transition zone					
Maryland Point	Spring 1981	Spring 1984	*Nanjemoy/ Port Tobacco River	Summer 1981	Fall 1984
transects	2/4	2/4		17/17	16/17
stations	5/20	20/38		53/108	76/135
grabs	8/60	39/114		119/324	173/405
Wicomico River	Summer 1981	Fall 1984			
transects	2/8	2/8			
stations	3/39	9/44			
grabs	6/117	24/132			

*Only transects which had three or more species in 1978-80 were sampled.

TABLE 11. GRID LOCATIONS IN THE TRANSITION ZONE OF THE POTOMAC RIVER WHERE THE DIFFERENT SPECIES OF SAV WERE FOUND BY THE NVCC SURVEY. PERCENTAGE OF VEGETATION FOUND IN EACH GRID IS ALSO PRESENTED (IH = INDIAN HEAD QUAD, WI = WIDEWATER, NA = NANJEMOY, MP = MATHIAS POINT, PC = POPES CREEK, PA = PASSAPATANZY, KG = KING GEORGE, DA = DAHLGREN, CB = COLONIAL BEACH NORTH; EACH NUMBER OF THE GRID REPRESENTS THE TWO LOWER LEFT COORDINATES. THE FIRST TWO REPRESENT THE VERTICAL NUMERALS AND THE SECOND TWO THE HORIZONTAL ONES (FROM ALLAIRE, ET AL., 1985).

Hydrilla

Grid	#	%
WI	0150	1
WI	0252	1
WI	0255	60
WI	0259	100
WI	0250	100
WI	0262	85
WI	0263	90
WI	0350	2
IH	0466	90
KG	1046	1
MP	2055	1
PA	9645	1
WI	9751	1

Myriophyllum

Grid	#	%
NA	1057	5
NA	1156	90
NA	1357	100
NA	1358	95
NA	1359	100
MP	1455	100
MP	1457	100
NA	1459	50
NA	1460	50
MP	1552	10
MP	1655	50
MP	1657	80
MP	1854	40
MP	2261	100
MP	2360	50
MP	2362	60
CB	2647	10
CB	2648	10
CB	2651	10

Ceratophyllum

Grid	#	%
PA	0145	90
WI	0150	9
WI	0252	99
WI	0255	30
WI	0263	5
WI	0350	2
IH	0466	10
NA	1056	5
PA	9347	90
WI	9454	100
WI	9555	30
PA	9645	99
PA	9648	100
PA	9649	100
PA	9748	98
WI	9751	9
PA	9947	100

Vallisneria

Grid	#	%	Grid	#	%
PA	0145	8	MP	2449	100
WI	0150	90	MP	2454	50
PA	0244	100	MP	2455	100
WI	0255	10	DA	2548	100
WI	0262	10	PC	2552	40
WI	0263	5	MP	2553	50
PA	0344	100	CB	2647	90
WI	0350	96	CB	2648	90
WI	0351	100	PC	2649	100
NA	0549	100	PC	2650	50
KG	0747	100	PC	2651	40
KG	0948	100	PC	9347	10
KG	1046	97	WI	9555	70
KG	1049	100	WI	9654	100
NA	1056	95	PA	9748	98
NA	1057	95			
NA	1149	100			
NA	1150	100			
NA	1156	10			
NA	1250	100			
NA	1358	5			
NA	1459	40			
NA	1460	50			
MP	1552	80			
MP	1553	100			
MP	1652	90			
MP	1655	50			
MP	1657	20			
MP	1752	100			
MP	1753	100			
MP	1950	100			
MP	1954	100			
MP	2051	100			
MP	2055	100			
MP	2057	90			
MP	2157	50			
MP	2160	40			
MP	2250	100			
MP	2349	100			
MP	2350	100			
MP	2362	30			

P. perfoliatus

Grid	#	%
KG	1046	2
MP	1652	5
MP	1853	50
MP	1854	50
MP	2057	5
MP	2157	50
MP	2160	40
MP	2357	90
MP	2454	50
MP	2553	40

P. pectinatus

Grid	#	%
NA	1459	10
MP	1853	50
MP	1854	10
MP	2359	10

P. crispus

Grid	#	%
MP	1652	5
PC	2552	60
PC	2650	50
PC	2651	50

Ruppia

Grid	#	%
MP	1552	5
MP	2057	5
MP	2160	20

Zannichella

Grid	#	%
MP	1552	5

Chara

Grid	#	%
PA	0145	2
WI	0262	5
MP	2553	10

Elodea

Grid	#	%
MP	2360	50
MP	2362	50
WI	9751	90

Figure 8. Distribution of wild celery (1), Vallisneria americana, in the trnsition zone of the Potomac River, 1984 (from Allaire, et al., 1985).

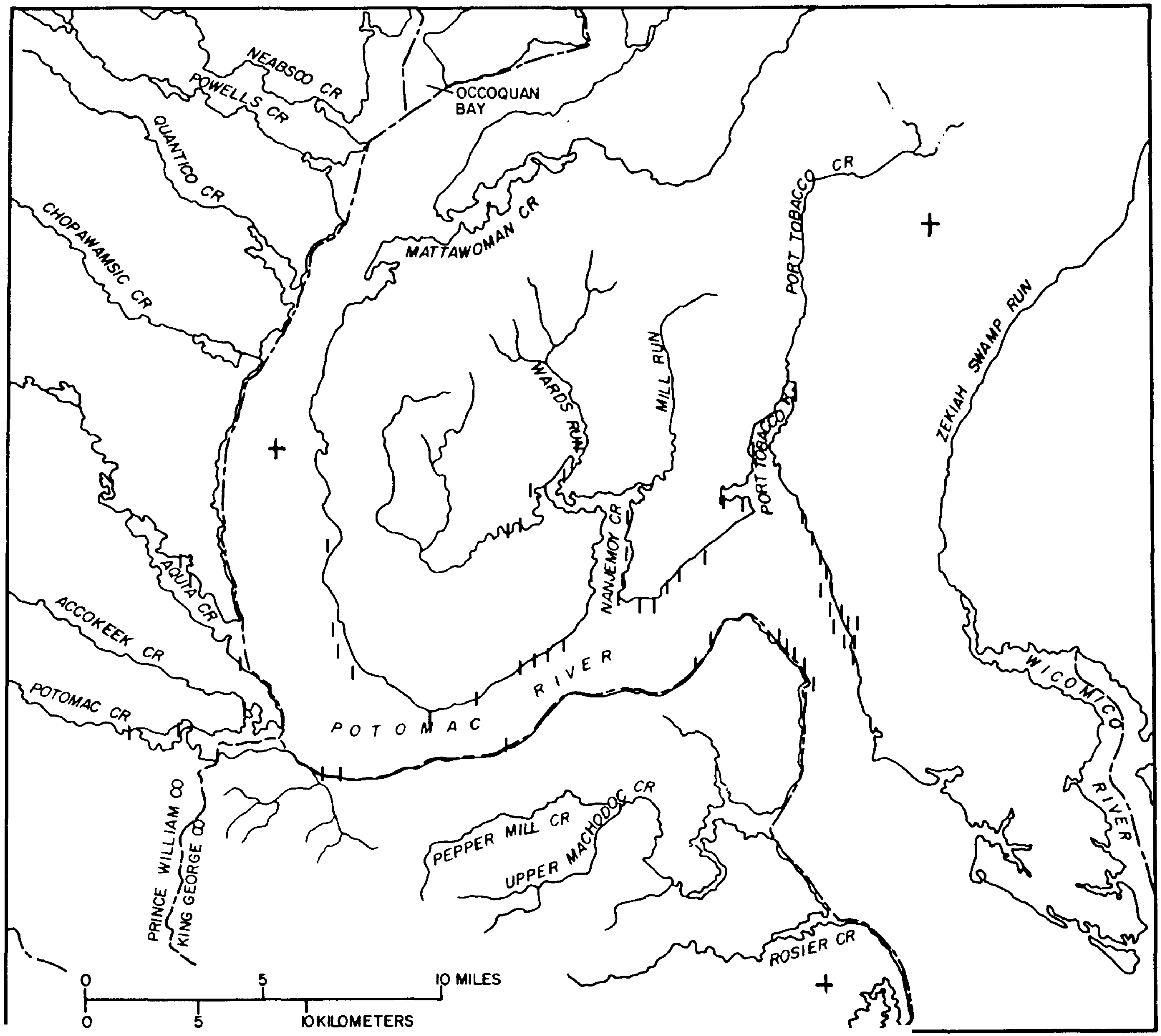

NEABSCO CR
POWELLS CR
OCCOQUAN BAY
QUANTICO CR
CHOPAWAMSIC CR
MATTAWOMAN CR
PORT TOBACCO CR
ZEKIAH SWAMP RUN
WARDS RUN
MILL RUN
PORT TOBACCO
NANJEMOY CR
AQUIA CR
ACCOKEEK CR
POTOMAC CR
POTOMAC RIVER
WICOMICO RIVER
PRINCE WILLIAM CO
KING GEORGE CO
PEPPER MILL CR
UPPER MACHODOC CR
ROSIER CR
0 5 10 MILES
0 5 10 KILOMETERS

Figure 9. Distribution of Hydrilla (1) *Hydrilla verticillata*, coontail (2) *Ceratophyllum demersum*, and milfoil (3) *Myriophyllum spicatum* in the transition zone of the Potomac River, 1984 (from Allaire, et al., 1985).

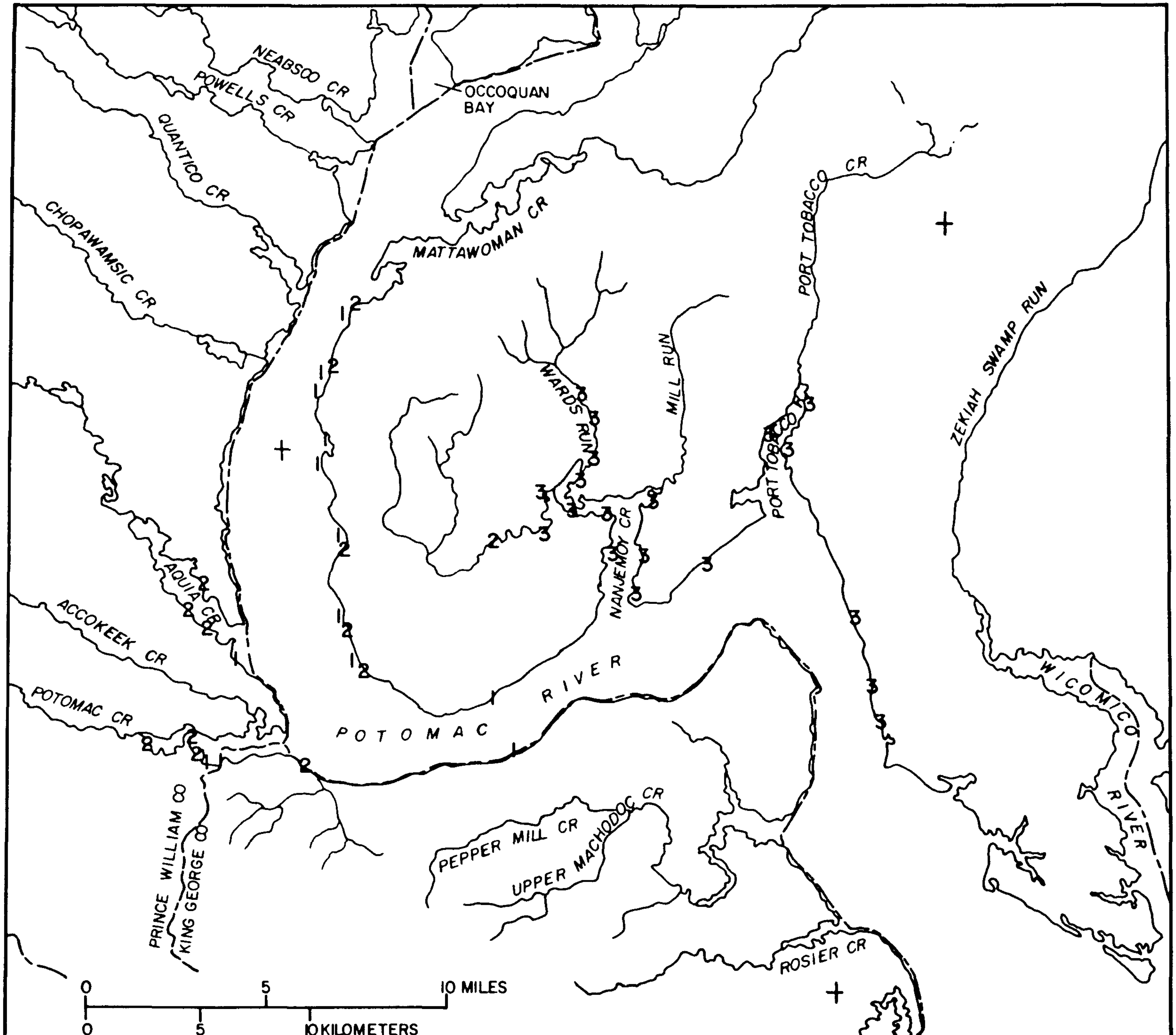

NEABSCO CR
OCCOQUAN BAY
POWELLS CR
QUANTICO CR
CHOPAWAMSIC CR
MATTAWOMAN CR
PORT TOBACCO CR
ZEKIAH SWAMP RUN
WARDS RUN
MILL RUN
NANJEMOY CR
PORT TOBACCO R
AQUIA CR
ACCOKEEK CR
POTOMAC CR
POTOMAC RIVER
WICOMICO RIVER
PRINCE WILLIAM
KING GEORGE
PEPPER MILL CR
UPPER MACHODOC CR
ROSIER CR
0 5 10 MILES
0 5 10 KILOMETERS

Figure 10. Distribution of sago pondweed (1) *P. pectinatus*, curly pondweed (2) *P. crispus* and redhead gras (3) *P. perfoliatus* in the transition zone of the Potomac River, 1984 (from Allaire, et al., 1985).

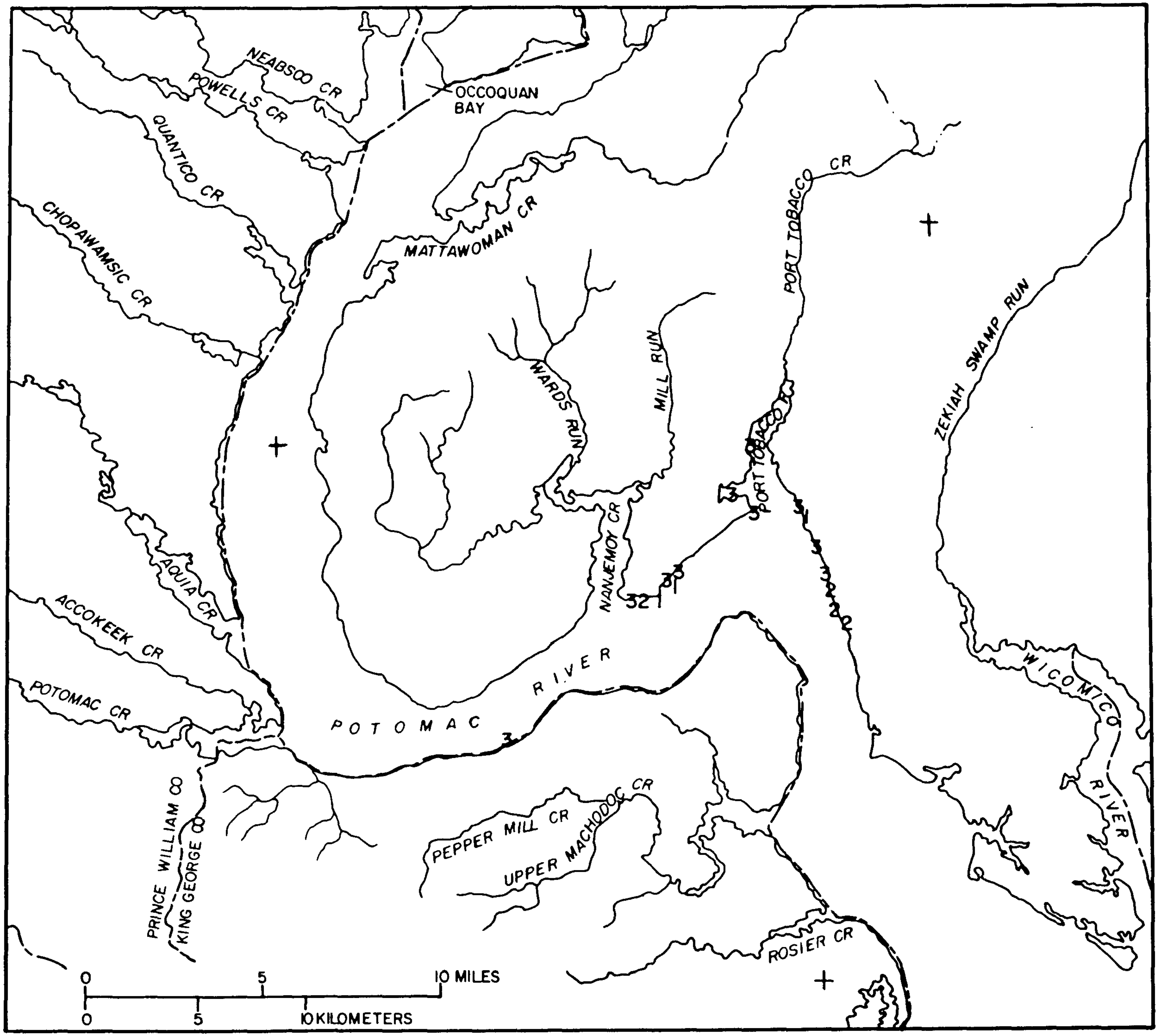
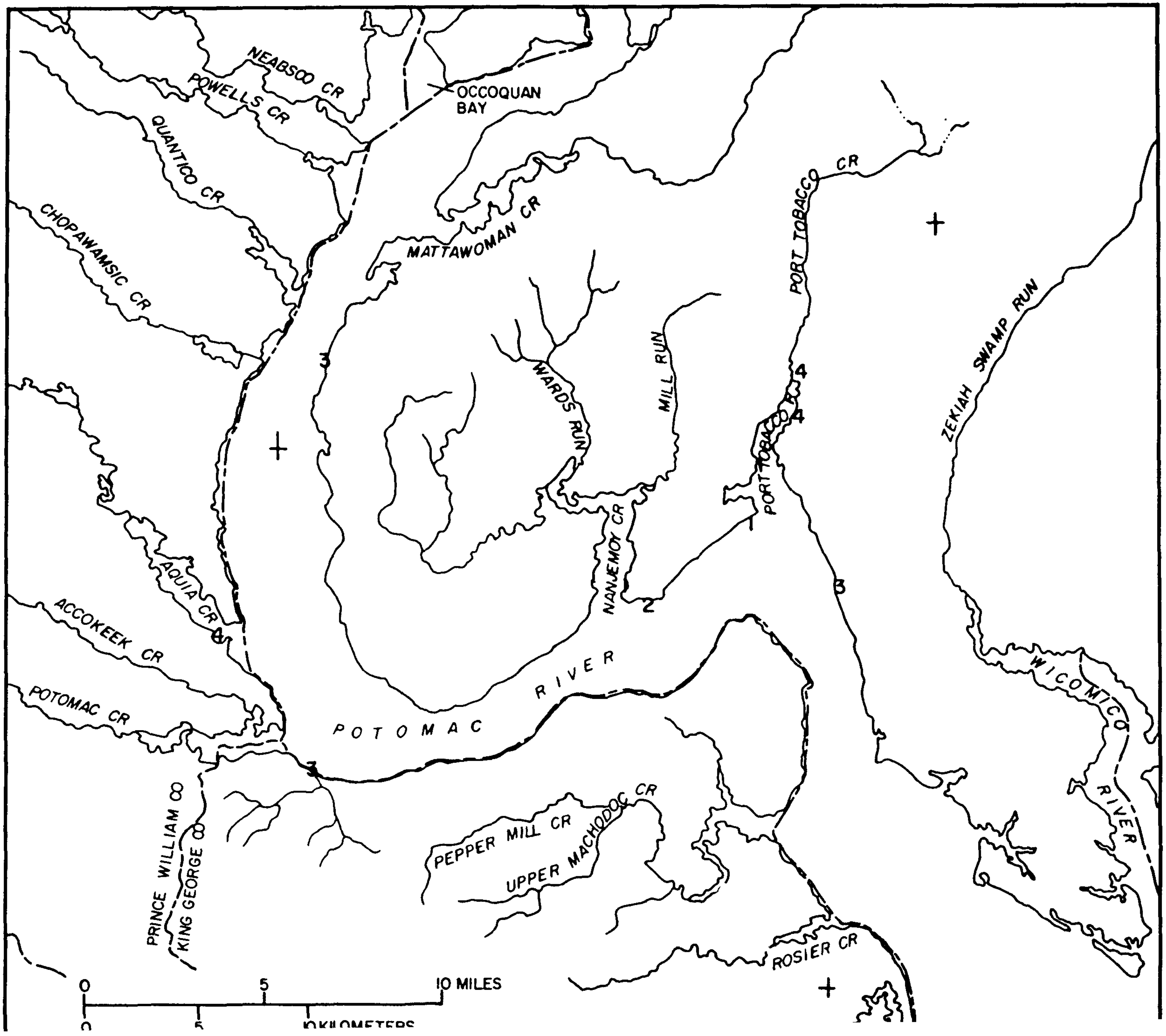

NEABSCO CR
POWELLS CR
OCCOQUAN BAY
QUANTICO CR
CHOPAWAMSIC CR
MATTAWOMAN CR
PORT TOBACCO CR
WARDS RUN
MILL RUN
ZEKIAH SWAMP RUN
PORT TOBACCO
NANJEMOY CR
32
AQUIA CR
ACCOKEEK CR
POTOMAC CR
POTOMAC RIVER
WICOMICO RIVER
PRINCE WILLIAM
KING GEORGE
PEPPER MILL CR
UPPER MACHODOC CR
ROSIER CR
0 5 10 MILES
0 5 10 KILOMETERS

Figure 11. Distribution of widgeongrass (1) Ruppia maritima, horned pondweed (2) Zannichelia palustris, Chara (3) sp., and common elodea (4) Elodea canadensis in the transition zone of the Potomac River, 1984 (from Allaire, et al., 1985).


NEABSCO CR
POWELLS CR
OCCOQUAN BAY
QUANTICO CR
CHOPAWAMSIC CR
MATTAWOMAN CR
PORT TOBACCO CR
ZEKIAH SWAMP RUN
WARDS RUN
MILL RUN
PORT TOBACCO
NANJEMOY CR
AQUIA CR
ACCOKEEK CR
POTOMAC CR
POTOMAC RIVER
WICOMICO RIVER
PRINCE WILLIAM CO
KING GEORGE CO
PEPPER MILL CR
UPPER MACHODOC CR
ROSIER CR
0 5 10 MILES

overflights in this area which were conducted after the peak in standing crop of SAV.

11. UPPER POTOMAC RIVER

This section may be one of the most interesting of this study because of its past history and what has been occurring with SAV in the last three years. This section of the river had been largely devoid of SAV since the 1930's although large beds of SAV were present in the early 1900's (Orth and Moore, 1984; Carter, et al., 1985b). During the 1978-81 USGS surveys no species of SAV were found. Since 1981, however, not only has there been a dramatic increase in many of the native species, but also three species, Hydrilla verticillata, Heteranthera dubia, and Najas minor, not present in earlier surveys (Carter, et al., 1985a,b) were reported. This increase has occurred in the reach between Alexandria, Virginia, and Marshall Hall, Maryland. Fig. 12 shows the species diversity of SAV in the tidal Potomac River in 1983 while Fig. 13 shows the increase in species diversity in this same area in 1984. Comparison of the 1984 transect data (Table 9, Fig. 6) with that of the 1978-81 survey clearly shows the increase in the upper tidal river (Table 10). All of the increase which occurred in the Mattawoman/Piscataway Creeks and the Gunston Cove regions was above Marshall Hall. There is still virtually no SAV in the reach between Marshall Hall and Quantico, Virginia.

The presence of Hydrilla is notable given the growth potential of this species. Hydrilla is a fast growing exotic plant from Southeast Asia. It is considered a nuisance in California, Florida and other southeastern states because it forms thick mats of vegetation which interfere with recreational use of the water. It reproduces both vegetatively and sexually, and overwinters by tubers and turions. In 1981, a small

Figure 12. SAV species diversity in the tidal Potomac River, 1983 (from Carter, et al., 1985a).

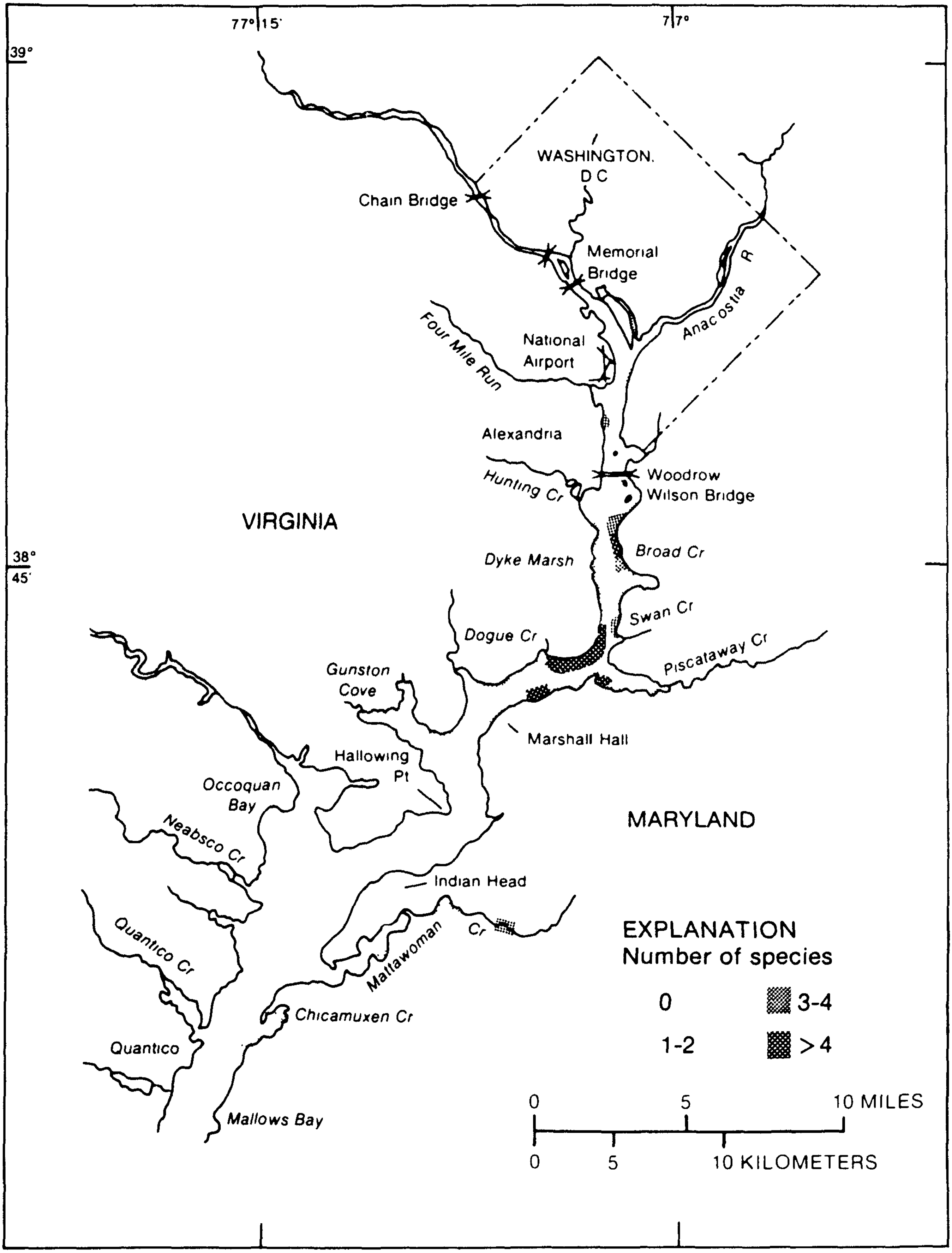
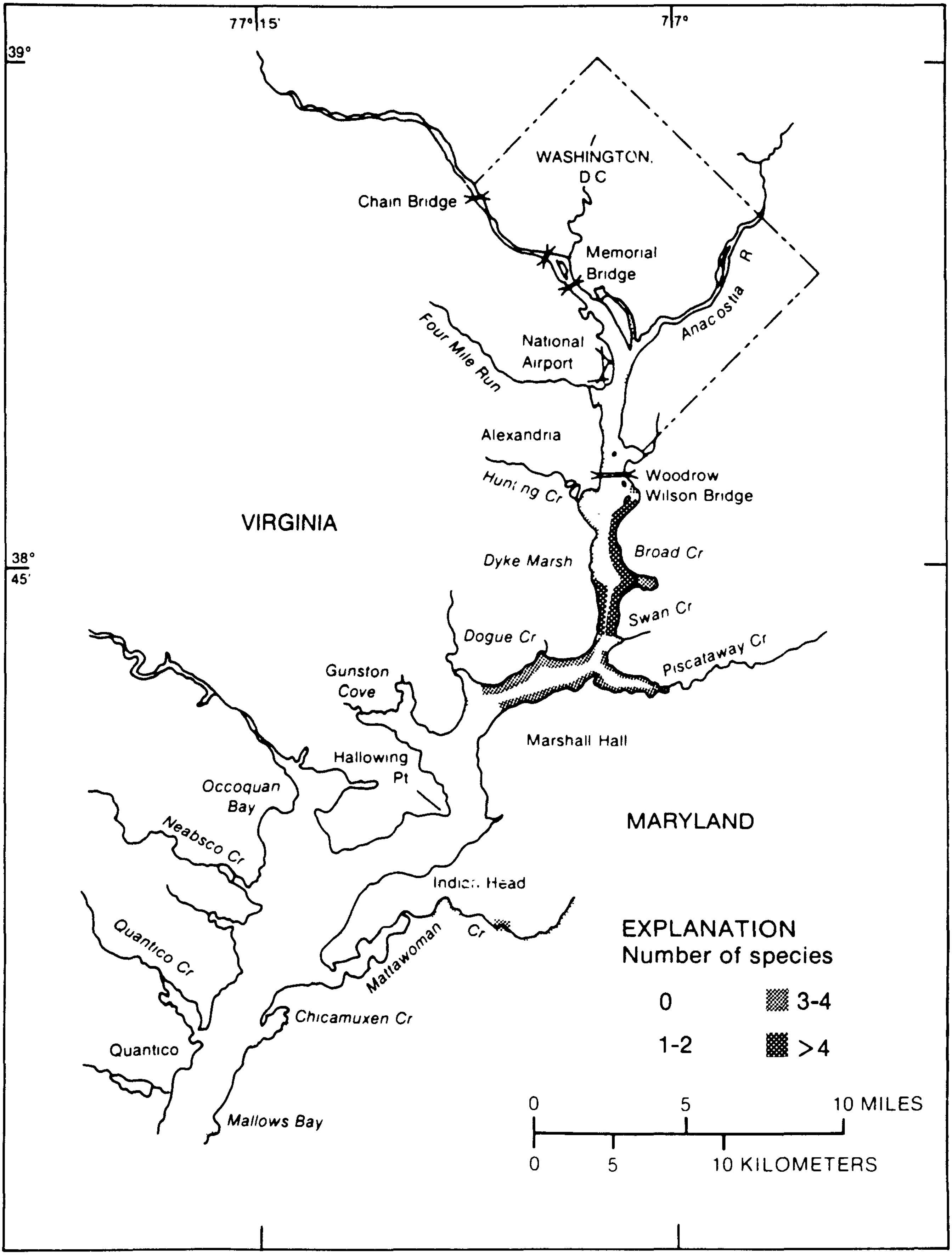

77°15'
77°
39°
38°
45'
WASHINGTON, D C
Chain Bridge
Memorial Bridge
Anacostia R
National Airport
Four Mile Run
Alexandria
Hunting Cr
Woodrow Wilson Bridge
VIRGINIA
Dyke Marsh
Broad Cr
Swan Cr
Dogue Cr
Piscataway Cr
Gunston Cove
Marshall Hall
Hallowing Pt
Occoquan Bay
Neabsco Cr
MARYLAND
Indian Head
Mattawoman Cr
Quantico Cr
Chicamuxen Cr
Quantico
Mallows Bay
EXPLANATION
Number of species
0
1-2
3-4
>4
0 5 10 MILES
0 5 10 KILOMETERS

Figure 13. SAV species diversity in the tidal Potomac River, 1984 (from Carter, et al., 1985a).

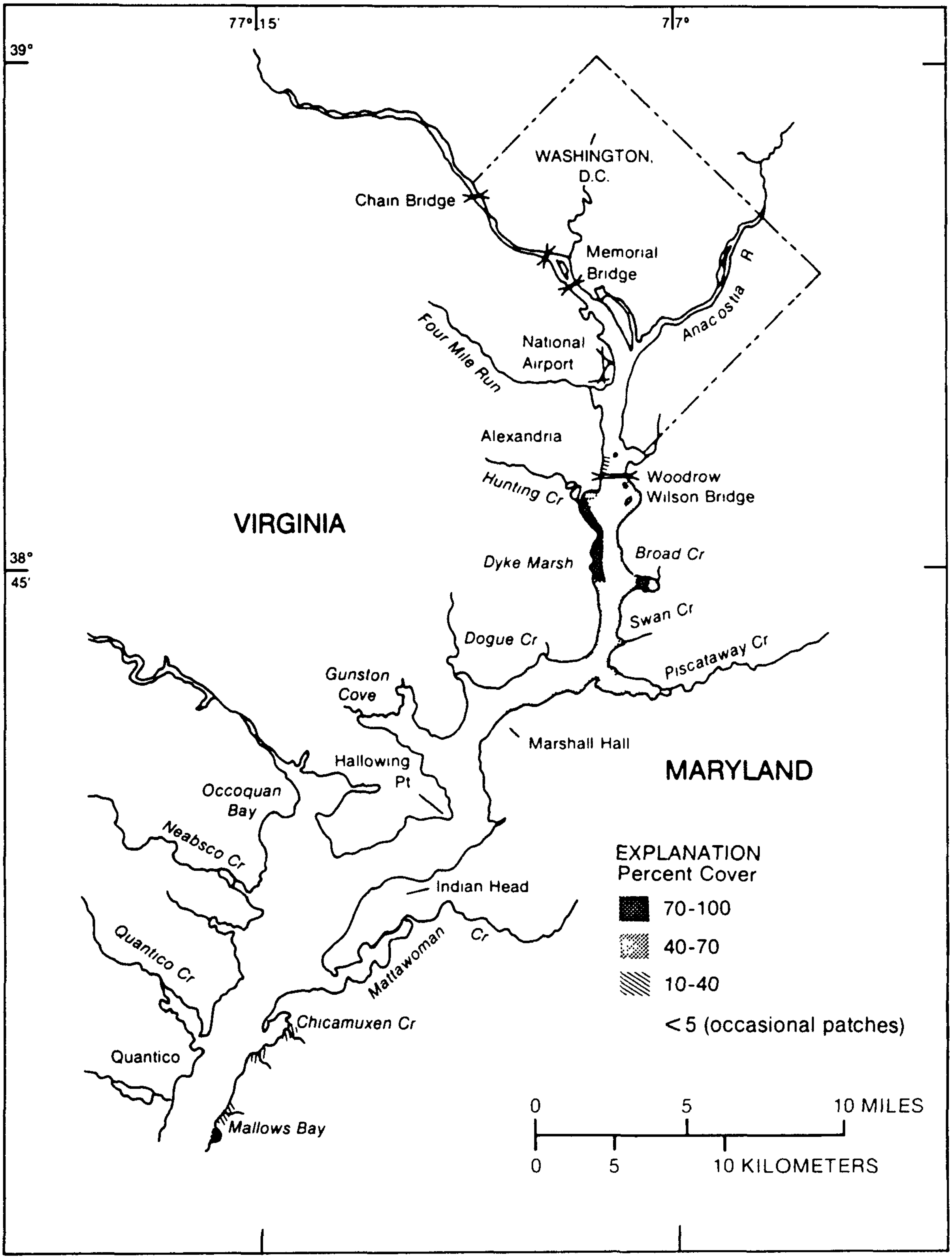

77° 15'
77°
39°
38° 45'
WASHINGTON, D C
Chain Bridge
Memorial Bridge
Anacostia R
Four Mile Run
National Airport
Alexandria
Woodrow Wilson Bridge
Hunting Cr
VIRGINIA
Broad Cr
Dyke Marsh
Swan Cr
Dogue Cr
Piscataway Cr
Gunston Cove
Marshall Hall
Hallowing Pt
Occoquan Bay
Neabsco Cr
MARYLAND
Indian Head
Quantico Cr
Mattawoman Cr
Chicamuxen Cr
Quantico
Mallows Bay
EXPLANATION
Number of species
0
1-2
3-4
>4
0 5 10 MILES
0 5 10 KILOMETERS

population of Hydrilla was found in Dyke Marsh, Virginia. In 1982, the Department of Agriculture made a positive identification and discovered that Hydrilla was widespread in lentic environments in the Washington, D.C. area. By 1983, Hydrilla was firmly established in the reach above Marshall Hall, with its greatest population in the Dyke Marsh area on the Virginia side of the river (Fig. 14). In 1984, it filled in along the Maryland and Virginia shorelines, with the largest populations along the shoreline adjacent to and across from Dyke Marsh (Fig. 15). In many parts of the tidal river, it is found growing with many other species and composes less than 10 percent of the total plant material. There is concern that Hydrilla might outcompete other desirable SAV species in the Potomac River.

Allaire et al. (1985) also reported Hydrilla in this section (Table 11) but much farther south than that reported by Rybicki et al. (1985). It was prevalent in the marsh guts on the Maryland side of the river down to Mathias Point and present in 13 of the 186 grids sampled (Fig. 9). One specimen was found floating in a tributary of Potomac Creek, and three plants were found rooted behind the marsh at Aquapo Beach on Aquia Creek. No Hydrilla was found rooted in the main part of the Potomac River in the transition zone.

Allaire et al. (1985) also found other species present in this section (Table 11, Figs. 8-11). No vegetation was found in the Quantico quadrangle while Indian Head, Widewater, Passapatanzy and King George had 20%, 28%, 32% and 12% of the grids vegetated, respectively. Coontail and wild celery were the most abundant species evident.

The Md.DNR survey sampled 52 stations in this section in 1984 and found vegetation in only one, Broad Creek. Hydrilla was present in the three samples collected from this site.


77° 15'
77°
39°
38°
45'
WASHINGTON, D.C.
Chain Bridge
Memorial Bridge
Anacostia R
National Airport
Four Mile Run
Alexandria
Woodrow Wilson Bridge
Hunting Cr
VIRGINIA
Broad Cr
Dyke Marsh
Swan Cr
Dogue Cr
Piscataway Cr
Gunston Cove
Marshall Hall
MARYLAND
Hallowing Pt
Occoquan Bay
Neabsco Cr
EXPLANATION
Percent Cover
70-100
40-70
10-40
<5 (occasional patches)
Indian Head
Quantico Cr
Mattawoman Cr
Chicamuxen Cr
Quantico
Mallows Bay
0
5
10 MILES
0
5
10 KILOMETERS

The 1984 aerial survey confirmed the presence of the SAV beds in this section (Tables 4-7) with 631 hectares mapped from the photography. Of the 11 quadrangles in this section, SAV was present in six, with 67% found in the Mt. Vernon quadrangle and 25% in the Alexandria quadrangle. As indicated from the ground surveys of the USGS, the SAV was a mixture of many species, including Hydrilla. No SAV was mapped for this section in 1978.

The cause for the increase in SAV in this section is not known but may be related to nutrient changes in this region. There has been a dramatic decrease in phosphate loading from the Blue Plains sewage treatment plant since the late 1970's. In 1983, Blue Plains began nitrification, changing the predominant nitrogen species in the river from ammonia to nitrate. At the same time, Blue Plains reduced the suspended solids output from the plant (Table 12). Secchi depths in the upper tidal river were significantly higher in 1983 than in the 1978-81 (Table 13). There were blue-green algae blooms during the summer of 1983 and 1984, but the 1983 bloom did not reach the Wilson Bridge until nearly September, moving upriver from the Quantico area. In 1984, the river discharge was higher and the bloom never reached the upper tidal river. These recent algal blooms have thus had little effect upon the water clarity and light available for SAV growth in this section.

12. MIDDLE EASTERN SHORE

In 1984, there was only 32.9 hectares of SAV in this section compared to 210 hectares found in 1978 (Tables 4-7). The earlier aerial survey found only four species present: widgeongrass, horned pondweed, sago pondweed and eelgrass. This section comprises a large area of the mid-bay section with many areas having large, broad flats (Bloodsworth and South Marsh Islands) or coves that would be conducive for SAV growth, yet very little is present

TABLE 12. TOTAL SUSPENDED SOLIDS OUTPUT FROM THE PRIMARY OUTLET OF BLUE PLAINS SEWAGE TREATMENT PLANT, 1982 AND 1983.

[Monthly mean in mg/L (number of observations)]

Month	1982	1983
April	9.8 (30)	1.2 (20)
May	4.16 (31)	1.0 (31)
June	7.09 (30)	1.3 (30)
July	4.82 (31)	1.1 (30)
August	5.18 (31)	1.2 (31)
September	6.7 (30)	1.2 (30)
October	5.24 (31)	1.3 (31)

TABLE 13. SECCHI DEPTH IN THE UPPER AND LOWER TIDAL RIVER, JULY-OCTOBER, 1978-81 AND JULY-OCTOBER, 1983 (SE = STANDARD ERROR, N = NUMBER OF OBSERVATIONS).

[Depth in cm]

Location/Date	Mean	SE	N
Upper tidal river			
July-October, 1978-81	51.8	3.28	38
July-October, 1983	85.5	4.69	48
July-August, 1983	87.3	5.20	39
Lower tidal river			
July-October, 1978-81	38.8	1.29	72
July-October, 1983	50.8	4.96	13
July-August, 1983	50.8	4.96	13

today in this section. Fifty-five percent of the SAV in this section in 1984 occurs in the Bloodsworth quadrangle with the remaining beds located in Golden Hill, Honga, Wingate and Richland Point quadrangles. No SAV occurs in 8 quadrangles.

The Md.DNR survey sampled 169 stations in this section, examining sites in the James-Barren Island system, Honga River, Fishing Bay, Nanticoke - Wicomico River, Manokin River and Big Annemessex River (Table 8, Fig. 7). Only 1 of 15 stations in the Manokin River had SAV (widgeongrass), while 1 of 12 stations in the Big Annemessex River was also vegetated with widgeongrass (Table 8, Fig. 7). All the stations sampled in the other areas were unvegetated.

13. TANGIER ISLAND COMPLEX

This section contains the second largest number of quadrangles that contain SAV (8) and is the section with the most SAV present. In 1984, 5,376 hectares were mapped compared to 3,759 hectares in 1978, a 43% increase (Tables 4-7). The number of hectares in this section was over twice as much as in the next largest section, the Lower Eastern Shore, which has 2,232 hectares. Of the SAV mapped in the Lower Bay zone, 48% is located in the Tangier Island Complex.

The SAV beds are concentrated in several distinct areas: adjacent to Big Marsh between Chesconessex Creek and Deep Creek, on the west side of Webb and Halfmoon Island, the east side of Fox Islands around Cedar Straits and the areas in and around Tangier and Smith Islands and the large broad shoal area between the two islands. Seventy-three percent (3,909 hectares) of the SAV in this section is located in the Tangier-Smith Island region. This, by far, is the section of the bay that has the densest concentration of SAV.

The Md.DNR survey of Smith Island indicated a decline in SAV from 1983 to 1984, when only 29.4% of the 17 stations were vegetated. This is in contrast to the photographic data showing a large increase in the Smith Island area. A comparison of the 17 DNR station locations and the distribution maps from aerial photography indicated that the twelve unvegetated stations were adjacent to existing beds outlined in the photographs and that the five vegetated stations were in areas classified as dense from the photography.

Two other areas were field checked by the Maryland survey. No SAV was found in the 22 stations in the Pocomoke Sound area although small scattered beds were aerially mapped very close to the shoreline, well inshore of the sampled stations. In the Little Annemessex River, the Maryland survey showed no SAV in 8 sampled stations. The aerial survey showed beds located on both shores of the river in a narrow band and well inshore of several of the Maryland stations. The SAV in the Crisfield quadrangle increased from 7 to 107 hectares from 1978 to 1984 in the aerial survey while the Maryland survey has shown no increase and very little vegetation in this region.

14. LOWER EASTERN SHORE

This section contains the largest number of quadrangles that contain SAV (9) and is the second largest section in SAV area in the Lower Bay zone. In 1984, 2,232 hectares, consisting of eelgrass and widgeongrass, were mapped compared to 1,991 hectares in 1978, an increase of 12% (Tables 4-7). The largest beds were found around Cape Charles at the mouth of Cherrystone Inlet, and at the mouths of Hungars and Mattawoman Creeks (also called Vaucluse Shores), Occahannock Creek, Craddock Creek, Pungoteague Creek and Onancock Creek. The areas between these creek systems are sparsely vegetated or unvegetated because of the exposed nature of these broad sand flats.

SAV in the Vaucluse Shores historical area (includes part of Hungars and Mattawoman Creeks) (see Orth, et al., 1979, for a detailed description of the site) has remained relatively stable since 1978 (Table 14, Fig. 16), although changes prior to 1978 were a result of the dynamic nature of the sand bars and spits in this region. The historical area was also the site where seven transects were made in 1978 for species distribution. These transects showed widgeongrass in the shallowest areas, eelgrass in the deeper sites and both species at intermediate depths. Horned pondweed has also been found mixed with widgeongrass in the shallowest depths.

15. REEDVILLE

In 1984, 264 hectares of SAV were observed in the section compared to the 364 hectares mapped in 1978 (Tables 4-7). Most of the beds, which are found throughout the section, were classified as sparse or very sparse (Table 7). This section contains the Fleets Bay historical site where 101 hectares were mapped in 1984 compared to 73 hectares in 1978 (Table 14, Fig. 16). SAV coverage actually decreased from 1978 to 1980 but increased in 1981. This increase from 1981 to 1984 was noted to occur in areas that were classified as sparse or very sparse.

16. RAPPAHANNOCK RIVER COMPLEX

Only 23 hectares of SAV were found in this section in 1984 compared to 93 in 1978 (Tables 4-7). Several small but dense beds are present in the Milford Haven area, remnants of the dense beds present in the early 1970's. The other beds are small and sparse, located along the north shore of the Rappahannock River. No SAV was observed in the Piankatank River. There were no SAV beds in the Parrott Island historical area (Table 14, Fig. 16).

TABLE 14. AREAS OF SAV AT HISTORICAL MAPPING SITES (LOWER BAY ZONE) 1937-1984

Parrott Islands

Date	Area m² <10%	10-40%	40-70%	70-100%	Total
1937	0	297,024	1,598,268	0	1,895,292
1951	394,797	778,146	1,222,410	1,158,384	3,553,737
1960	411,306	631,566	547,014	1,947,372	3,537,258
1968	92,064	1,354,110	1,205,628	124,374	2,776,176
1974	0	2,922	7,710	0	10,632
1978	0	22,872	0	0	22,872
1980	0	0	0	0	0
1981	0	0	0	0	0
1984	0	0	0	0	0

Fleets Bay

Date	Area m² <10%	10-40%	40-70%	70-100%	Total
1937	0	1,385,424	548,076	744,864	2,678,364
1953	1,488,258	597,354	591,018	284,232	2,960,862
1961	1,572,612	1,330,140	1,643,892	884,280	5,430,924
1969	1,436,403	1,938,660	1,592,170	270,372	5,237,605
1974	105,714	1,624,884	1,325,040	0	3,055,638
1978	167,688	528,918	33,592	0	730,198
1980	0	121,890	26,040	2,472	150,402
1981	0	683,250	9,816	13,986	707,052
1984	232,164	730,680	33,318	14,556	1,010,718

Mumfort Islands

Date	Area m² <10%	10-40%	40-70%	70-100%	Total
1937	0	495,060	397,368	23,832	916,260
1953	151,728	699,252	106,356	1,461,846	2,419,182
1960	0	258,210	1,880,238	0	2,138,448
1971	0	685,536	1,088,976	0	1,774,512
1974	0	127,488	23,826	0	151,314
1978	0	0	0	0	0
1980	0	0	0	0	0
1981	0	0	0	0	0
1984	0	0	0	0	0

continued

TABLE 14. (continued)

Jenkins Neck

Date	<10%	10-40%	Area m² 40-70%	70-100%	Total
1937	0	1,180,200	820,612	32,520	2,033,332
1953	426,480	647,112	717,180	1,811,832	3,602,604
1960	140,448	794,178	639,012	2,067,948	3,641,586
1971	0	278,586	2,350,380	33,792	2,662,758
1974	93,972	303,804	1,599,228	93,912	2,090,916
1978	132,714	299,760	671,616	162,408	1,266,498
1980	60,810	191,605	690,968	179,589	1,122,972
1981	0	0	763,194	309,012	1,072,206
1984	72,876	289,388	563,268	954,360	1,879,892

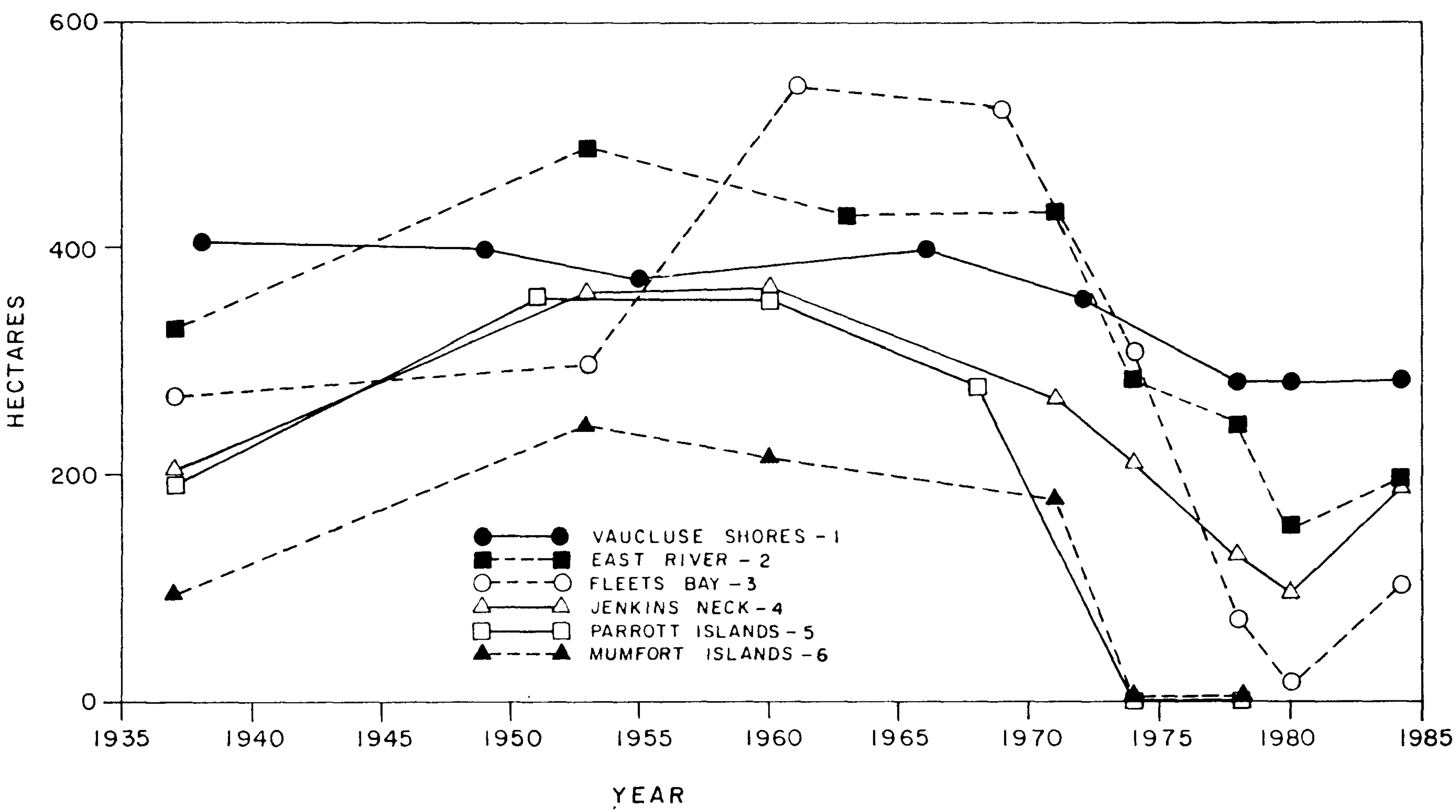
East River

Date	<10%	10-40%	Area m² 40-70%	70-100%	Total
1937	1,024,010	809,770	1,357,790	85,530	3,277,100
1953	591,840	1,158,490	1,394,740	1,742,050	4,887,120
1963	31,032	1,916,530	2,340,480	0	4,288,042
1971	0	2,007,460	2,253,080	96,620	4,357,160
1974	509,730	348,820	1,955,130	0	2,813,680
1978	47,860	515,000	1,864,850	0	2,427,710
1980	191,520	451,351	808,842	158,634	1,610,347
1981	0	96,174	1,183,542	198,474	1,478,190
1984	496,445	739,836	706,736	88,458	2,031,475

Vaucluse Shores

Date	<10%	10-40%	Area m² 40-70%	70-100%	Total
1938	0	1,120,284	1,451,392	1,480,128	4,051,804
1948	506,706	1,171,884	1,715,556	0	3,994,146
1955	1,938,258	0	528,996	1,238,124	3,705,378
1966	452,940	402,324	2,534,178	604,176	3,993,618
1972	286,554	364,764	2,515,740	391,770	3,558,828
1978	187,728	507,054	80,872	2,036,526	2,812,180
1980	359,551	7,098	697,842	1,783,938	2,848,429
1981	327,786	97,950	355,344	1,852,392	2,633,472
1984	0	15,792	1,137,882	1,731,678	2,885,352

Figure 16. Trends in areal coverage of SAV at six intensively mapped areas in the lower Chesapeake Bay, 1937-1984.



600
400
200
0
HECTARES
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
YEAR
VAUCLUSE SHORES - 1
EAST RIVER - 2
FLEETS BAY - 3
JENKINS NECK - 4
PARROTT ISLANDS - 5
MUMFORT ISLANDS - 6

17. NEW POINT COMFORT REGION

Dense beds of SAV were found in this section in 1984 from New Point Comfort Lighthouse to just north of Horn Harbor (Tables 4-7). Two hundred ninety-nine hectares of SAV were mapped in 1984 compared to 271 hectares in 1978. Prominent features of this section are the distinct, unvegetated sand bars found parallel to the shoreline with SAV found in the troughs between successive bars.

Two transects were made in the area in 1978 for species distribution. Both eelgrass and widgeongrass were present, with widgeongrass in the shallower depths along the transect and eelgrass in the deeper zones.

18. MOBJACK BAY COMPLEX

This section contains one of the largest amounts of SAV in the lower Bay zone. In 1984, 1,550 hectares were mapped compared to 1785 hectares in 1978 (Tables 4-7). SAV beds, consisting of eelgrass and widgeongrass, are present along the shorelines of the entire Mobjack Bay and three of the four tributaries: Severn, Ware and North Rivers. Little SAV is present in the East River. One of the largest and densest beds found along the western shore of the lower bay is present around the Guinea Marshes in the New Point Comfort quadrangle.

Four transects on the Achilles quadrangle (Browns Bay and Ware Point) and two in the New Point Comfort quadrangle (mouth of East River) were made in 1978. Data from these transects also showed widgeongrass in the shallowest depths and eelgrass predominantly in the deeper locations with the two found together at intermediate depths.

SAV in the East River historical area (see Orth, et al., 1979, for a detailed description of this site) decreased from 1978 to 1984, but examination of data collected in 1980 and 1981 showed SAV increasing 37%

from 1981 to 1984 (Table 14, Fig. 16). Observation of this area has shown the increase also occurring from recruitment and growth of seedlings.

19. YORK RIVER

There were 238 hectares of SAV mapped in 1984 compared to 157 hectares in 1978, an increase of 52% (Tables 4-7). The major SAV beds, consisting of eelgrass and widgeongrass, in this section are present on the north side of lower York River in the Achilles quadrangle. There are no SAV beds above Gloucester Point in the Clay Bank quadrangle. One small bed present in the Yorktown quadrangle in 1984 near Gloucester Point was transplanted to this area in the fall of 1983 (Orth, unpublished data). Monitoring of the lower York River has shown these areas to be increasing as a result of seedling recruitment from adjacent, upstream beds, followed by rapid growth of these seedlings.

There was still no SAV present in the Mumfort Island historical area while SAV increased 48% from 1978 in the Jenkins Neck historical area (Table 14, Fig. 16) (see Orth, et al., 1979, for a detailed description of the sites). The increase is a result of seedling establishment and growth.

Two additional 0.25-hectare beds were transplanted near Gloucester Point in the Achilles quadrangle, one in the fall of 1982 and the second in the fall of 1983. The 1982 planting was done on 1.0 and 0.5 m centers using eelgrass. The bed has grown almost into one unit in less than three years. The 1983 eelgrass planting was conducted on 2 m centers and the units have not coalesced but are still present and growing very well. The 0.25-hectare plot in the Yorktown quadrangle was also planted on 2 m centers.

20. LOWER WESTERN SHORE

The SAV in this section, consisting of eelgrass and widgeongrass, was found in the Broad Bay area off Lynnhaven River, Back River, Drum Island

Flats between Back and Poquoson Flats, Poquoson River and on the south side of Goodwin Island. There were 1,149 hectares of SAV mapped in 1984 compared to 925 hectares in 1978 (Tables 4-7). The SAV beds in the Broad Bay area (37.87 hectares-Cape Henry quadrangle) were not mapped in 1978, although it is most likely they were present that year since subsequent surveys from 1980 through 1983 has shown the persistence of this vegetation. The distribution of vegetation in the Hampton and Poquoson West quadrangles remained similar while there was a 33% increase in SAV (516 to 687 hectares) in Poquoson East quadrangle. This increase occurred on the Drum Island Flats adjacent to existing beds of SAV that have persisted since the early 1970's. Most of the beds in this section have been classified as moderate (40 to 70%) or dense (70 to 100%) (Table 7).

21. JAMES RIVER

The small patches of SAV, consisting of eelgrass, in the Hampton Roads area present in 1978 had disappeared by 1980 and were still absent in 1984 (Tables 4-7). The remaining SAV beds identified in 1978 were located in the Norge quadrangle, and although this area was not photographed and mapped in 1984, an aerial reconnaissance survey of the area in late 1984 indicated that these beds were still present that appeared very similar to the 1978 distribution maps. We have assumed here that the 1984 total would be similiar to the 1978 total. These beds occur as narrow fringing beds located along the edge of the marsh channels at water depths of less than 1 meter. The dominant species here are coontail, several Naiad species and common elodea (Orth, et al., 1979).

SECTION 5

SUMMARY AND CONCLUSIONS

The distribution of beds of submerged aquatic vegetation in the Chesapeake Bay and tributaries in 1984 was examined using both aerial photographic and ground surveys. Aerial photographs were used to map SAV bed outlines onto topographic quadrangles while ground surveys provided both photo verification of the SAV beds and species identification. To delineate SAV beds on a baywide basis, the distribution of SAV was divided into three major zones and 21 sections within the three zones. The areas mapped were displayed on 157 topographic quadrangles. The quadrangles include all areas with a potential for SAV growth in the bay region. The distribution data for 1984 were compared to data collected from a baywide survey conducted in 1978.

In 1984, SAV was found occupying 15,400 hectares of bottom. Of this total, 18.7% of the beds were classified as very sparse (<10% coverage), 18.6% as sparse (10-40%), 27.3% as moderate (40-70%) and 35.5% as dense (70-100%). In 1984, 20.6% of the SAV beds were located in the Upper Bay zone, 6.3% in the Middle Bay zone and 73.0% in the Lower Bay zone. The coverage of SAV in 1984 was less than the total found in 1978 (16,637 hectares). In the 1978 survey, 16.8% of the vegetation was found in the Upper Bay zone, 26.7% in the Middle Bay zone and 56.5% in the Lower Bay zone. Increases in SAV coverage from 1978 to 1984 were measured in 8 of the 21 sections: Susquehanna Flats, Upper Eastern Shore, Upper Potomac River, Tangier Island Complex, Lower Eastern Shore, New Point Comfort Region, York River and Lower Western Shore. Decreases were measured in 13 of the 21 sections: Upper Western Shore, Chester River, Central Western Shore, Eastern Bay, Choptank River, Patuxent River, Middle Western Shore, Lower Potomac River, Middle

Eastern Shore, Reedville, Rappahannock River Complex, Mobjack Bay Complex and James River.

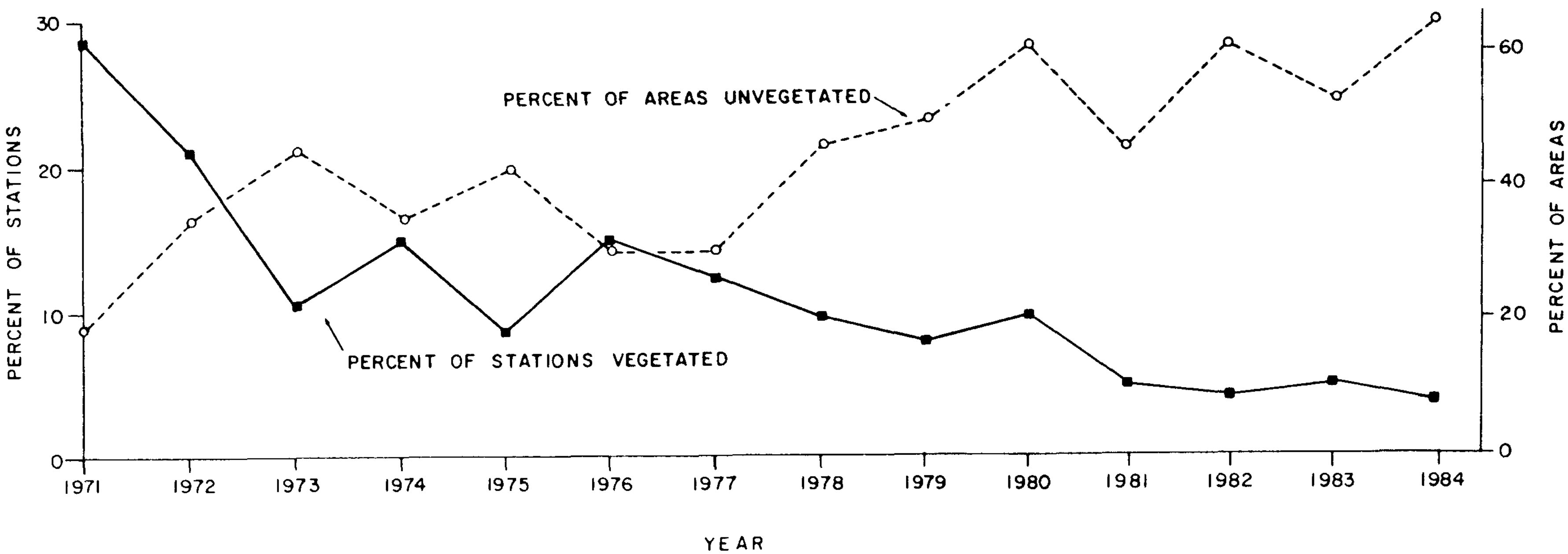
In the Upper Bay zone, although there was an increase noted, all of this occurred on the Susquehanna Flats where 95% of the area was classified as very sparse (<10% coverage). Independent aerial and ground surveys of this area in 1982 and 1984, respectively, indicate that there has been an expansion of SAV in this section since 1978 but that the vegetation is very patchy and not readily apparent on higher altitude photography. Most of the SAV observed on the Susquehanna Flats was Myriophyllum spicatum (milfoil) with Vallisneria americana (wild celery) occurring in lesser abundance. A total of only 2 species were noted in the ground surveys in 1984, in contrast to the 15 species found here in the late 1950's (Bayley, et al., 1978; Orth and Moore, 1984). Reductions of SAV were recorded in the Upper Eastern Shore and Upper Western Shore sections. Although, there was some loss of the aerial imagery from these two sections, the Md.DNR ground survey showed reductions of SAV in these areas.

SAV in the Middle Bay zone was reduced from 1978 to 1984: 4,446 to 984 hectares, respectively. Seven of the eight sections showed a decline of SAV. In one of these sections, Lower Potomac River, aerial photography obtained late in the season may have resulted in an underestimation of SAV abundance. Ground surveys by USGS and NVCC personnel documented SAV presence at a number of stations in areas that did not show SAV in the aerial photography. Given the survey information for 1984, and what was observed for the entire Potomac River in 1984, the actual abundance of SAV in the Lower Potomac River was at least equal to that recorded in 1978. The Upper Potomac River section was the only area of the river to show a significant increase. No aerial photography of the Upper Potomac was obtained in 1978 and ground surveys found no SAV through 1981. From 1981 to 1984, 631 hectares of river bottom became vegetated with SAV. This increase includes not only many native species but also significant populations of two species not recorded in earlier surveys of the river: Hydrilla verticillata (Hydrilla) and Heteranthera dubia (water stargrass). Since Hydrilla has become a problem species in other areas of the U.S., there is concern over its increase to nuisance levels in certain sections of the Potomac. The river should be carefully monitored in succeeding years to follow the growth of Hydrilla as well as other native species.

The Lower Bay zone showed an increase of 1778 hectares since 1978 (19%) with most of the increase (82%) occurring in the Tangier Island Complex. Increases in SAV beds in the York River have been observed to occur from seed recruitment from nearby vegetated areas. This increase was also noted in 3 of the 6 historical sites in this zone: Jenkins Neck, East River and Fleets Bay. As in 1978, no SAV was observed at two sites (Mumfort Island and Parrott Island). The sixth site, Vaucluse Shores, has remained relatively stable since 1978.

In summary, although the total amount of SAV in the bay in 1984 is somewhat less than that found in 1978, both increases and decreases have been observed in particular sections. Most of the decrease has occurred in the region from just below the Susquehanna Flats to Smith Island. This decrease in vegetation during the last 6 years has also been noted by the Md.DNR vegetation survey (Table 8, Fig. 17). The number of sampled stations with SAV has continued to decrease from earlier years. In 1984, only 4.0% of the stations were vegetated compared to 9.5% in 1978. Seventeen of 26 areas were without any SAV compared to 12 in 1978. However, certain procedures used in the Maryland DNR survey, such as stations located in

Figure 17. Trends in occurrence of SAV in the Maryland portion of the Chesapeake Bay, 1971-1984. Values represent the percentage of stations with vegetation (N = 644) and the percentage of unvegetated areas (N = 26).


PERCENT OF STATIONS
PERCENT OF AREAS
PERCENT OF AREAS UNVEGETATED
PERCENT OF STATIONS VEGETATED
30
20
10
0
60
40
20
0
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
YEAR

waters too deep to support SAV growth, may be resulting in a skewed or an unrealistically low impression of total SAV presence.

Increases in SAV have been noted in the Upper Potomac River, Susquehanna Flats and at a number of locations in the Lower Bay zone. The increase of SAV in the upper Potomac River may be related to nutrient changes in this part of the river, primarily from a reduction in phosphate loading and suspended solids from the Blue Plains sewage treatment plant and the initiation of nitrification in 1983. The causes for the increase in SAV in several sections and decreases in others is not known, but annual monitoring of SAV populations along with the monitoring of nutrient and light parameters at these areas is essential for generating any significant correlative data. In addition, the success of various transplant efforts by both states should be examined carefully with regard to the nutrient and light regimes found in those river systems where the transplanting is being conducted. These data will be critical in understanding the success at these sites.

SECTION 6

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APPENDIX A

SPECIES OF SUBMERGED AQUATIC PLANTS FOUND IN THE CHESAPEAKE BAY AND TRIBUTARIES (MODIFIED FROM CARTER, ET AL., 1985)

Family	Species	Common name
Characeae (muskgrass)	Chara braunii Gm.	Muskgrass
	Chara zeylanica Km. ex Wild	
	Nitella flexilis (L). Ag.	
Najadaceae (pondweed)	Potamogeton perfoliatus L.	Redhead-grass
	Potamogeton pectinatus L.	Sago pondweed
	Potamogeton crispus L	Curly pondweed
	Potamogeton pusillus L.	Slender pondweed
	Ruppia maritima L.	Widgeongrass
	Zannichellia palustris L.	Horned pondweed
	Najas quadalupensis (Spreng.) Morong	Southern naiad
	Najas gracillima Magnus	Naiad
	Najas minor All	
Hydrocharitaceae (frogbit)	Vallisneria americana Michx.	Wildcelery
	Elodea canadenis (Michx.) Planch.	Common elodea
	Egeria densa Planch.	Water-weed
	Hydrilla verticillata (L.f.) Caspary	Hydrilla
Ceratophyllaceae (coontail	Ceratophyllum demersum L.	Coontail
Haloragidaceae (watermilfoil)	Myriophyllum spicatum L.	Eurasian watermilfoil
Pondedariceae (pickerelweed)	Heteranthera dubia (Jacqin) MacM.	Water-stargrass
Potamogetonaceae	Zostera marina (L.)	eelgrass

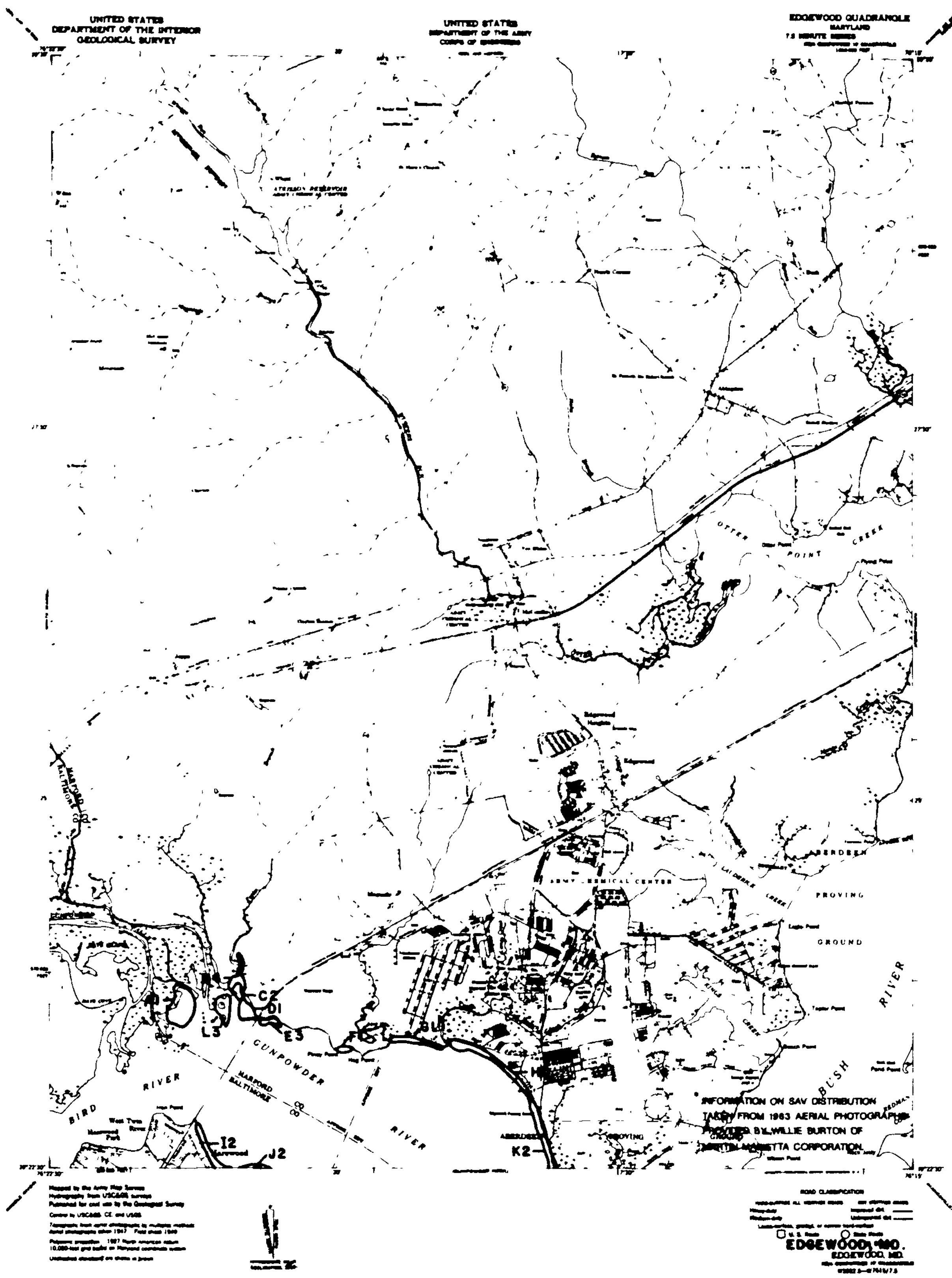
APPENDIX B

TOPOGRAPHIC QUADRANGLES SHOWING THE DISTRIBUTION AND ABUNDANCE OF SAV (1 = <10%; 2 = 10-40%; 3 = 40-70%; 4 = 70-100%)

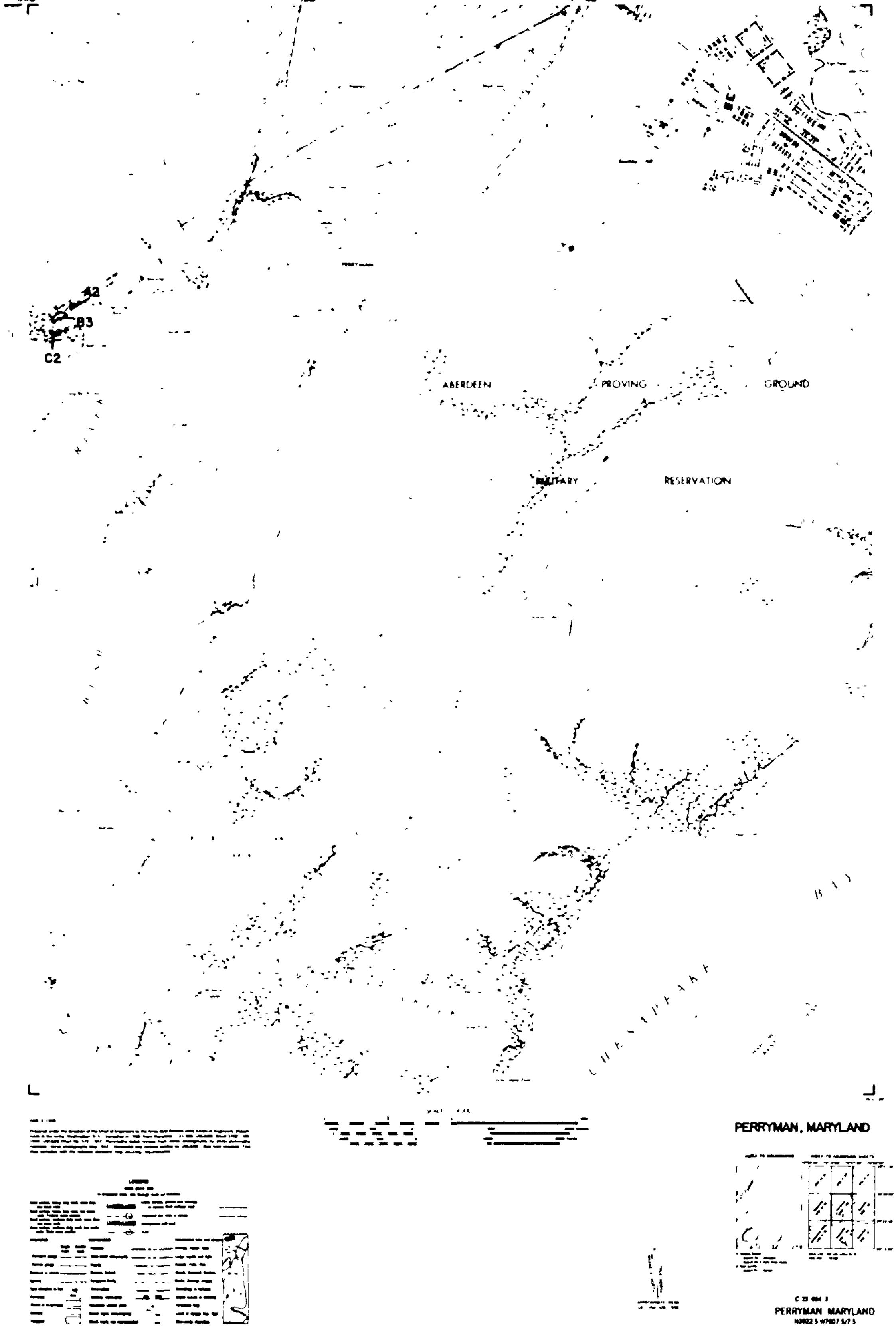

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
HAVRE DE GRACE QUADRANGLE
MARYLAND
K3
W2
HAVRE DE GRACE, MD

SUBMERGED AQUATIC VEGETATION 1984

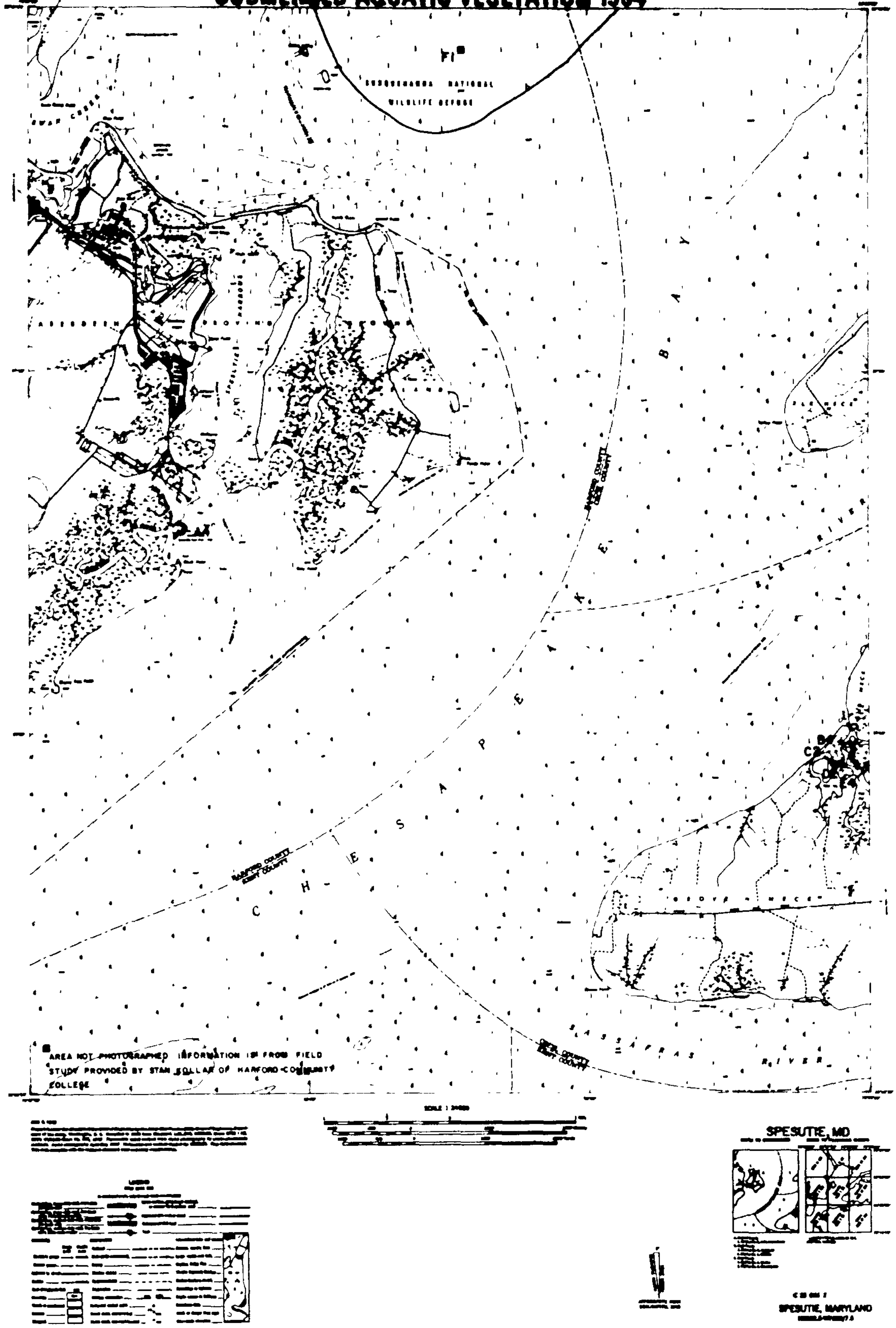
SUBMERGED AQUATIC VEGETATION 1984*



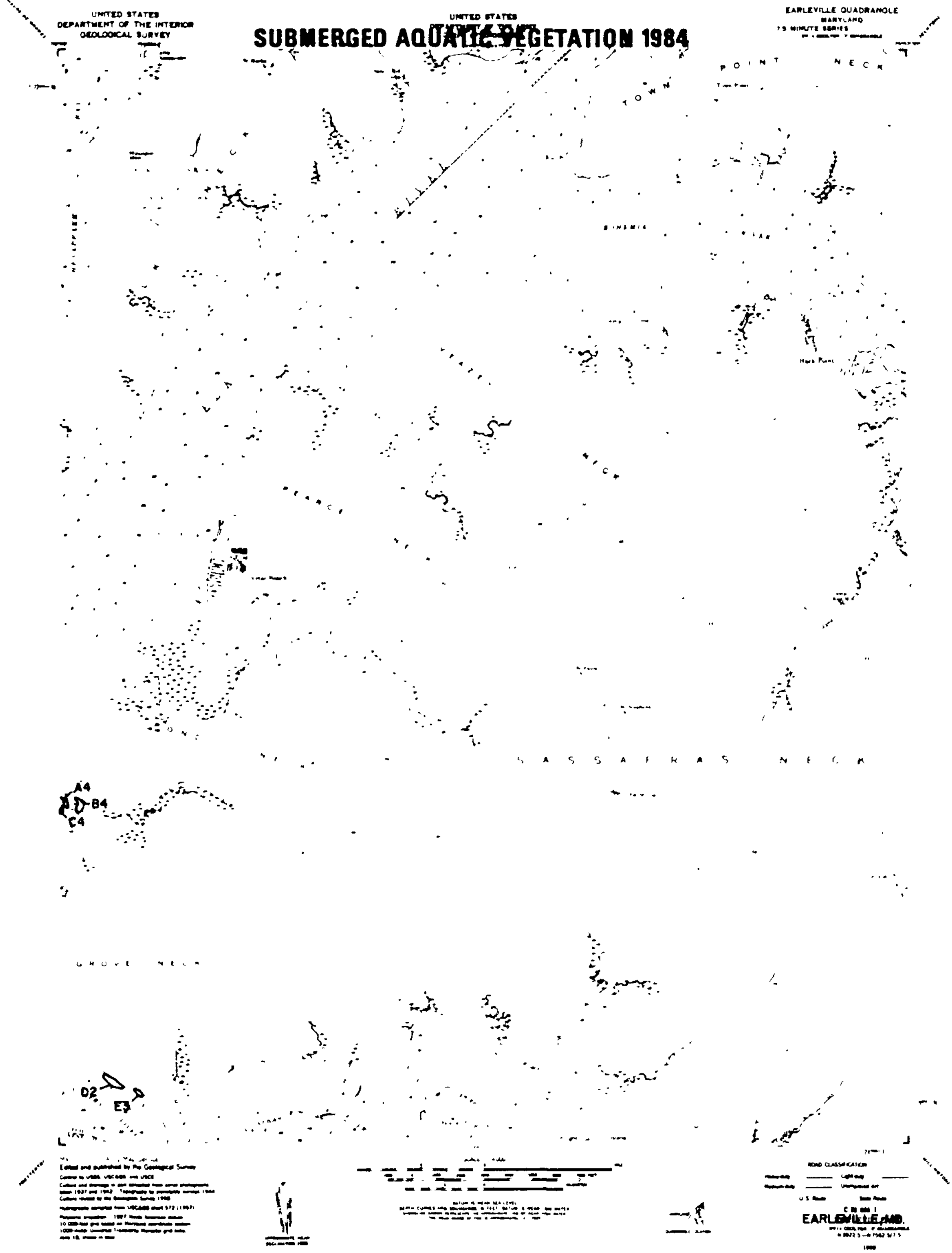
SUBMERGED AQUATIC VEGETATION 1984



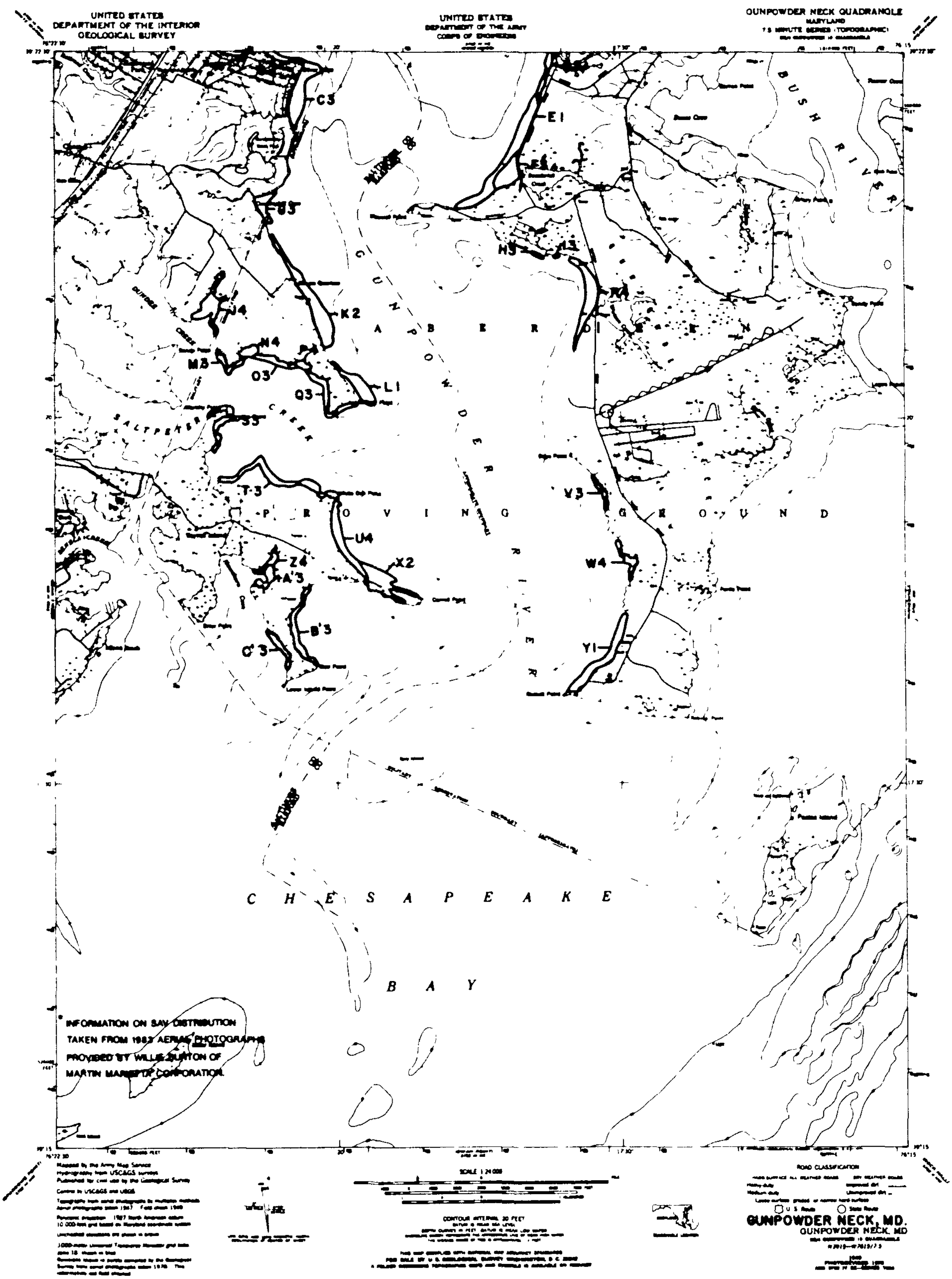
SUBMERGED AQUATIC VEGETATION 1984

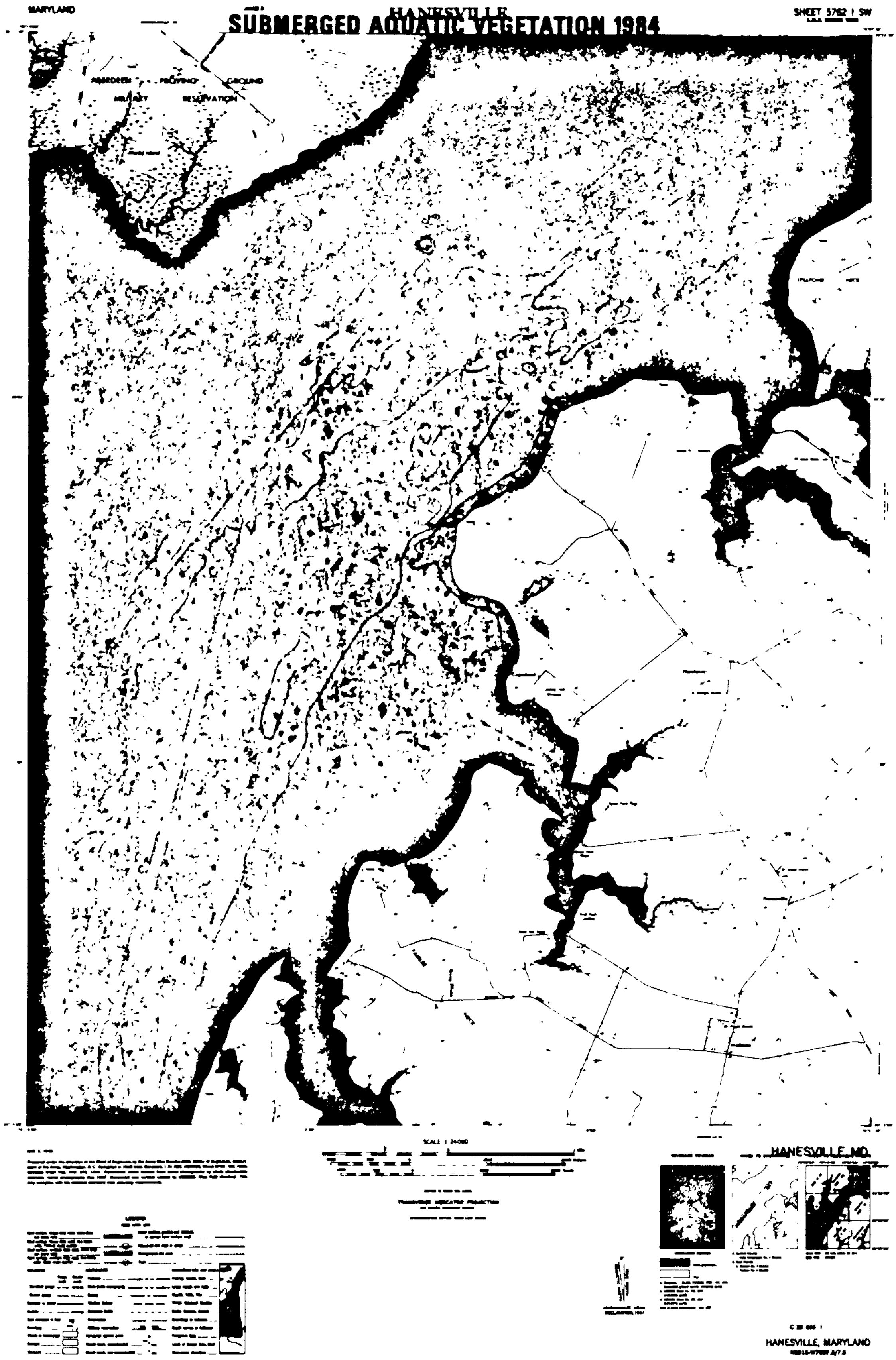


SUBMERGED AQUATIC VEGETATION 1984

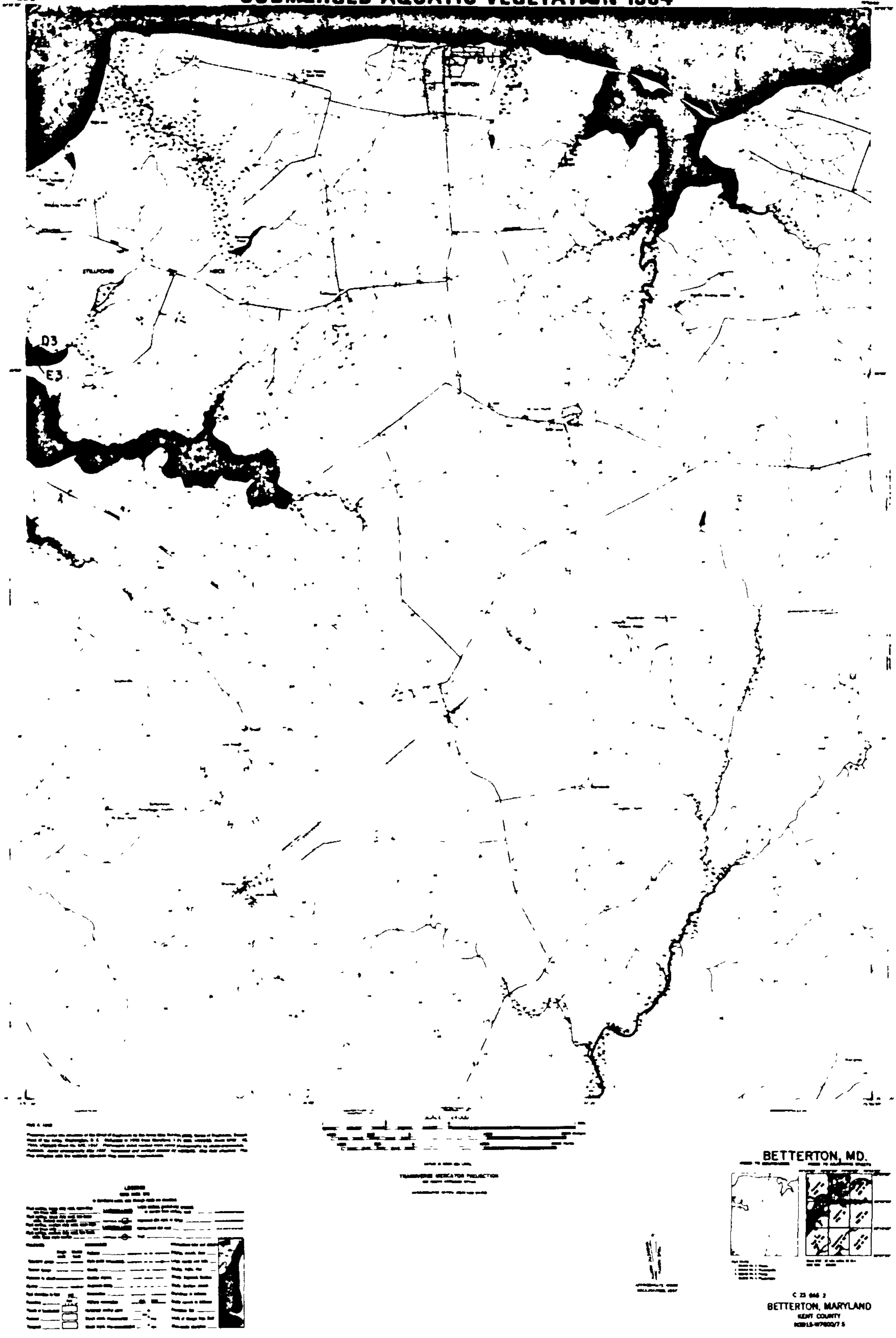


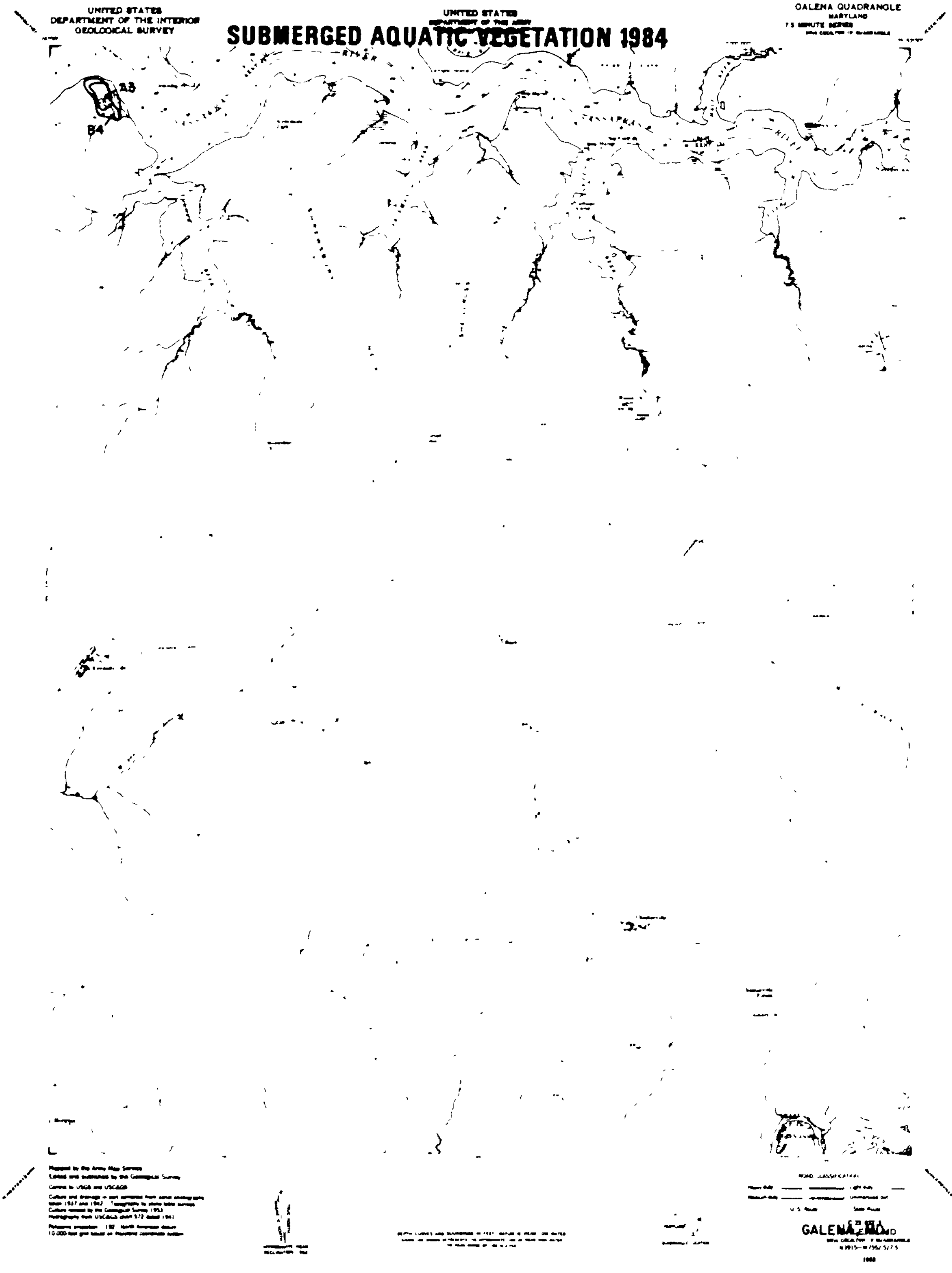
SUBMERGED AQUATIC VEGETATION 1984*




MARYLAND
HANESVILLE
SUBMERGED AQUATIC VEGETATION 1984
SHEET 5762 I SW
ABERDEEN PROVING GROUND
MILITARY RESERVATION
HANESVILLE, MD.
HANESVILLE, MARYLAND

SUBMERGED AQUATIC VEGETATION 1984

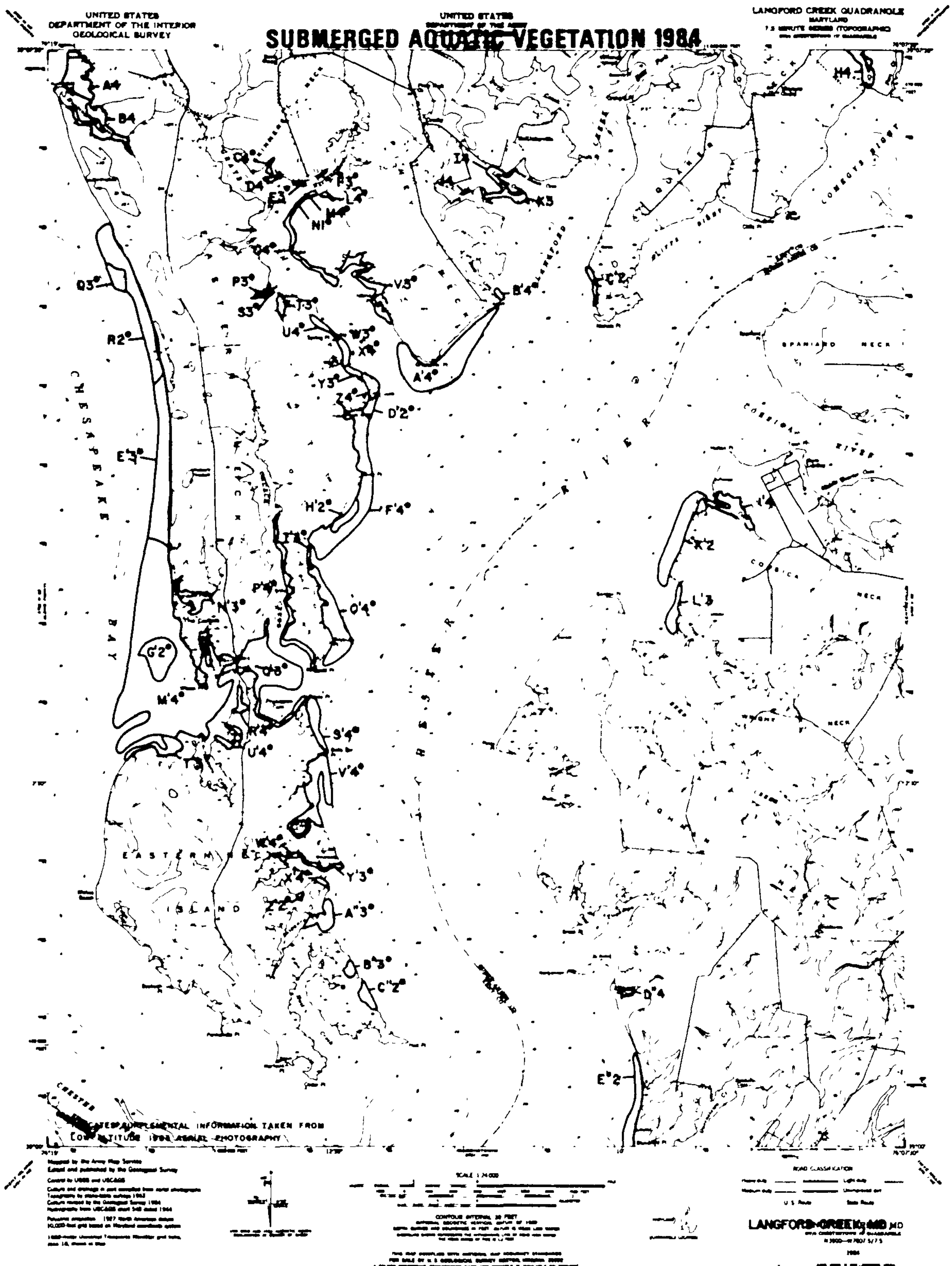



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
GALENA QUADRANGLE
MARYLAND
7.5 MINUTE SERIES
A5
B4
GALENA, MD

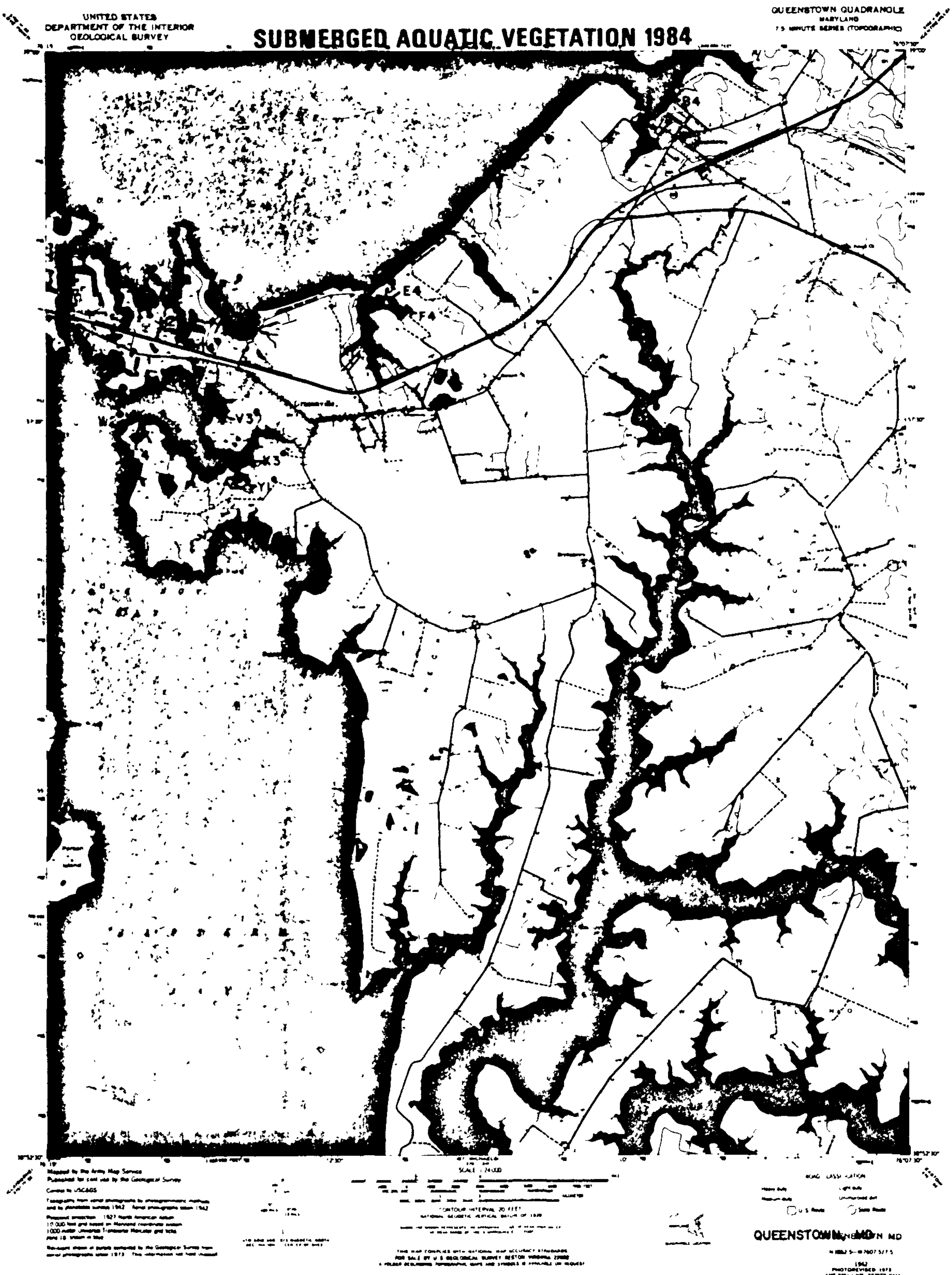
SUBMERGED AQUATIC VEGETATION 1984


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
ROCK HALL QUADRANGLE
MARYLAND—KENT CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
B4
C2
D4
E3
F4
I3
I1
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
ROCK HALL, MD

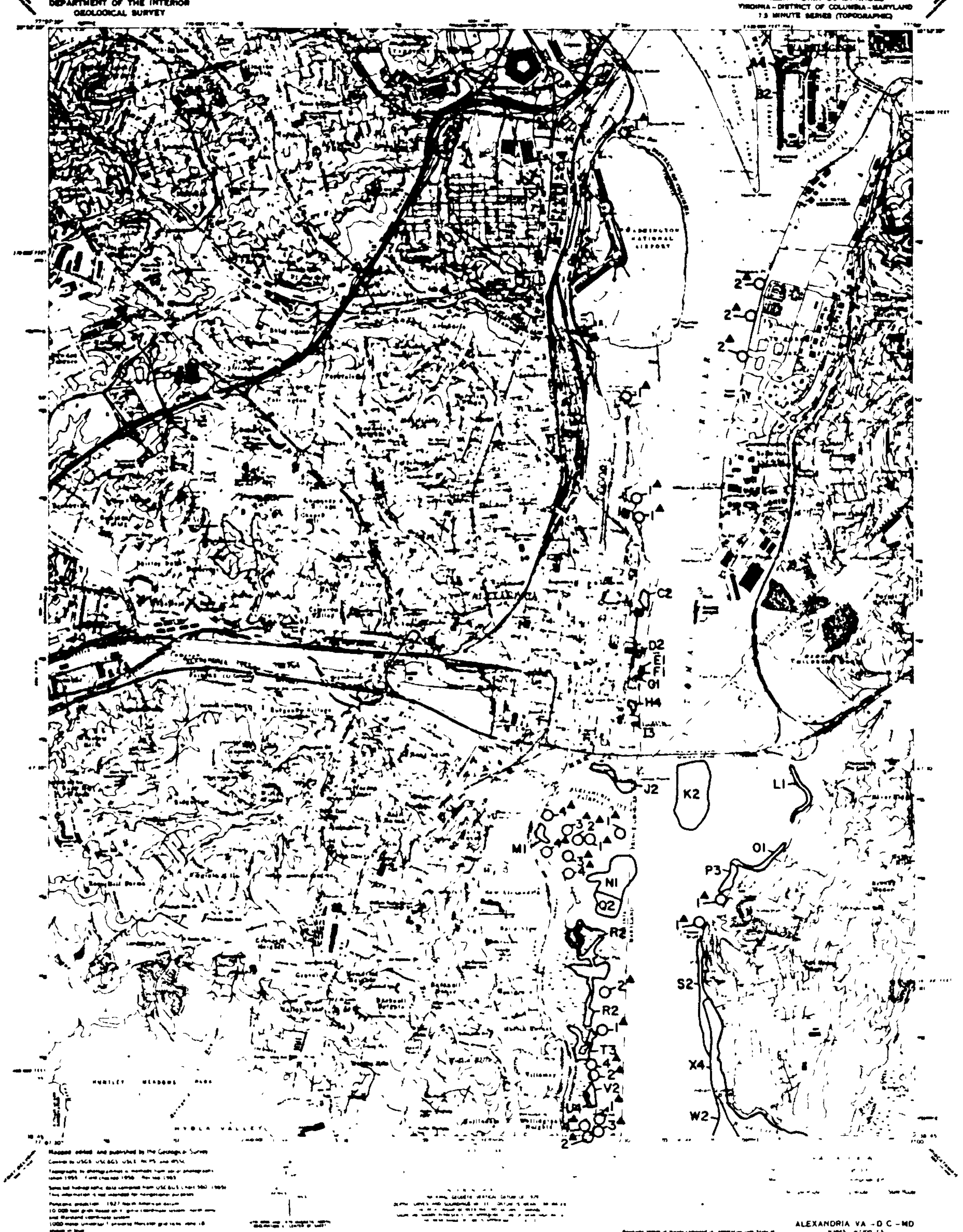

SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
UNITED STATES
GIBSON ISLAND QUADRANGLE
B3
C3
D3
E3
F2
G2
H2
I2
K3
GIBSON ISLAND, MD.


SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
LANGFORD CREEK QUADRANGLE
MARYLAND
CHESAPEAKE
BAY
EASTERN NECK
ISLAND
CHESTER
RIVER
A4
B4
H4
K5
V3
B'4
C'2
Q3
P3
S3
T3
R2
U4
A'4
Y3
Z4
D'2
E'3
H'2
F'4
X'2
L'3
P'4
N'3
O'4
G'2
M'4
S'4
U'4
V'4
W'4
Y'3
X'4
A"3
B"3
C"2
D"4
E"2
LANGFORD CREEK, MD
1984

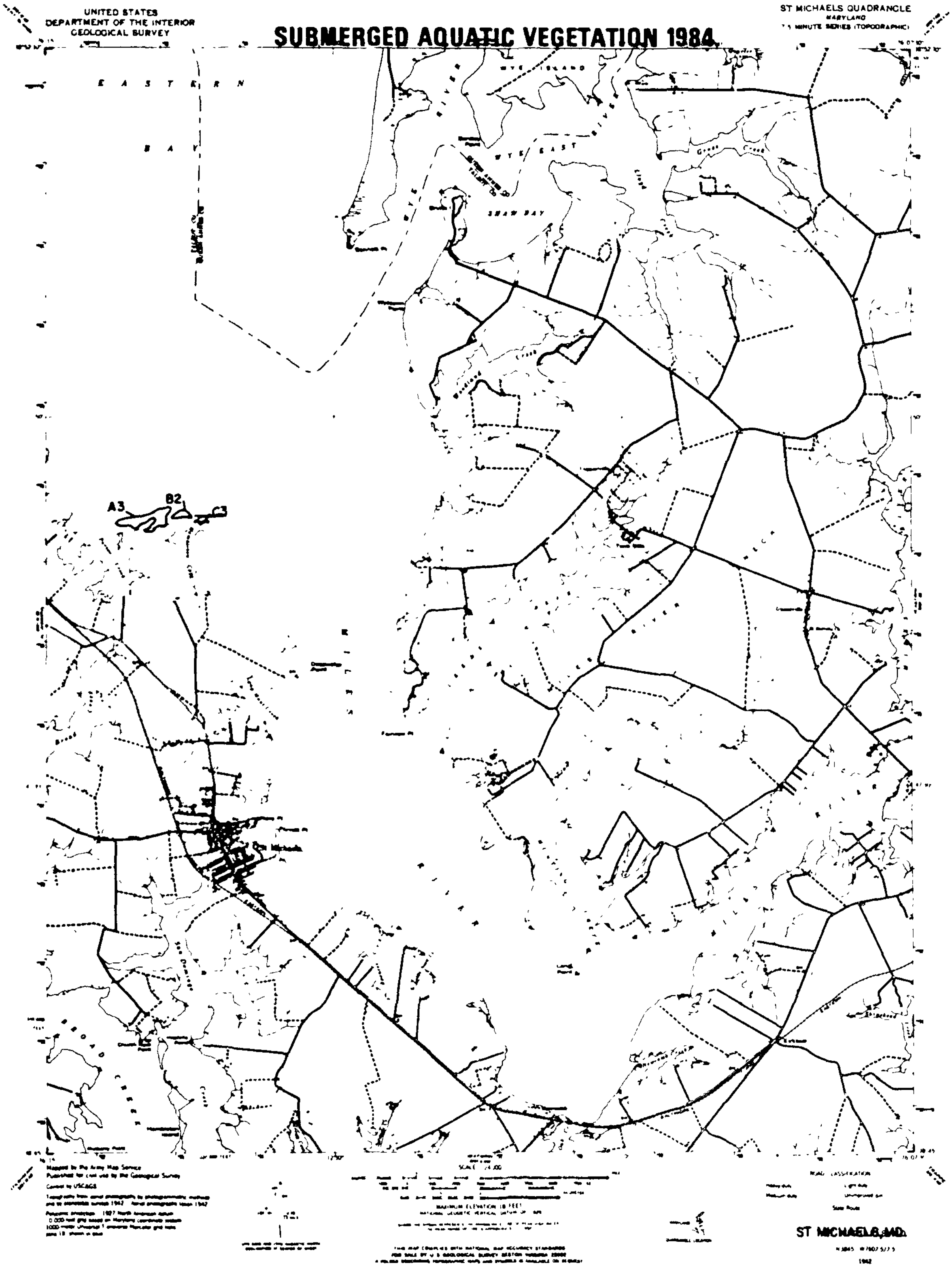

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
UNITED STATES
SUBMERGED AQUATIC VEGETATION 1984
KENT ISLAND QUADRANGLE
MARYLAND
B3
C3
D4
F3
I4
N4
M4
O4
P4
R3
U3
T4
ROAD CLASSIFICATION
KENT ISLAND, MD.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
QUEENSTOWN QUADRANGLE
MARYLAND
7.5 MINUTE SERIES (TOPOGRAPHIC)
B4
E4
F4
V3
K3
Y1
CONTOUR INTERVAL 20 FEET
QUEENSTOWN, MD

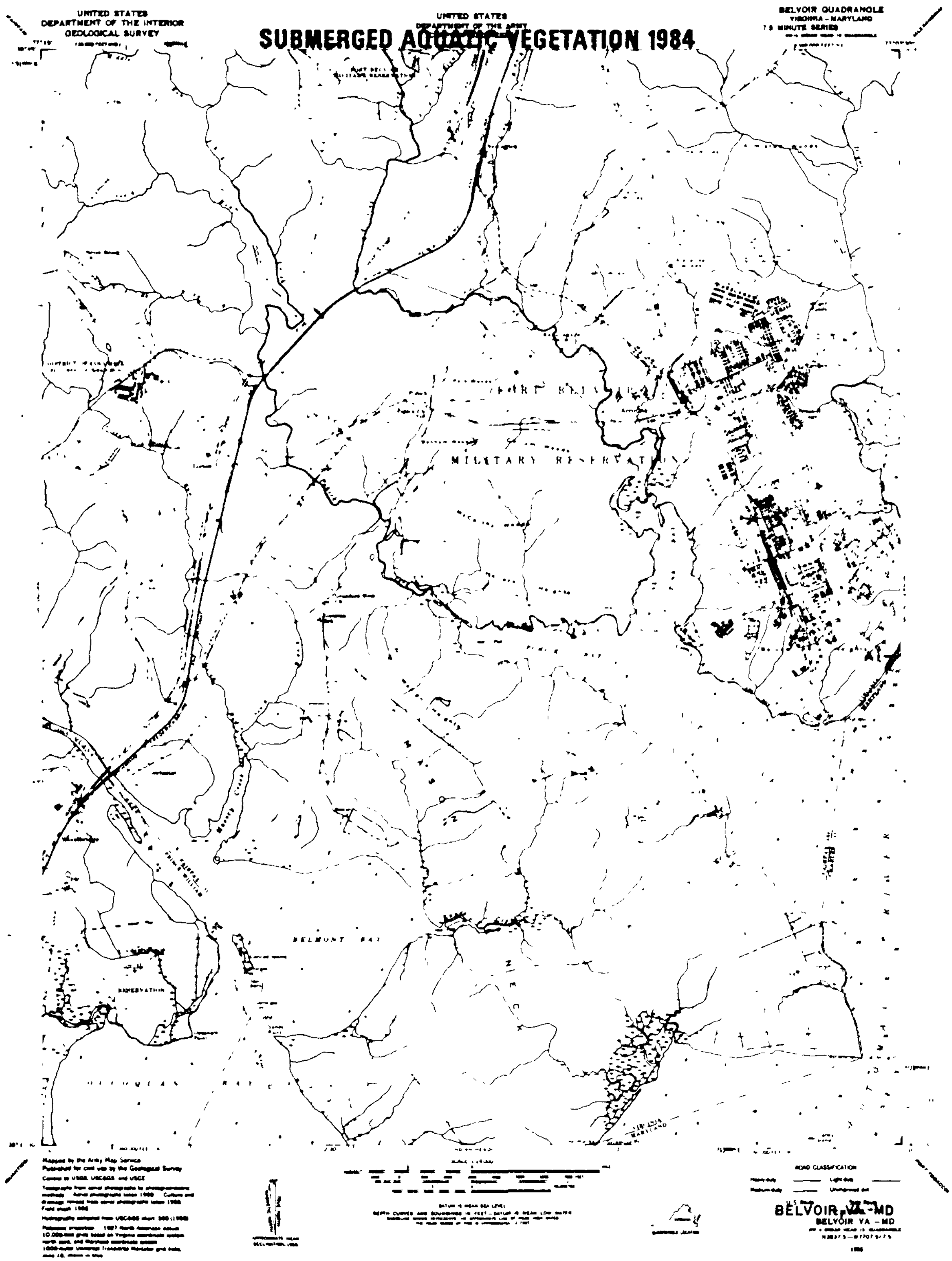
SUBMERGED AQUATIC VEGETATION 1984

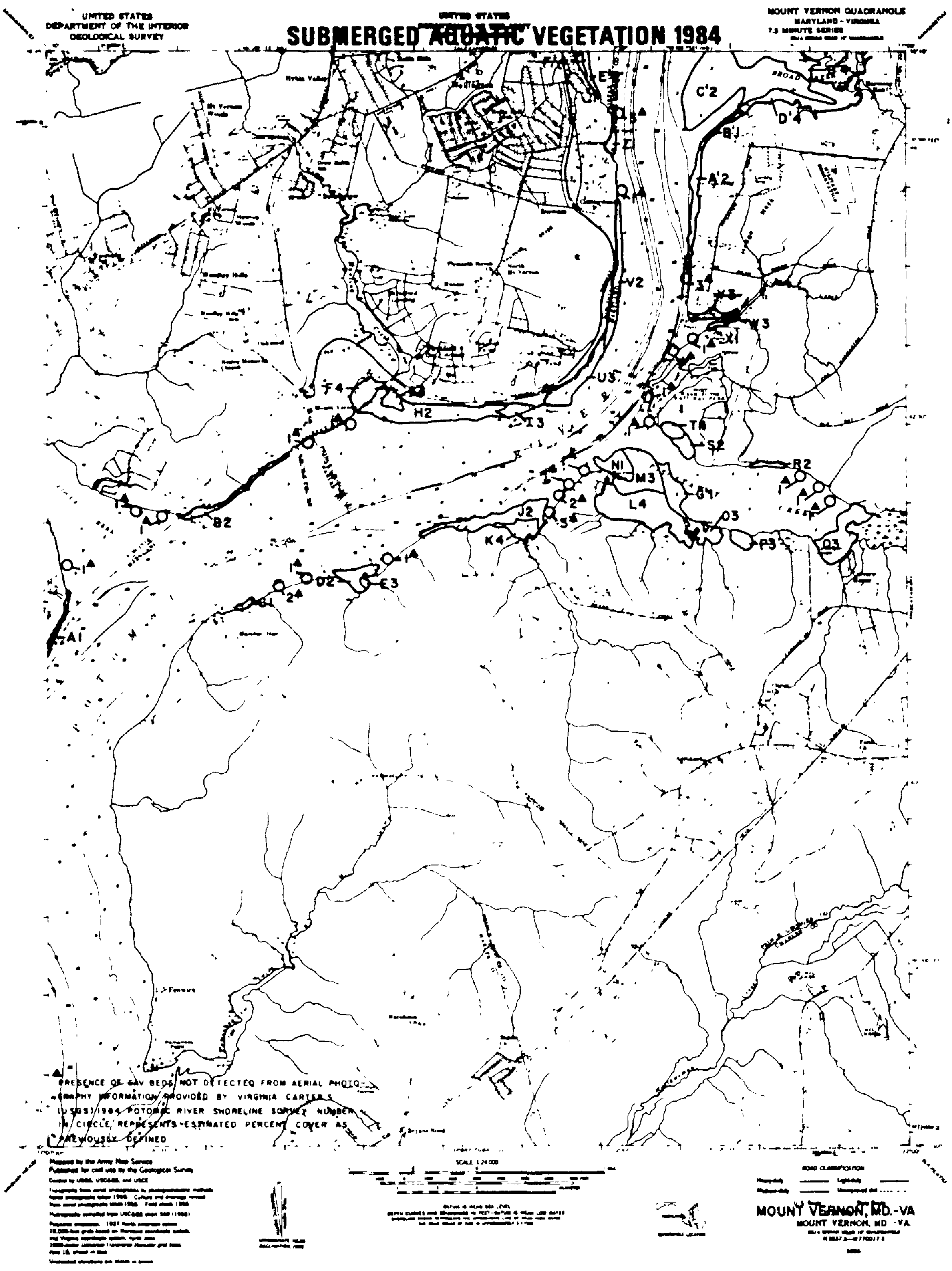


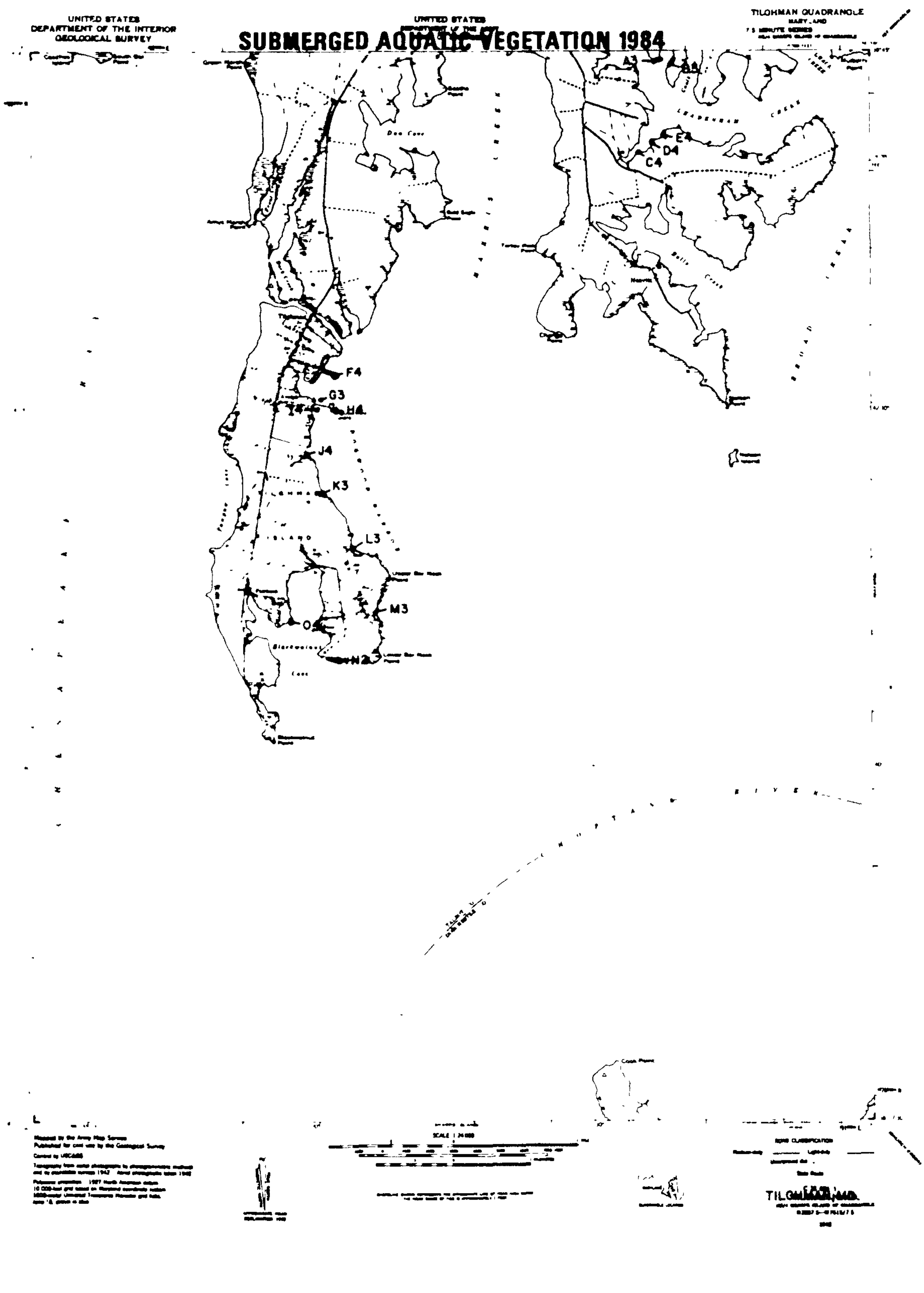

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVE
SUBMERGED AQUATIC VEGETATION 1984
CLAIBORNE QUADRANGLE
MARYLAND
7.5 MINUTE SERIES (TOPOGRAPHIC)
A2
C1
D2
E3
I3
J4
K3
MAXIMUM ELEVATION 20 FEET
CLAIBORNE, MD

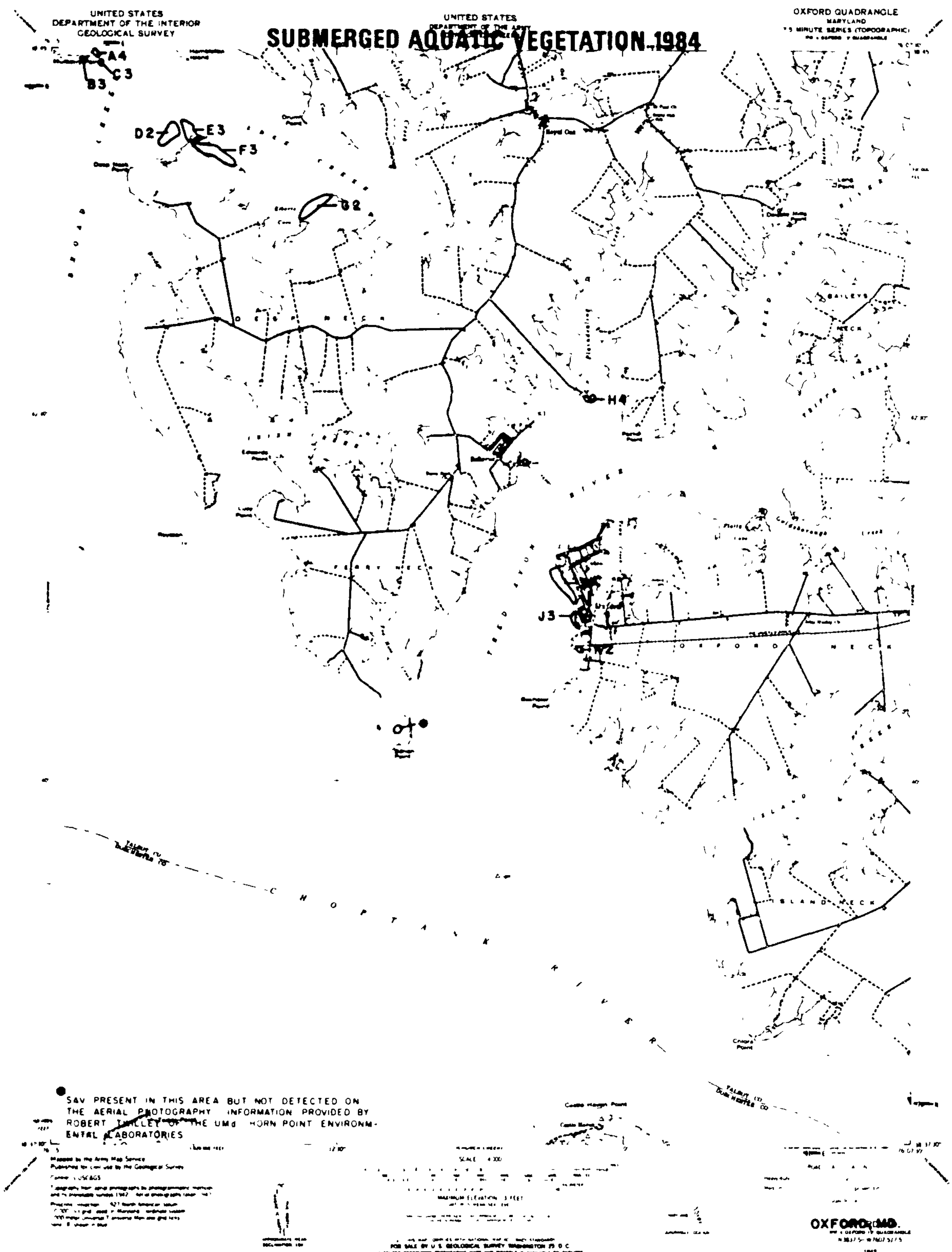


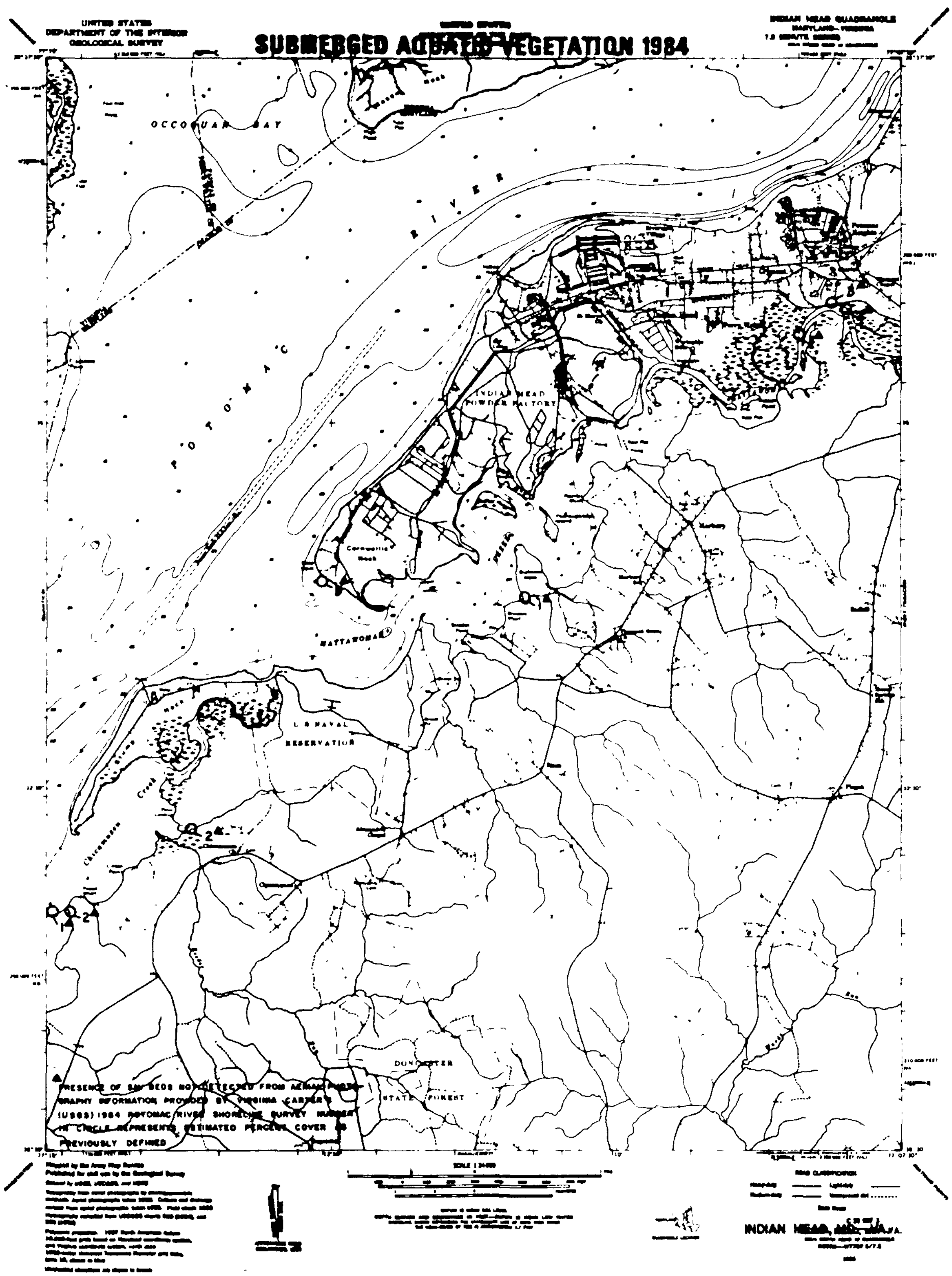
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
ST MICHAELS QUADRANGLE
MARYLAND
EASTERN
BAY
SHAW BAY
A3
B2
C3
ST MICHAELS, MD.

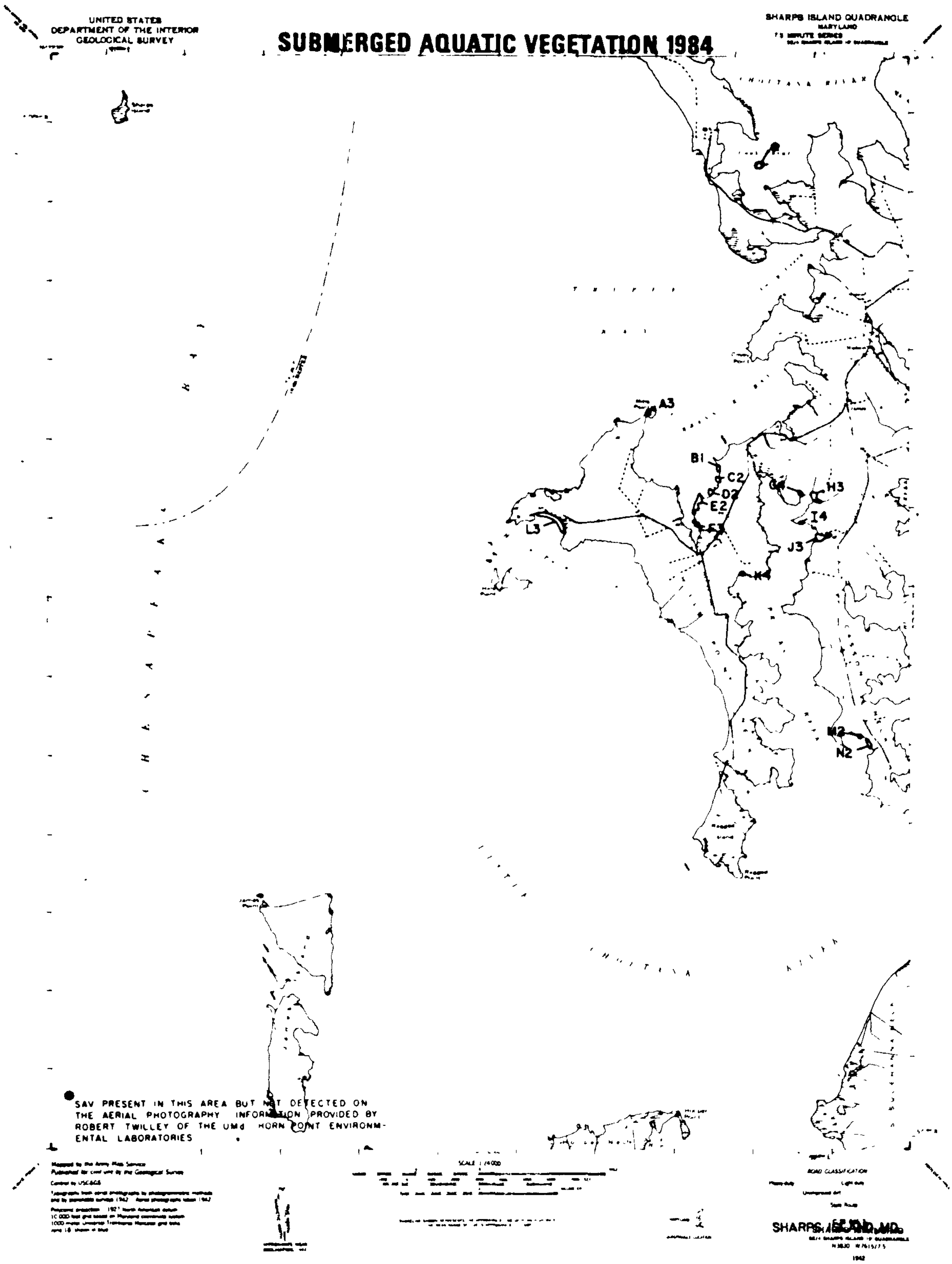

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
UNITED STATES
DEPARTMENT OF THE ARMY
SUBMERGED AQUATIC VEGETATION 1984
BELVOIR QUADRANGLE
VIRGINIA-MARYLAND
7.5 MINUTE SERIES
MILITARY RESERVATION
BELMONT BAY
ROAD CLASSIFICATION
BELVOIR VA - MD

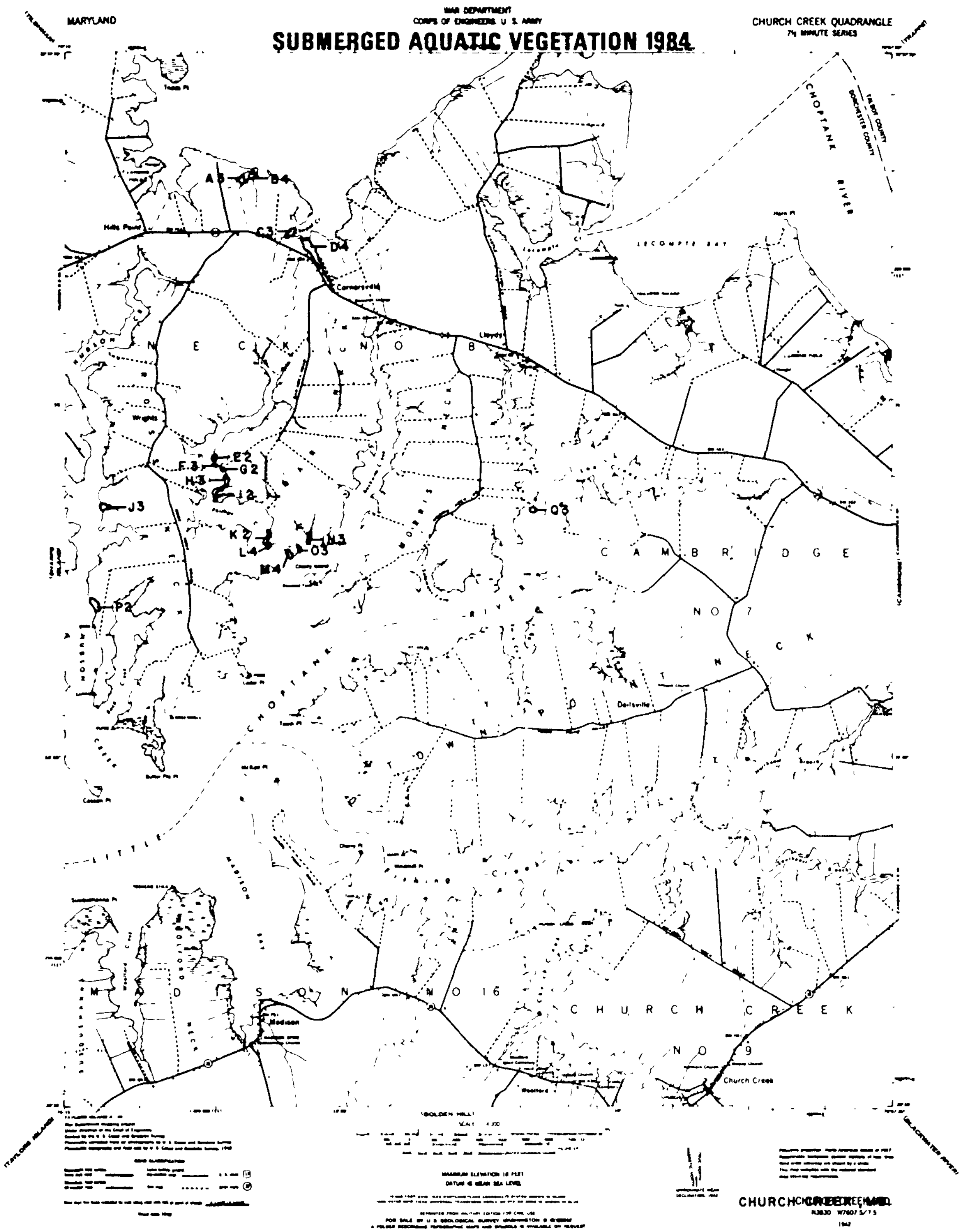

SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MOUNT VERNON QUADRANGLE
MARYLAND - VIRGINIA
7.5 MINUTE SERIES
PRESENCE OF SAV BEDS NOT DETECTED FROM AERIAL PHOTOGRAPHY INFORMATION PROVIDED BY VIRGINIA CARTER'S (USGS) 1984 POTOMAC RIVER SHORELINE SURVEY. NUMBER IN CIRCLE REPRESENTS ESTIMATED PERCENT COVER AS PREVIOUSLY DEFINED
Mapped by the Army Map Service
Published for civil use by the Geological Survey
MOUNT VERNON, MD.-VA

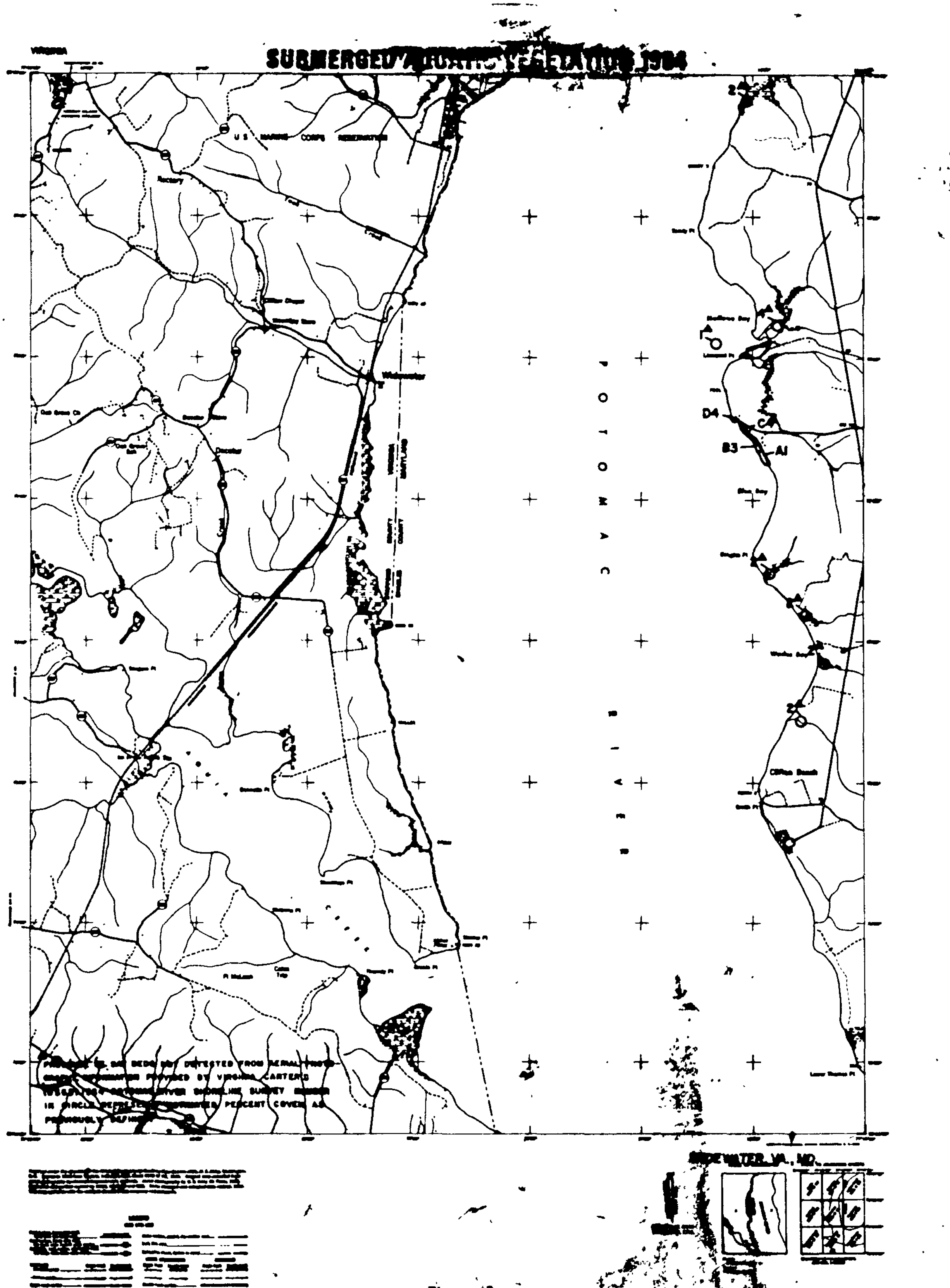

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
TILGHMAN QUADRANGLE
A3
A4
E4
D4
C4
F4
G3
H4
J4
K3
L3
M3
O4
N2
TILGHMAN, MD.


SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
UNITED STATES
OXFORD QUADRANGLE
MARYLAND
A4
C3
B3
D2
E3
F3
G2
H4
J3
J2
SAV PRESENT IN THIS AREA BUT NOT DETECTED ON THE AERIAL PHOTOGRAPHY. INFORMATION PROVIDED BY ROBERT TWILLEY OF THE UMd HORN POINT ENVIRONMENTAL LABORATORIES
OXFORD, MD.


SUBMERGED AQUATIC VEGETATION 1984
OCCOQUAN BAY
POTOMAC RIVER
INDIAN HEAD POWDER FACTORY
MATTAWOMAN
U.S. NAVAL RESERVATION
DONCASTER STATE FOREST
OF SAV BEDS FROM AERIAL
INFORMATION BY CARTER'S
(USGS) 1984 POTOMAC RIVER SURVEY
ESTIMATED COVER
PREVIOUSLY DEFINED
INDIAN HEAD

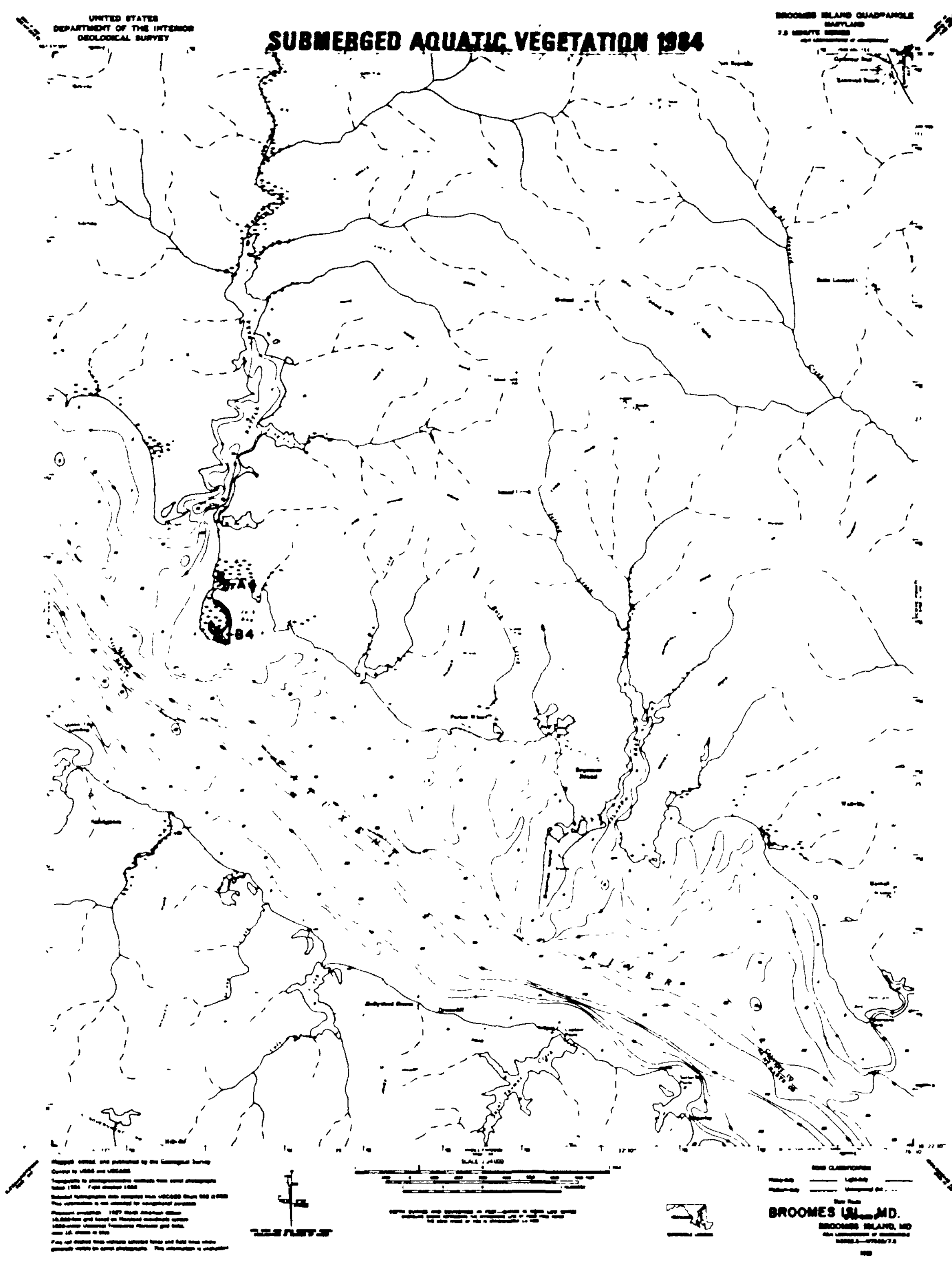

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
SHARPS ISLAND QUADRANGLE
MARYLAND
A3
B1
C2
D2
E2
F3
G4
H3
I4
J3
K4
L3
M2
N2
SAV PRESENT IN THIS AREA BUT NOT DETECTED ON THE AERIAL PHOTOGRAPHY INFORMATION PROVIDED BY ROBERT TWILLEY OF THE UMd HORN POINT ENVIRONMENTAL LABORATORIES
SHARPS ISLAND, MD.


MARYLAND
WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
SUBMERGED AQUATIC VEGETATION 1984
CHURCH CREEK QUADRANGLE
7½ MINUTE SERIES
A3
B4
C3
D4
E2
F3
G2
H3
I2
J3
K2
L4
M4
N3
O3
P2
Q3
CHOPTANK RIVER
LECOMPTE BAY
Cornersville
Lloyds
C A M B R I D G E
N O 7
N E C K
Madison
C H U R C H C R E E K
N O 9
Church Creek

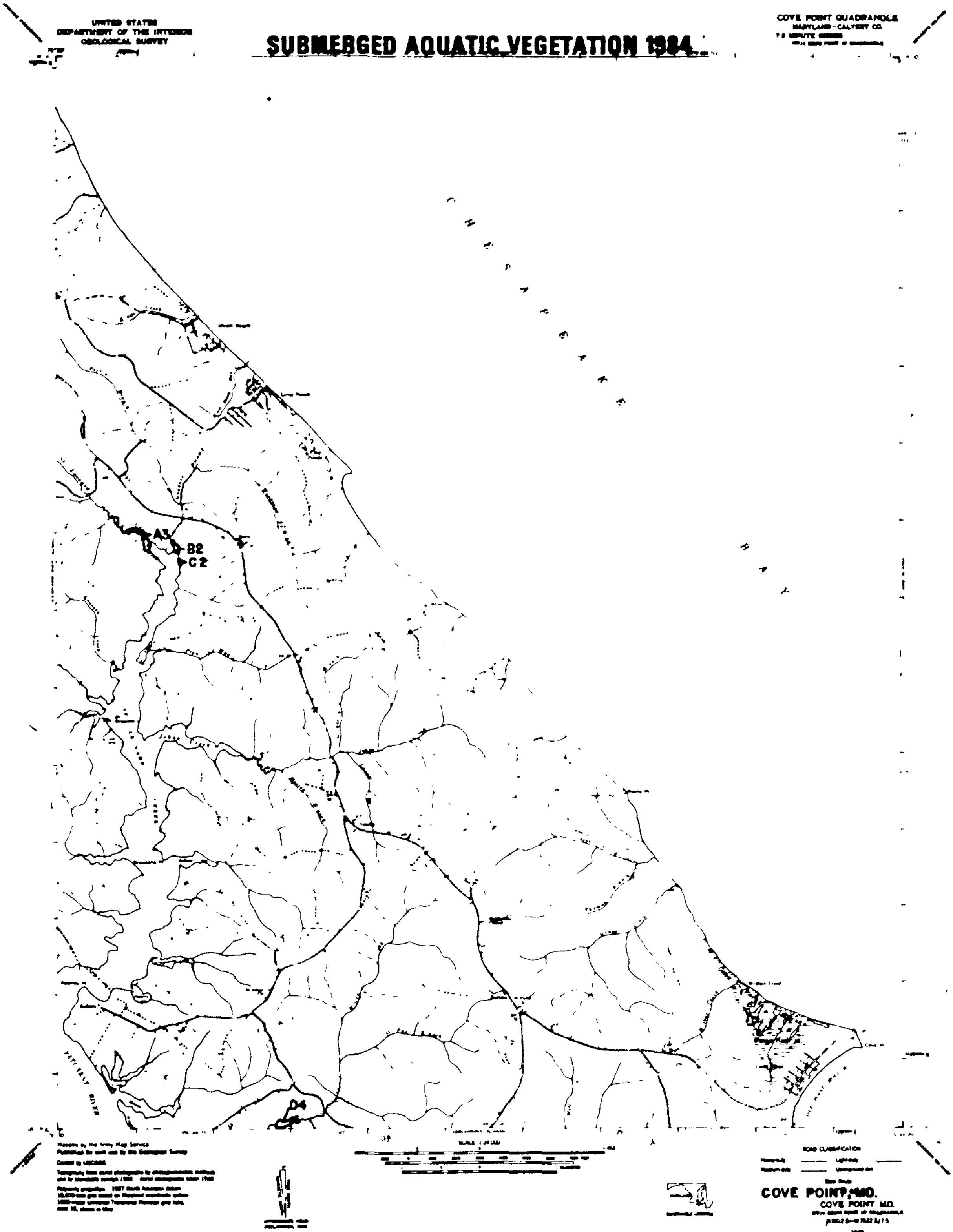

SUBMERGED
U S MARINE CORPS RESERVATION
POTOMAC RIVER
D4
B3
C
A1
TIDEWATER, VA.-MD.

SUBMERGED AQUATIC VEGETATION 1984

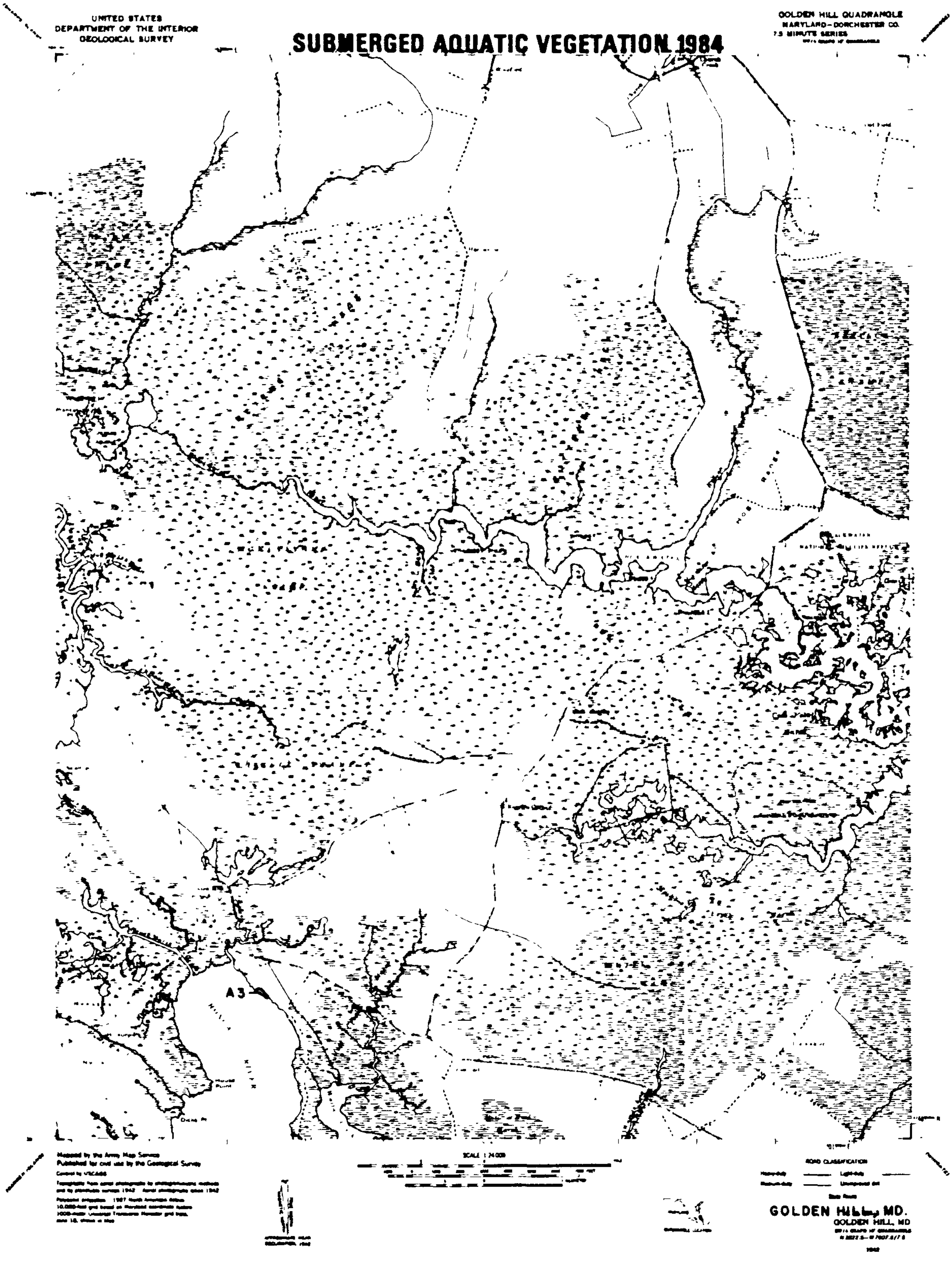
SUBMERGED AQUATIC VEGETATION 1984

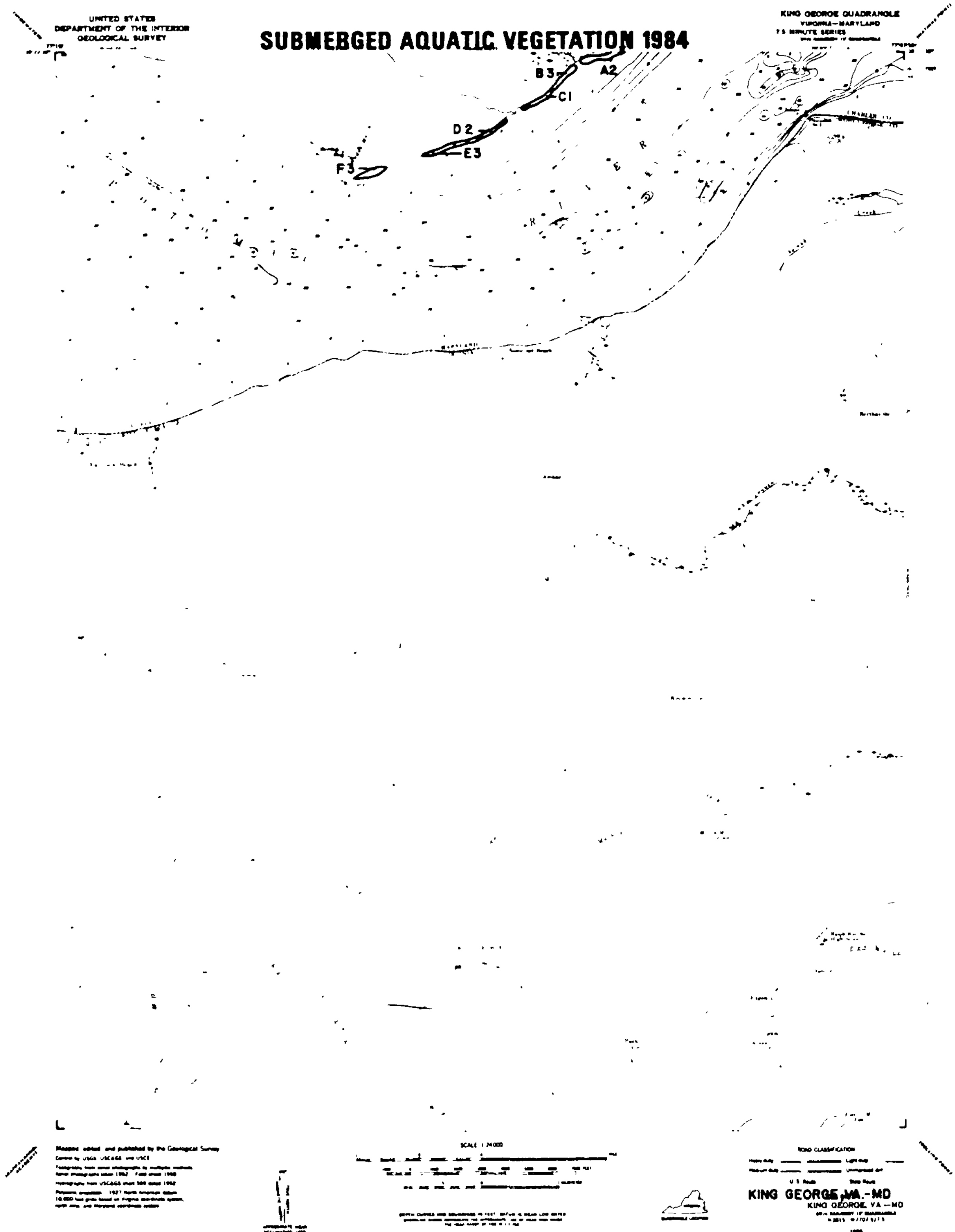

SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BROOMES ISLAND, MD.

SUBMERGED AQUATIC VEGETATION 1984

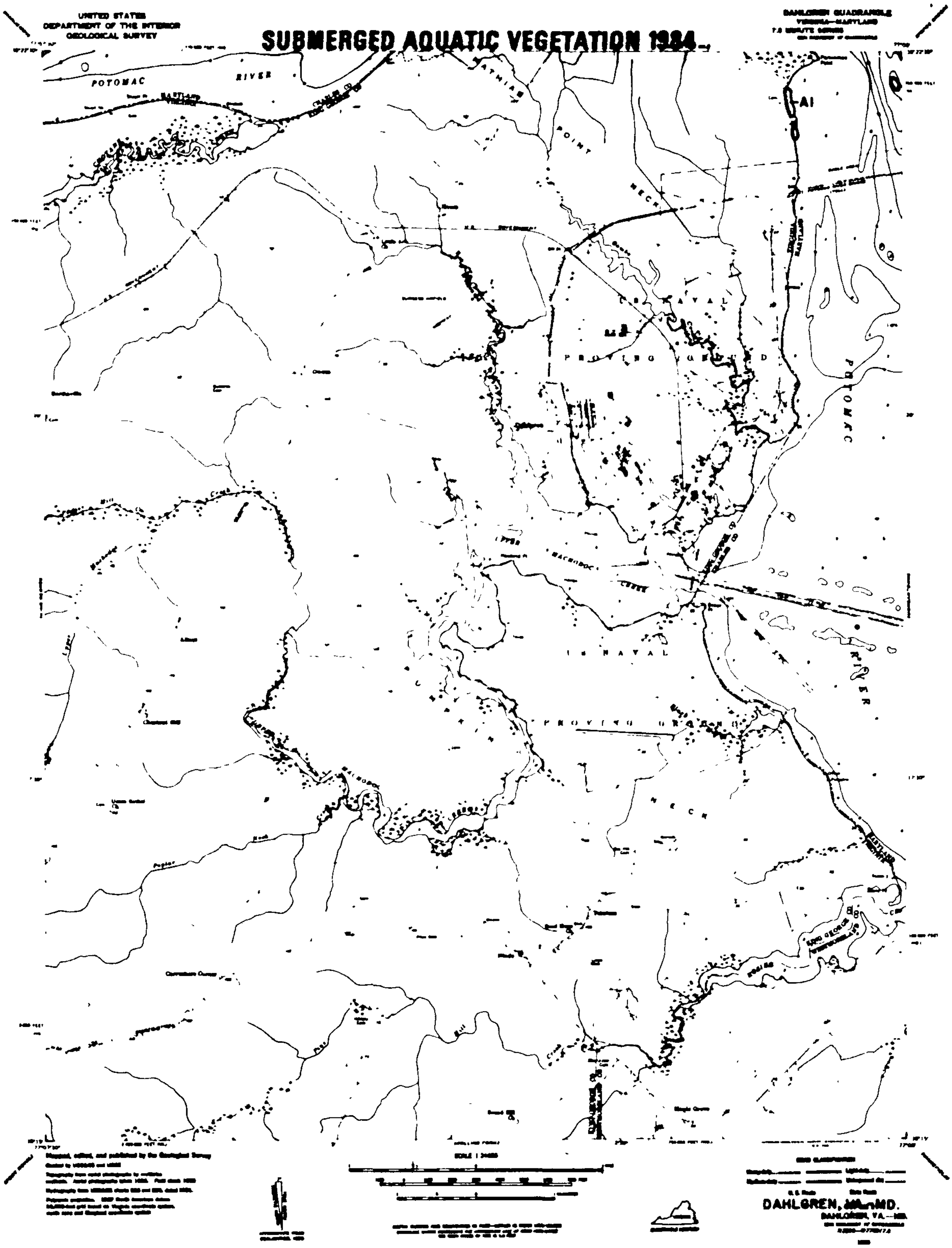



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
TAYLORS ISLAND QUADRANGLE
MARYLAND DORCHESTER CO
7.5 MINUTE SERIES
A1
B3
D1
D4
E4
F2
SCALE 1:24 000
ROAD CLASSIFICATION
TAYLORS ISL., MD.
TAYLORS ISLAND MD
1982


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
GOLDEN HILL QUADRANGLE
MARYLAND–DORCHESTER CO.
7.5 MINUTE SERIES
A3
Mapped by the Army Map Service
Published for civil use by the Geological Survey
ROAD CLASSIFICATION
GOLDEN HILL, MD.
GOLDEN HILL, MD


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
KING GEORGE QUADRANGLE
VIRGINIA—MARYLAND
7.5 MINUTE SERIES
A2
B3
C1
D2
E3
F3
SCALE 1:24000
KING GEORGE, VA.-MD

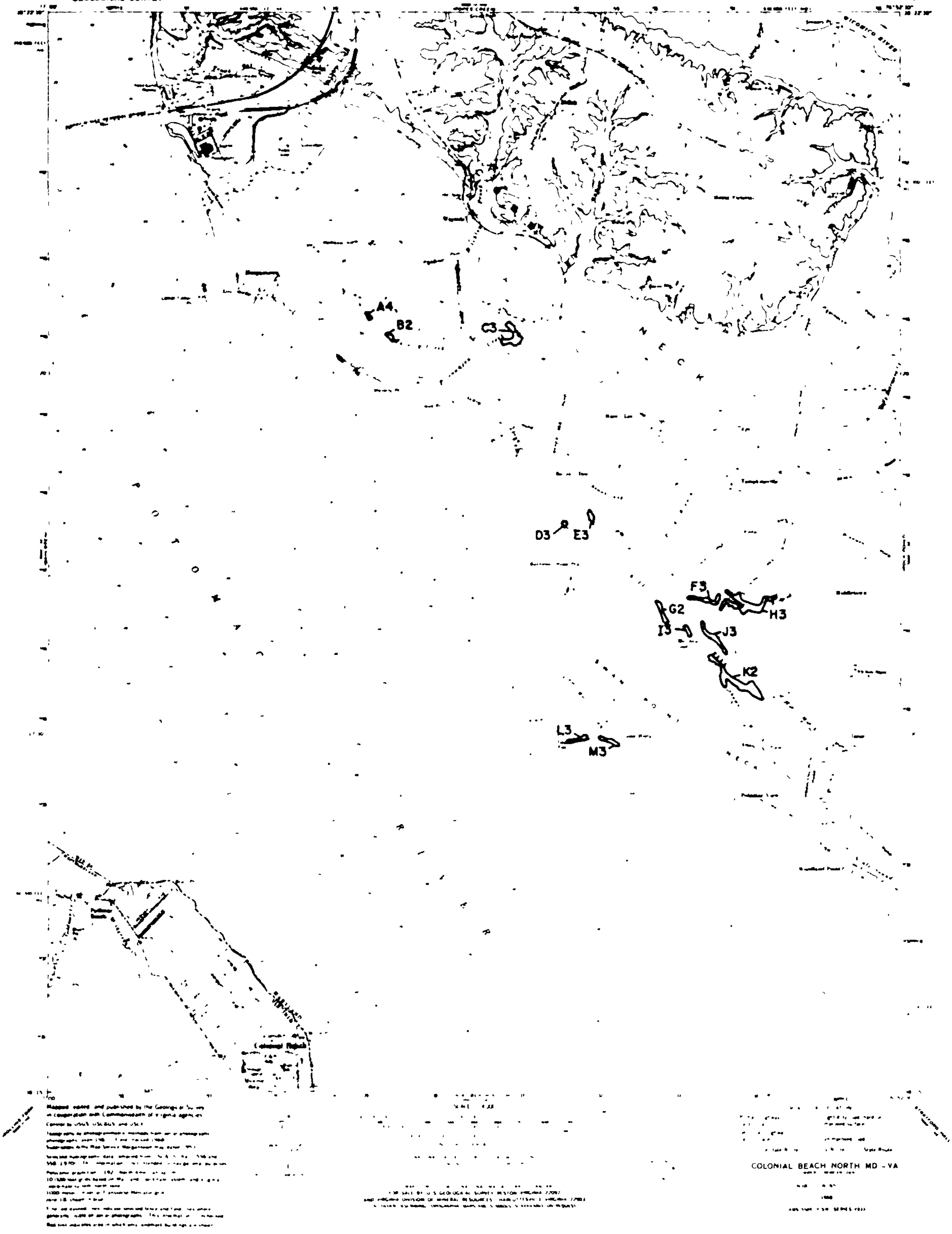
SUBMERGED AQUATIC VEGETATION 1984



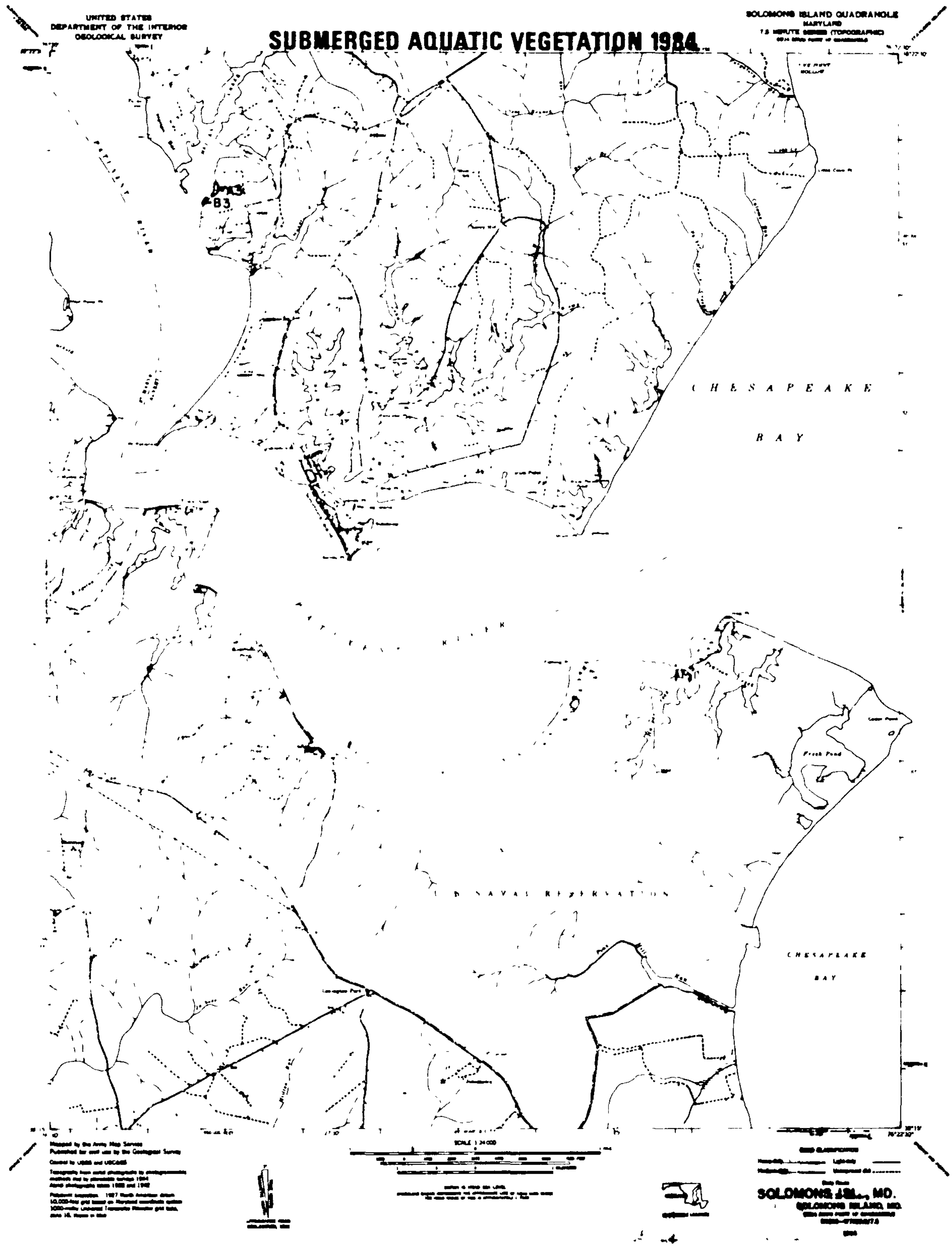
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

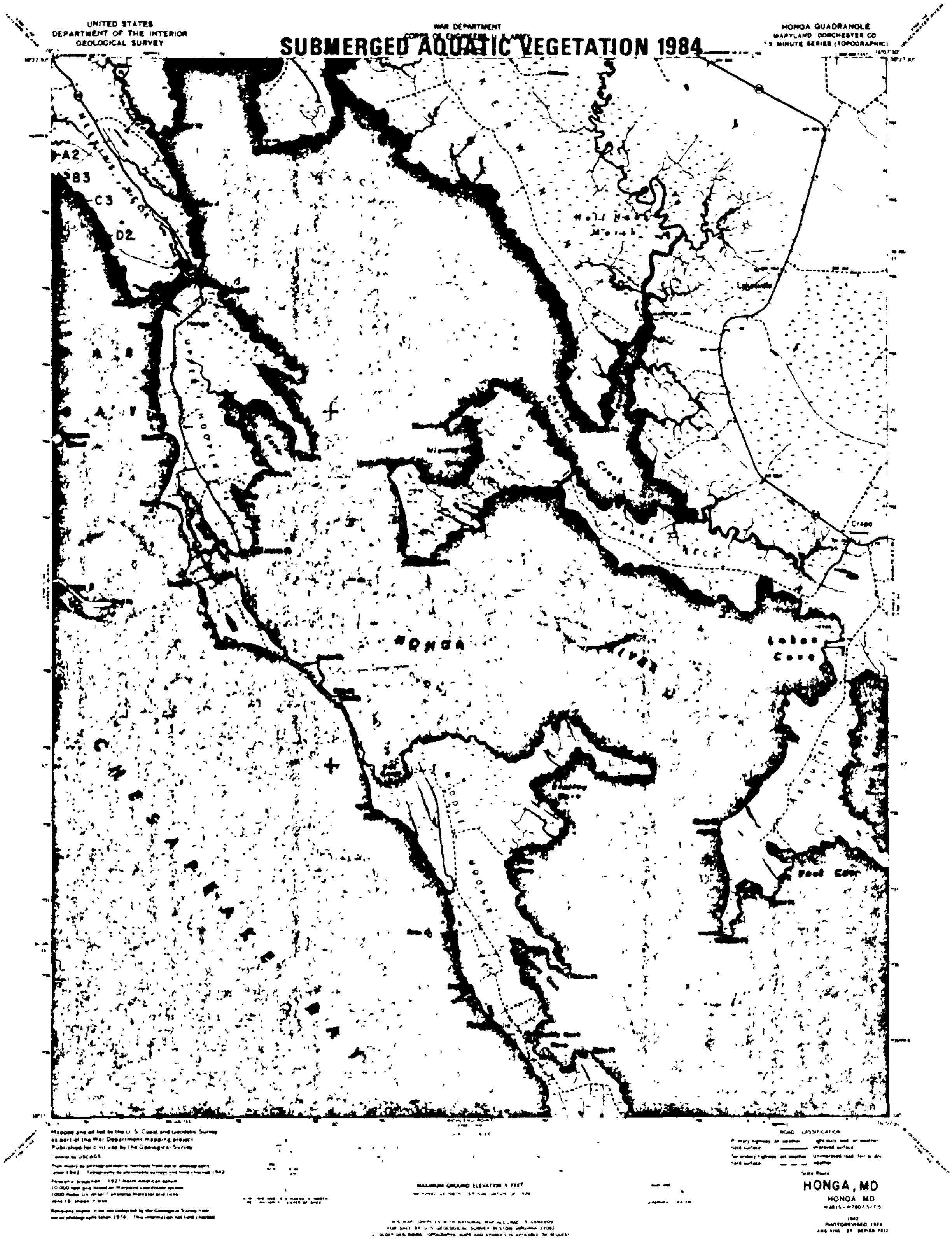
SUBMERGED AQUATIC VEGETATION 1984

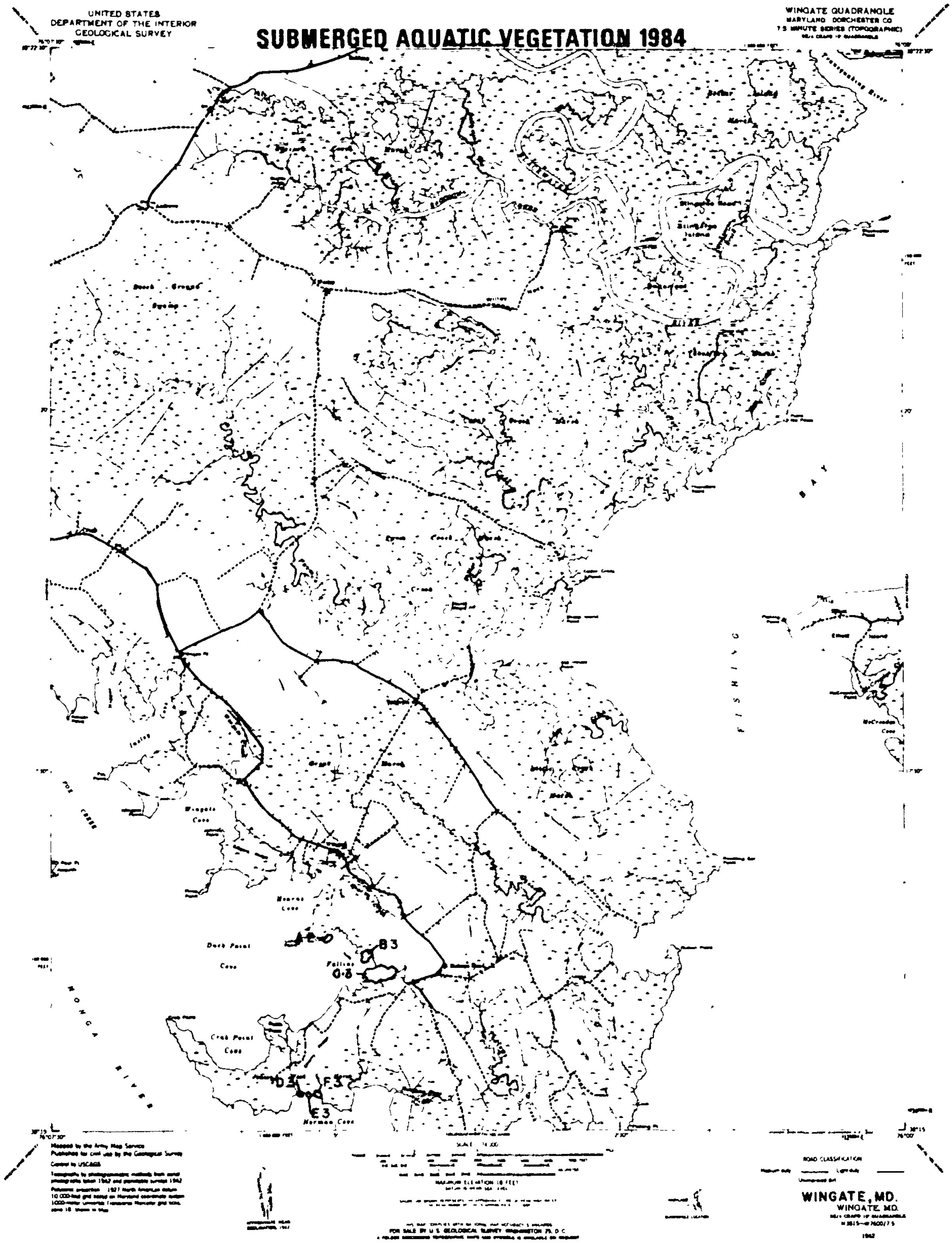
COLONIAL BEACH NORTH QUADRANGLE
MARYLAND - VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



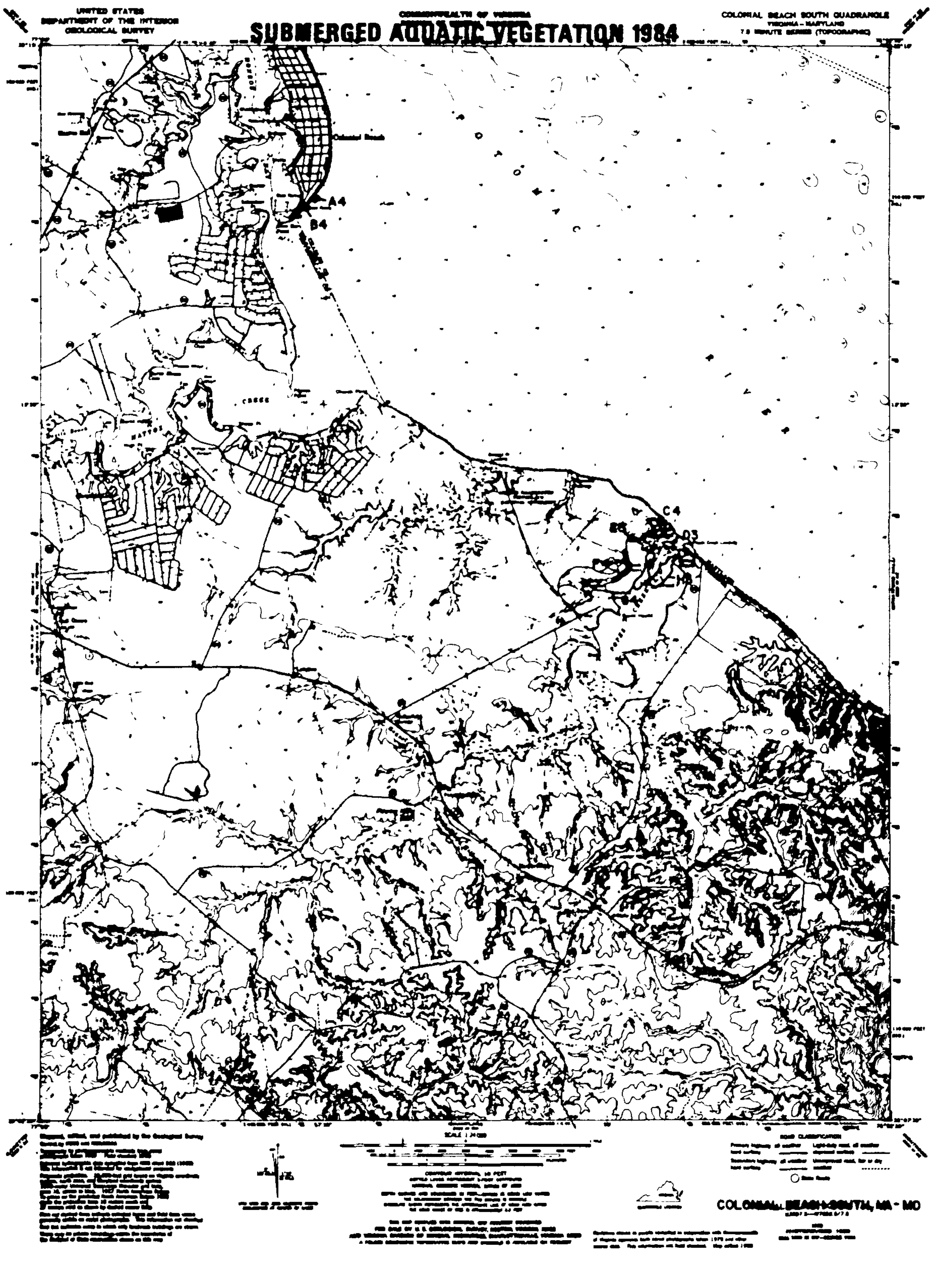
COLONIAL BEACH NORTH MD - VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
SOLOMONS ISLAND QUADRANGLE
MARYLAND
7.5 MINUTE SERIES (TOPOGRAPHIC)
B3
CHESAPEAKE
BAY
CHESAPEAKE
BAY
SOLOMONS ISL., MD.

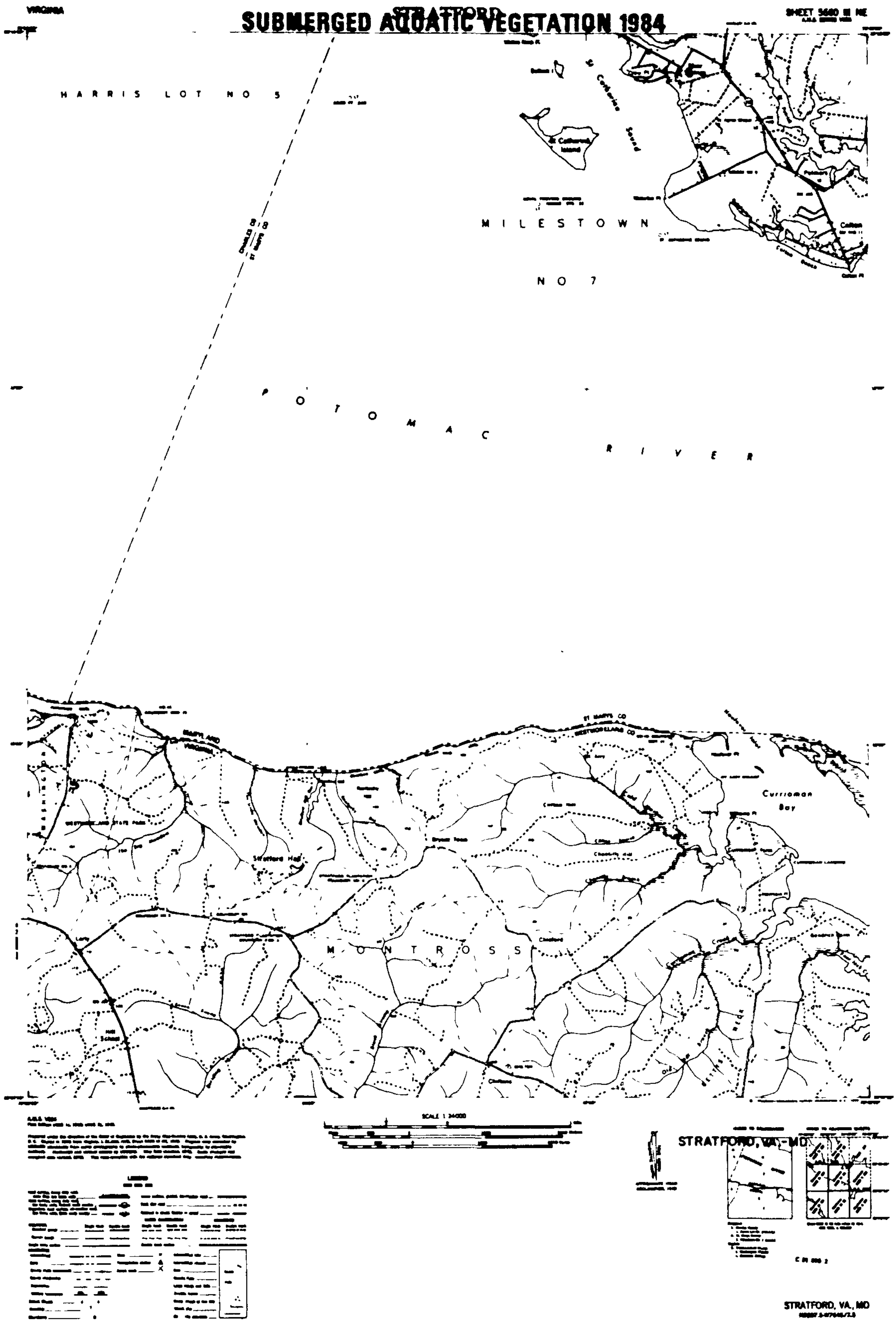

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WAR DEPARTMENT
SUBMERGED AQUATIC VEGETATION 1984
HONGA QUADRANGLE
MARYLAND DORCHESTER CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
A2
B3
C3
D2
HONGA
Crapo
HONGA, MD

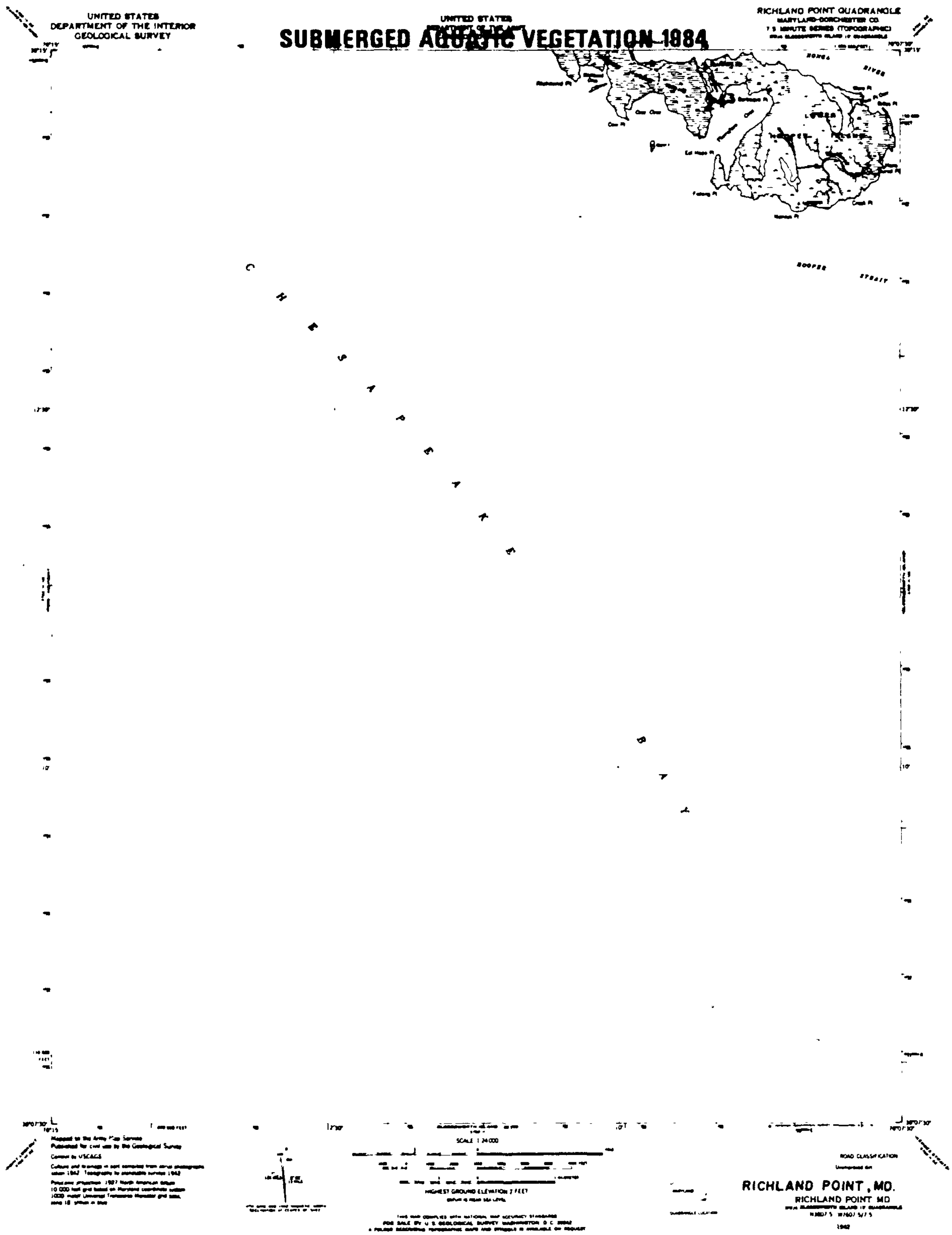


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
WINGATE QUADRANGLE
MARYLAND DORCHESTER CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
A2
B3
C3
D3
F3
E3
WINGATE, MD.

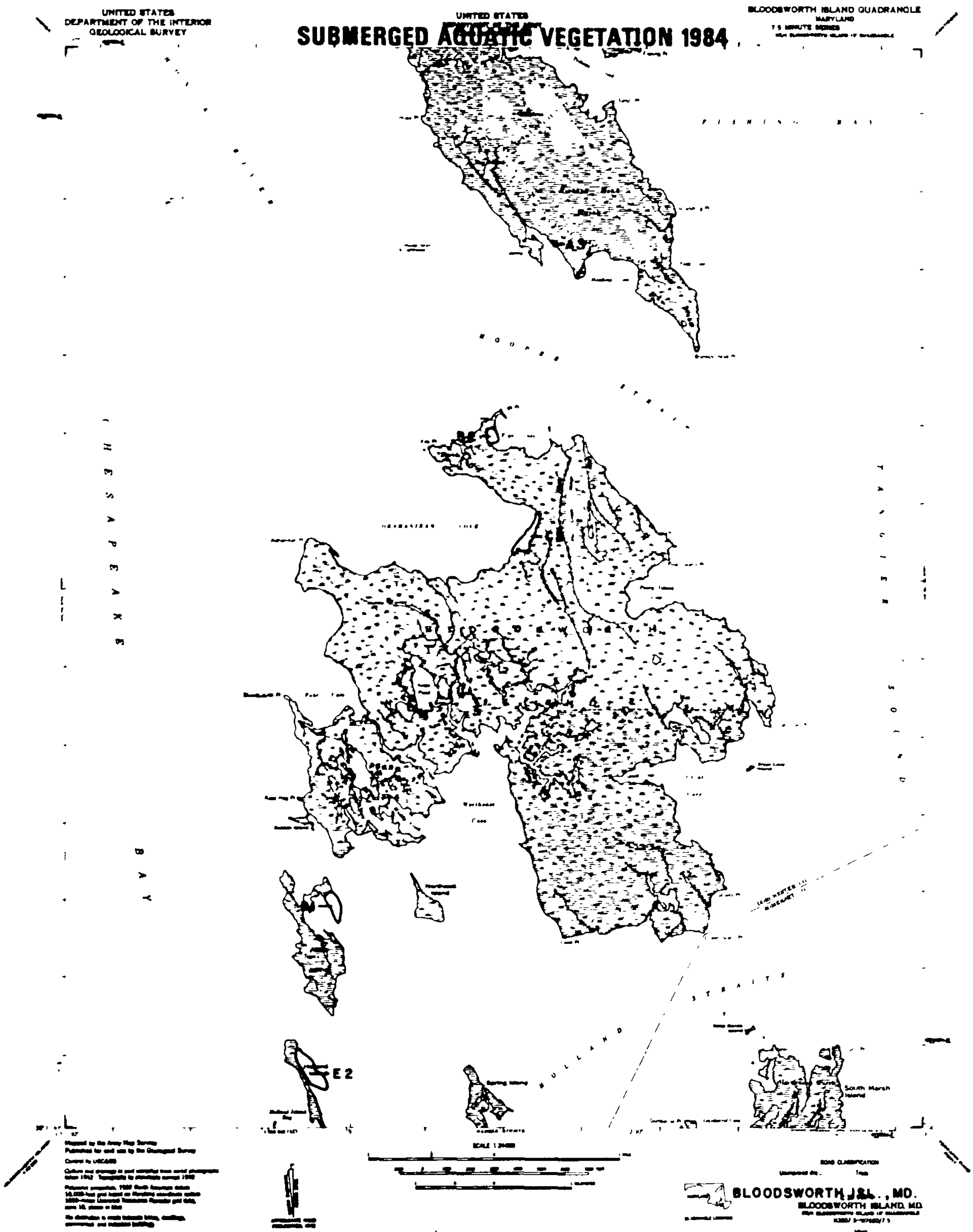

SUBMERGED AQUATIC VEGETATION 1984
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COLONIAL BEACH SOUTH QUADRANGLE
A4
B4
C4
D3
COLONIAL BEACH SOUTH, VA - MD

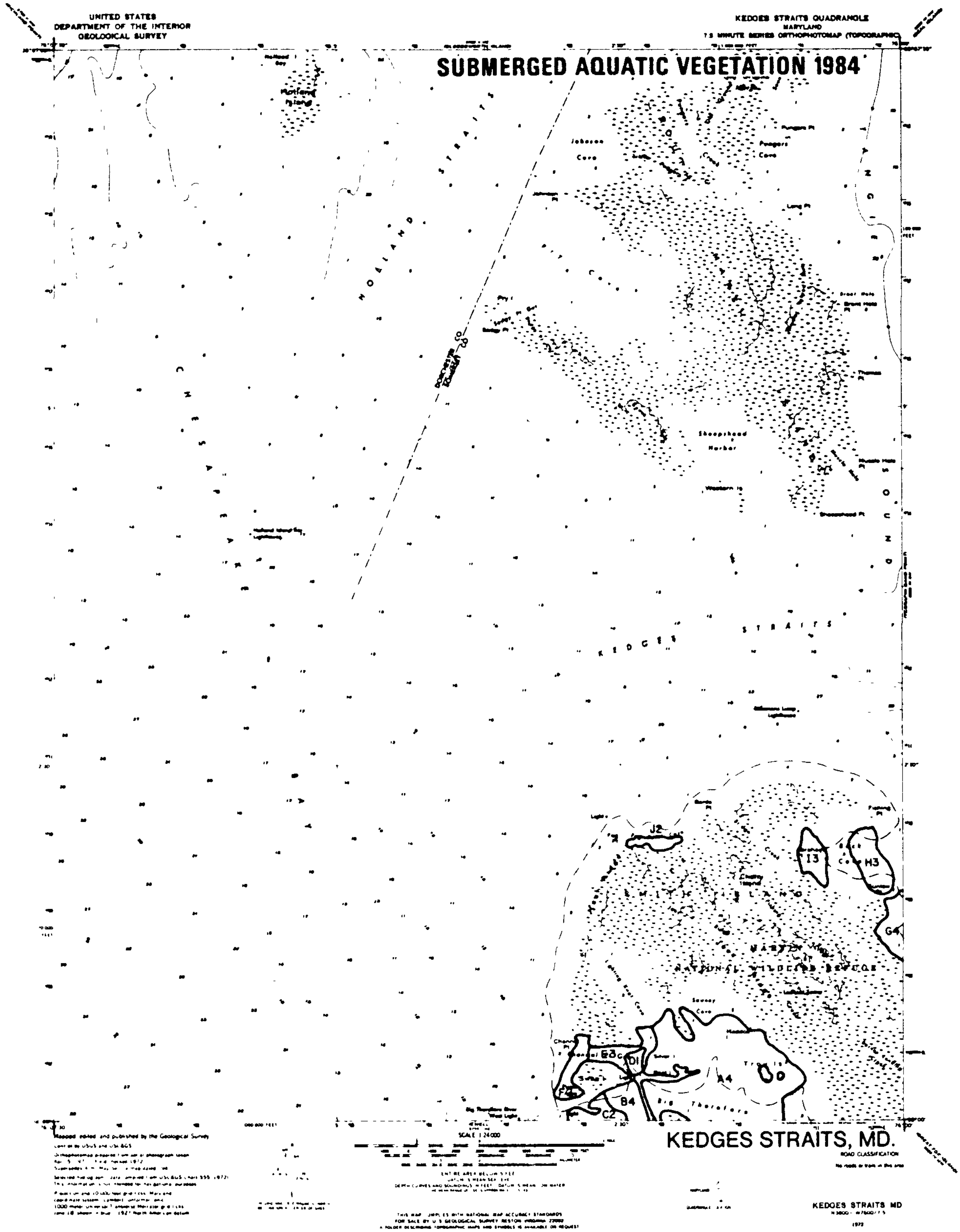
SUBMERGED AQUATIC VEGETATION 1984

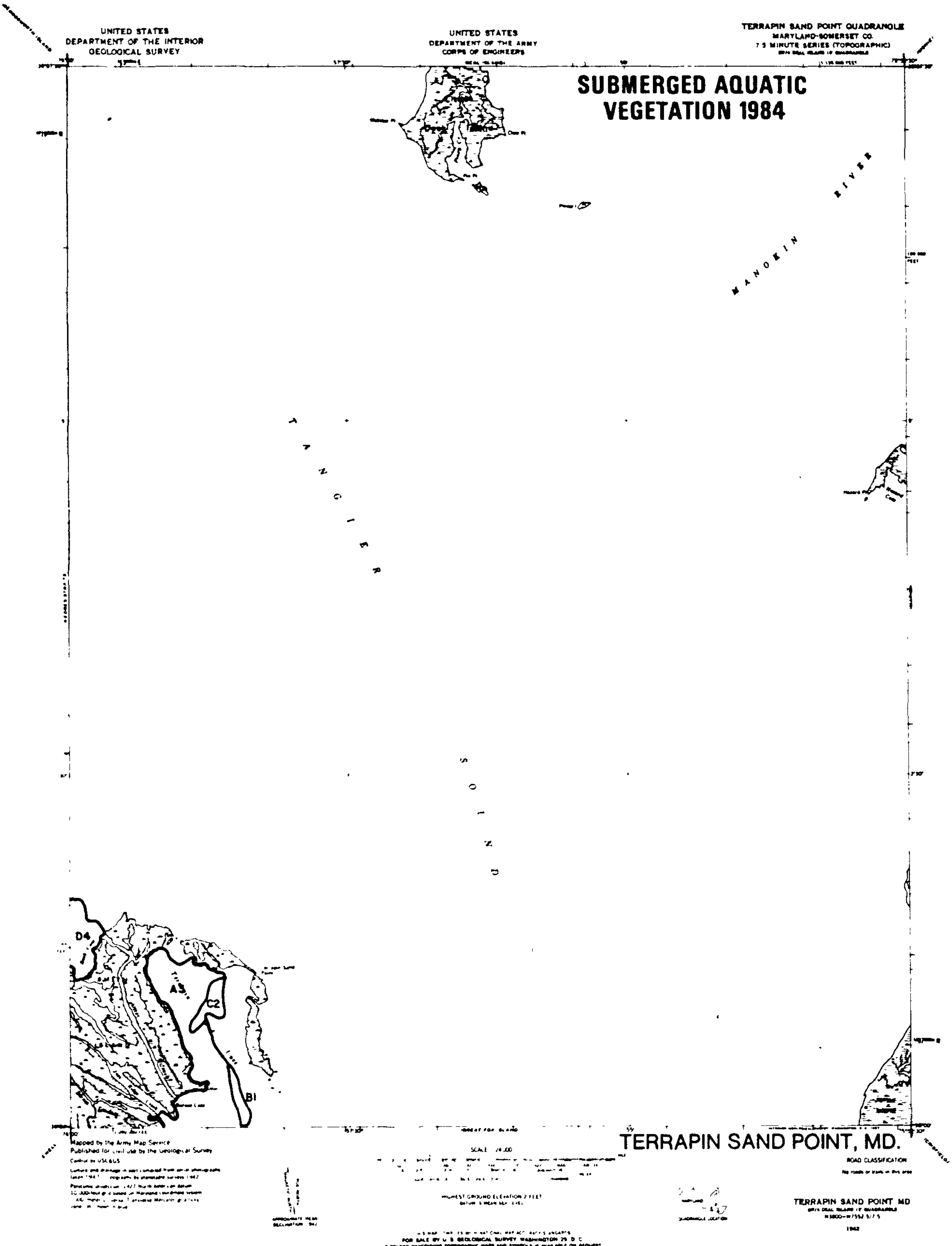


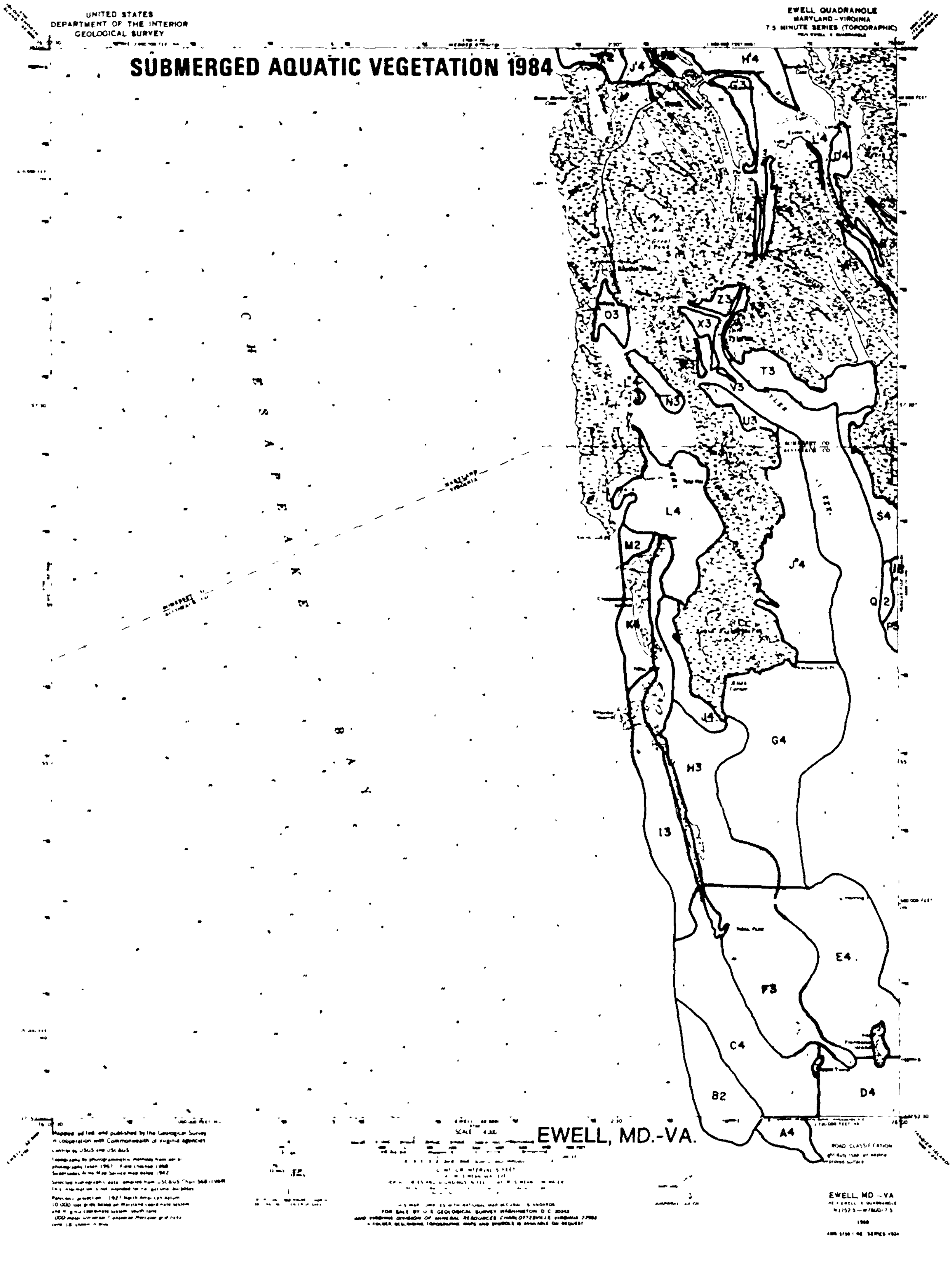

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SUBMERGED AQUATIC VEGETATION 1984
RICHLAND POINT QUADRANGLE
C H E S A P E A K E
B A Y
SCALE 1:24 000
HIGHEST GROUND ELEVATION 2 FEET
RICHLAND POINT, MD.
RICHLAND POINT MD

SUBMERGED AQUATIC VEGETATION 1984




UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
KEDGES STRAITS QUADRANGLE
MARYLAND
7.5 MINUTE SERIES ORTHOPHOTOMAP (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
HOOPER STRAITS
KEDGES STRAITS
Sheephead Harbor
SMITH ISLAND
J2
I3
H3
G4
E3
D1
F2
C2
B4
A4
SCALE 1:24000
KEDGES STRAITS, MD.
KEDGES STRAITS MD
1972


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
UNITED STATES
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
TERRAPIN SAND POINT QUADRANGLE
MARYLAND-SOMERSET CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
MANOKIN RIVER
TANGIER SOUND
D4
A3
C2
B1
TERRAPIN SAND POINT, MD.
Mapped by the Army Map Service
Published for civil use by the Geological Survey
ROAD CLASSIFICATION
TERRAPIN SAND POINT MD
FOR SALE BY U.S. GEOLOGICAL SURVEY WASHINGTON 25, D.C.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
EWELL QUADRANGLE
MARYLAND-VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
CHESAPEAKE
BAY
H4
J4
G3
L4
D4
R3
Z3
X3
O3
N3
V3
T3
U3
L4
S4
M2
J4
Q2
K4
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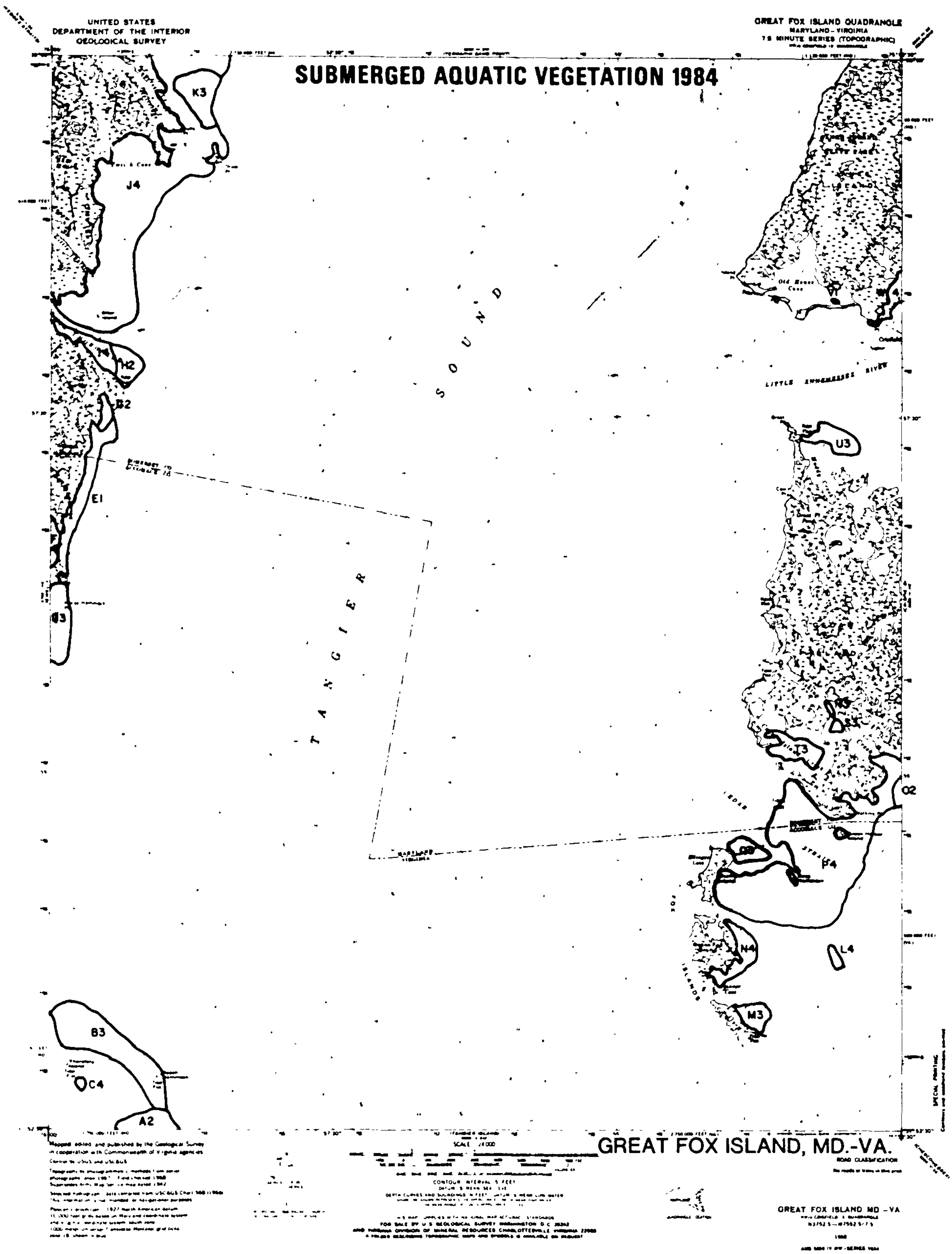
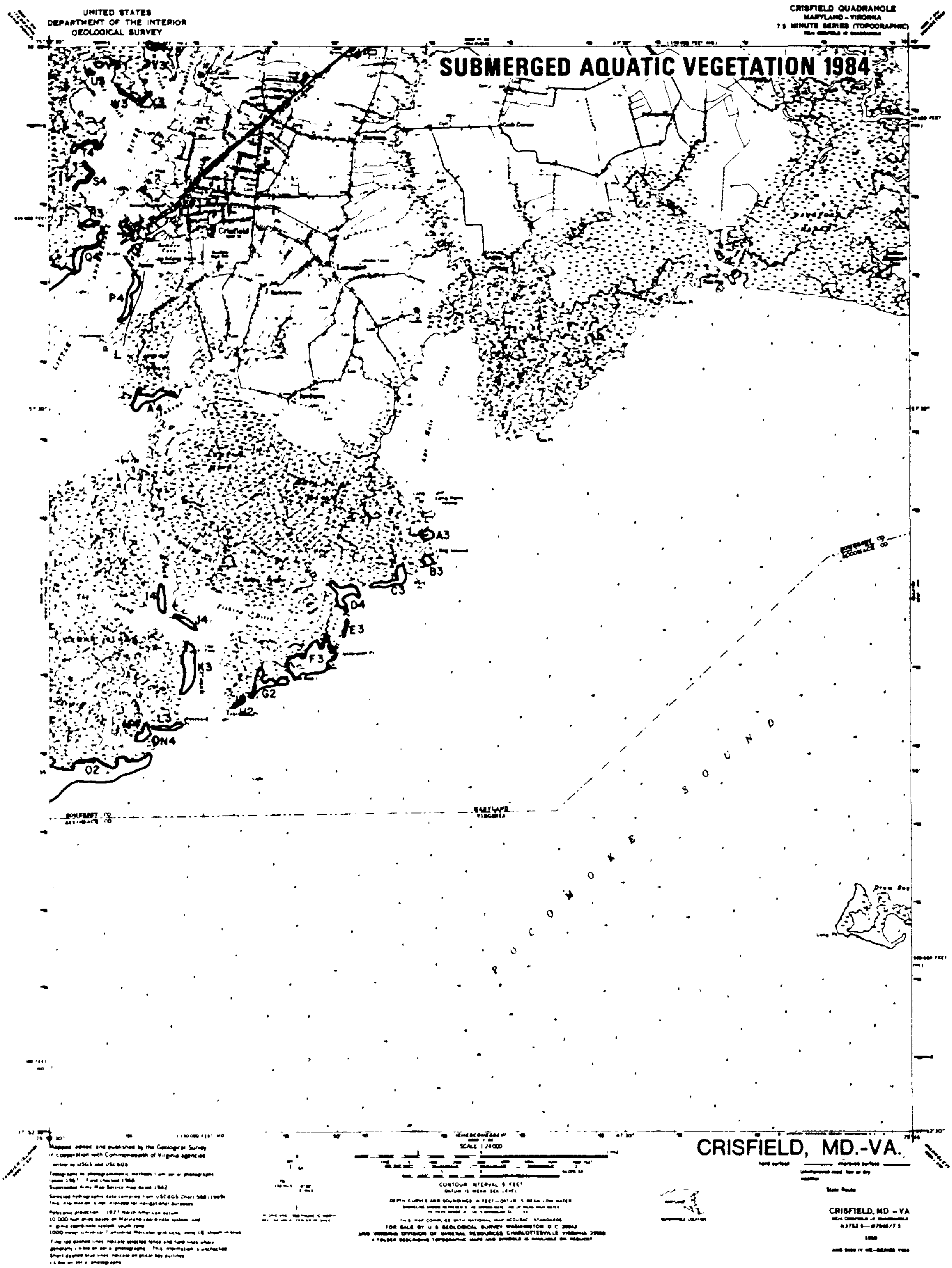
EWELL, MD.-VA.
EWELL, MD.-VA.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
GREAT FOX ISLAND QUADRANGLE
MARYLAND - VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
K3
J4
H4
H2
B2
E1
B3
B3
C4
A2
TANGIER SOUND
LITTLE ANNEMESSEX RIVER
U3
T3
O2
F4
L4
N4
M3
GREAT FOX ISLAND, MD.-VA.
CONTOUR INTERVAL 5 FEET
GREAT FOX ISLAND MD - VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CRISFIELD QUADRANGLE
MARYLAND - VIRGINIA
SUBMERGED AQUATIC VEGETATION 1984
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B3
C3
D4
E3
F3
G2
H2
I4
J4
K3
L3
N4
O2
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R3
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T4
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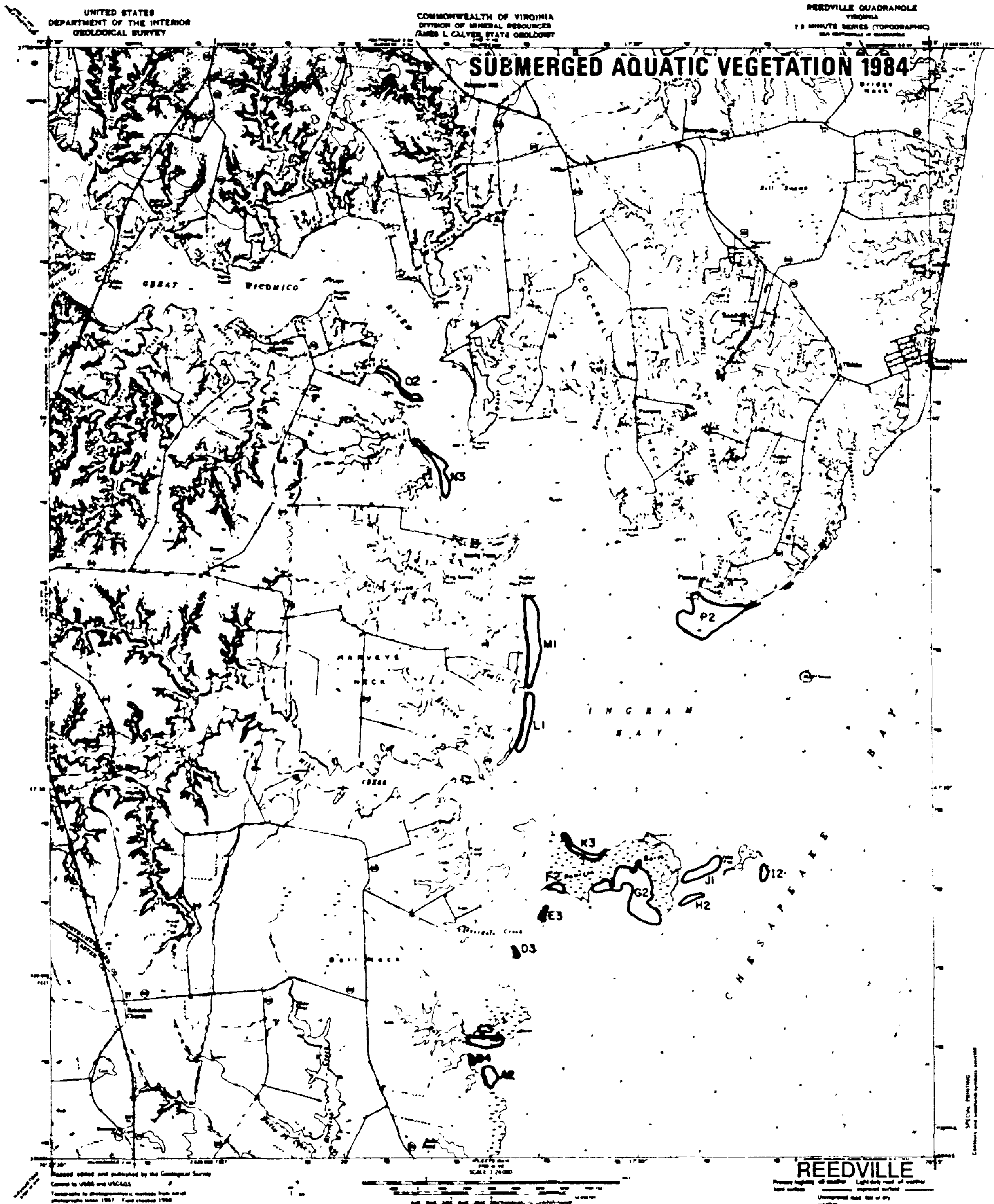
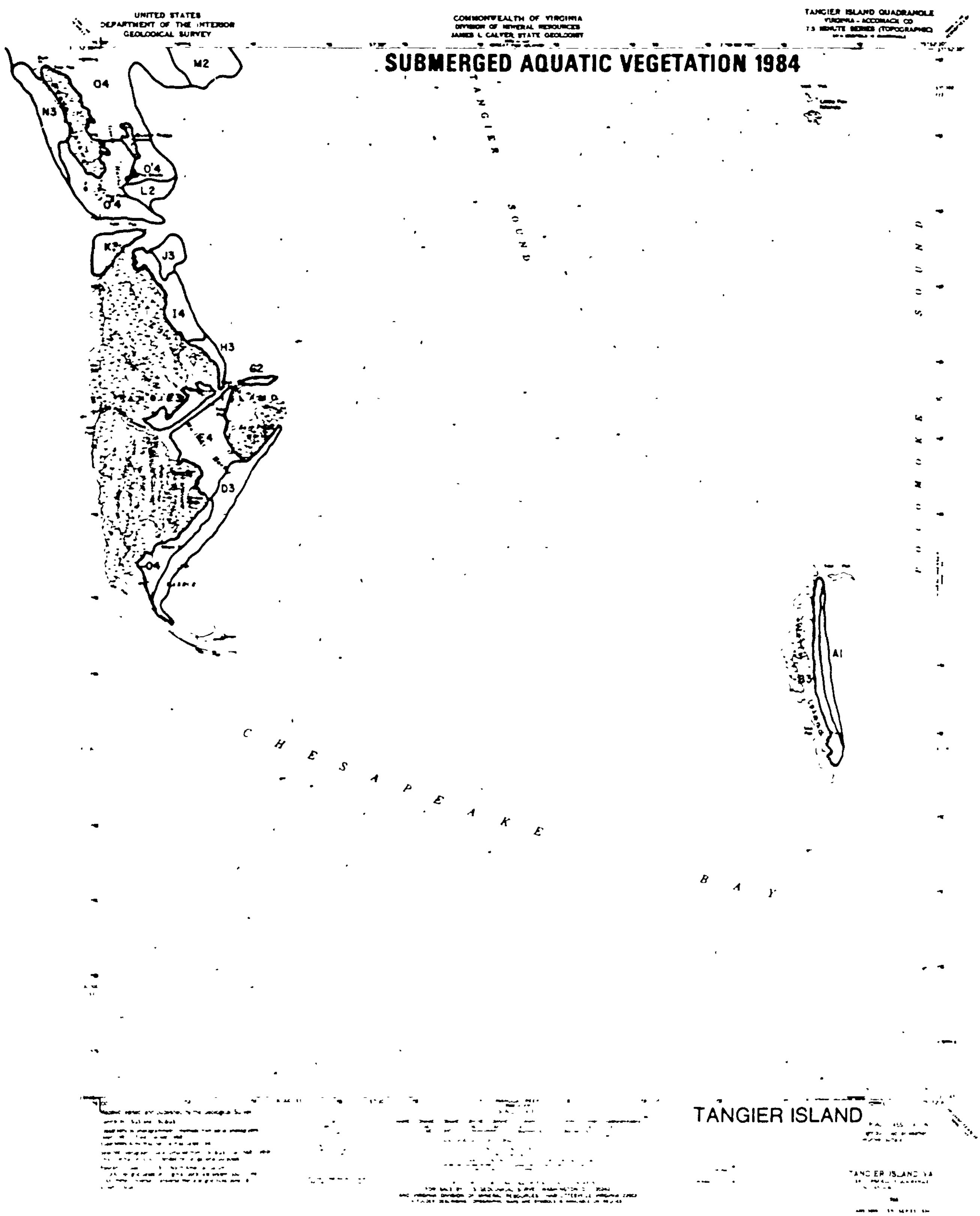
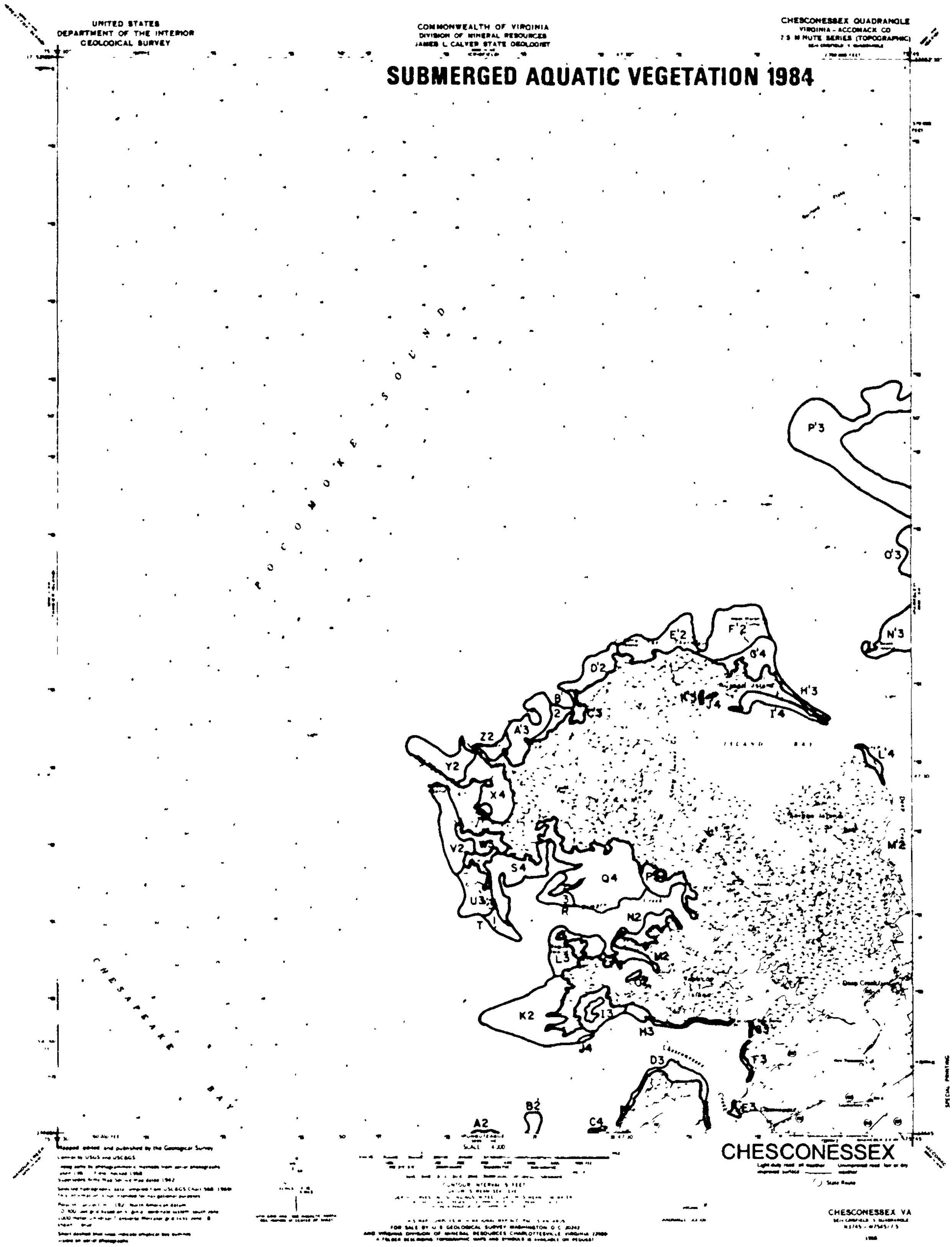
V3
W3
X3
POCOMOKE SOUND
CRISFIELD, MD.-VA.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER, STATE GEOLOGIST
REEDVILLE QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
GREAT WICOMICO RIVER
COCKREL
HARVEYS NECK
INGRAM BAY
CHESAPEAKE BAY
Q2
K3
P2
M1
L1
K3
F2
G2
J1
H2
I2
E3
D3
A2
SCALE 1:24000
CONTOUR INTERVAL 10 FEET
REEDVILLE
REEDVILLE, VA
SPECIAL PRINTING


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
TANGIER ISLAND QUADRANGLE
VIRGINIA - ACCOMACK CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
M2
O4
N3
O'4
L2
O'4
K2
J3
I4
H3
G2
E4
D3
O4
A1
B3
TANGIER SOUND
CHESAPEAKE BAY
TANGIER ISLAND


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER STATE GEOLOGIST
CHESCONESSEX QUADRANGLE
VIRGINIA - ACCOMACK CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
POCOMOKE SOUND
CHESAPEAKE BAY
P'3
O'3
N'3
E'2
F'2
G'4
D'2
H'3
B2
C3
K'3
J4
I'4
A'3
Z2
Y2
L'4
X4
V2
M'2
S4
Q4
P
U3
R
N2
T
L3
M2
K2
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H3
J4
D3
F3
E3
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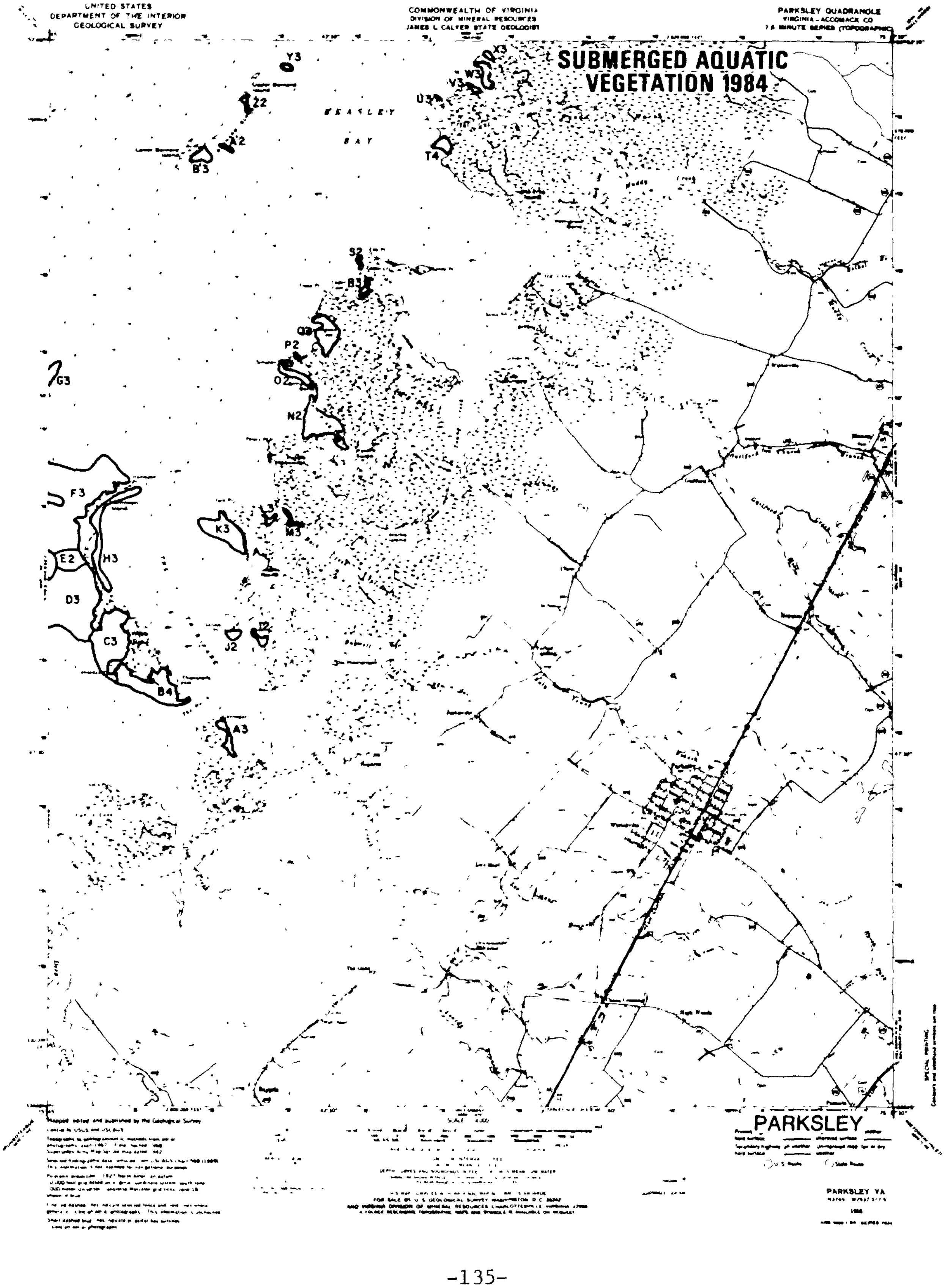
B2
C4
CHESCONESSEX
CHESCONESSEX VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
PARKSLEY QUADRANGLE
SUBMERGED AQUATIC
VEGETATION 1984
Y3
Z2
A2
B3
X3
W3
V3
U3
T4
S2
R3
Q3
P2
O2
N2
G3
F3
E2
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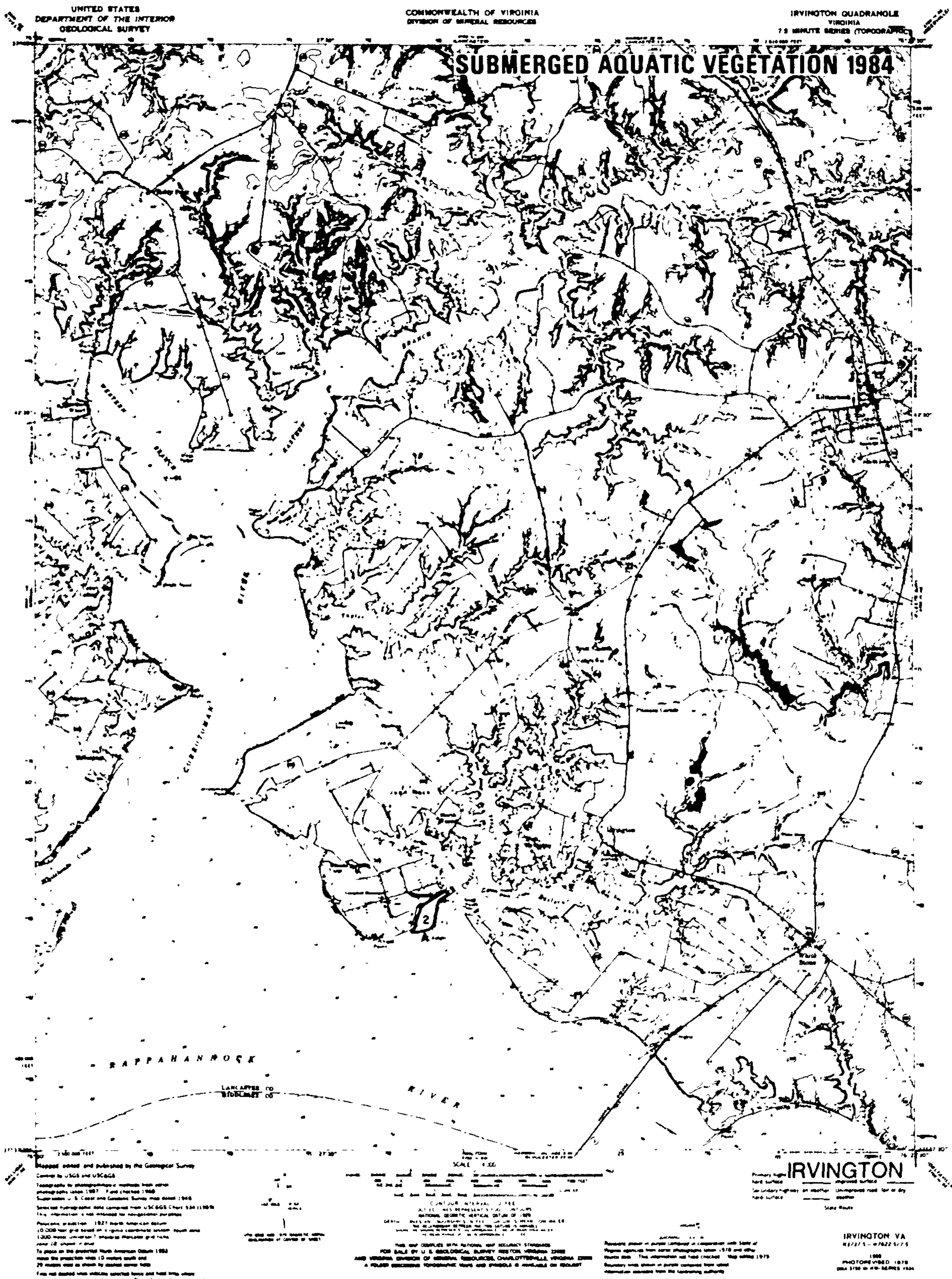
K3
L3
M3
J2
I2
C3
B4
A3
PARKSLEY
PARKSLEY VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
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VIRGINIA
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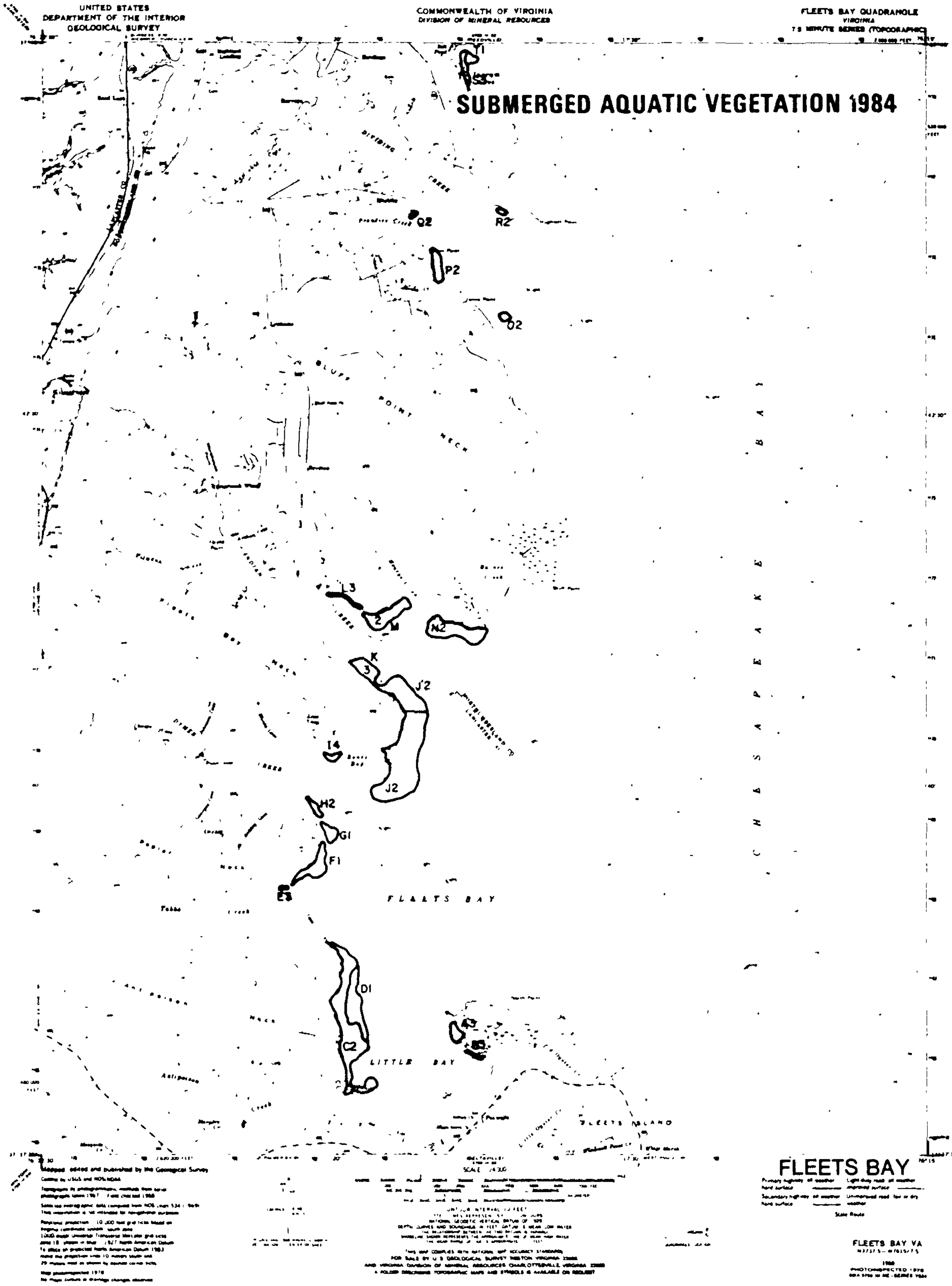
RAPPAHANNOCK
RIVER
IRVINGTON
IRVINGTON VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
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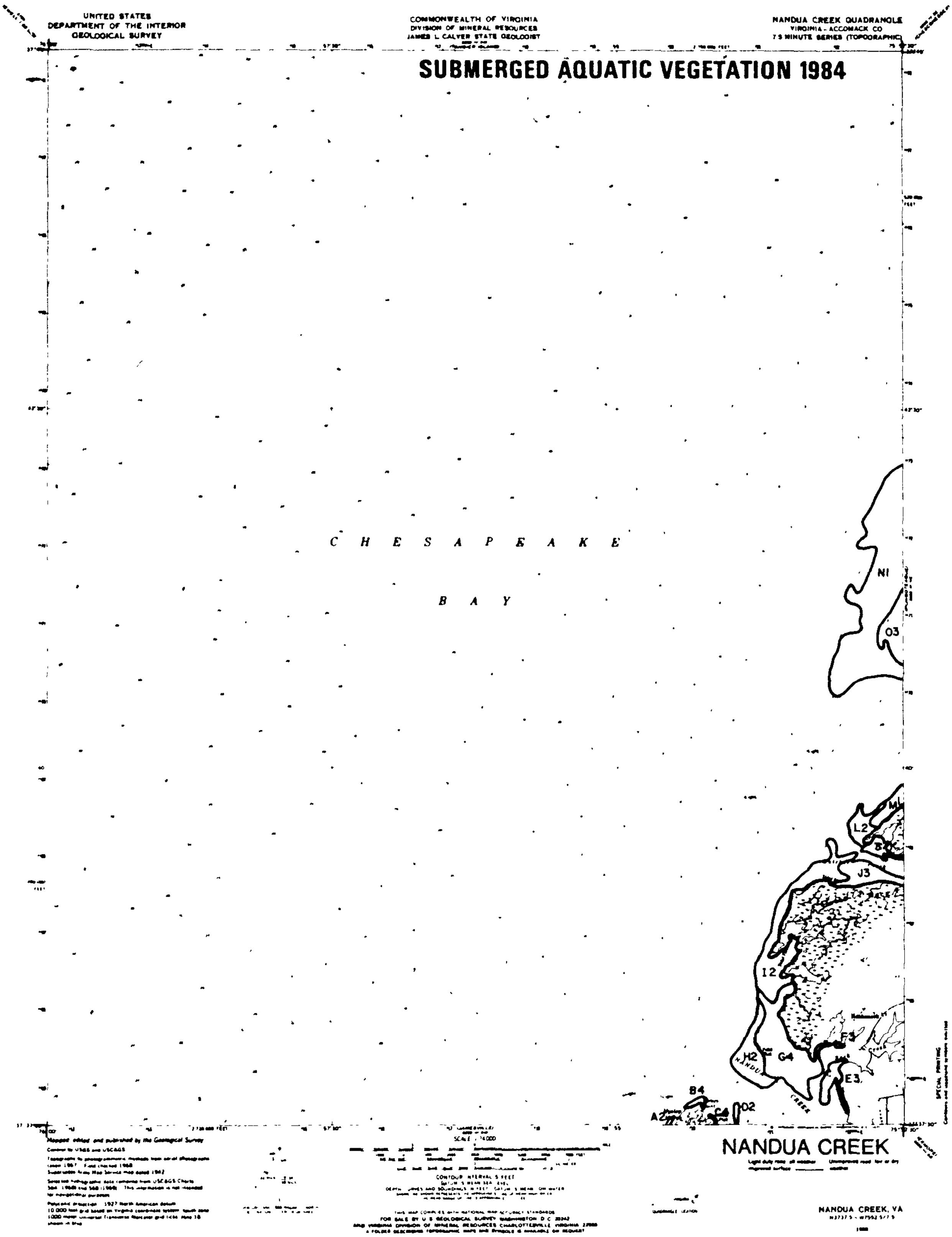
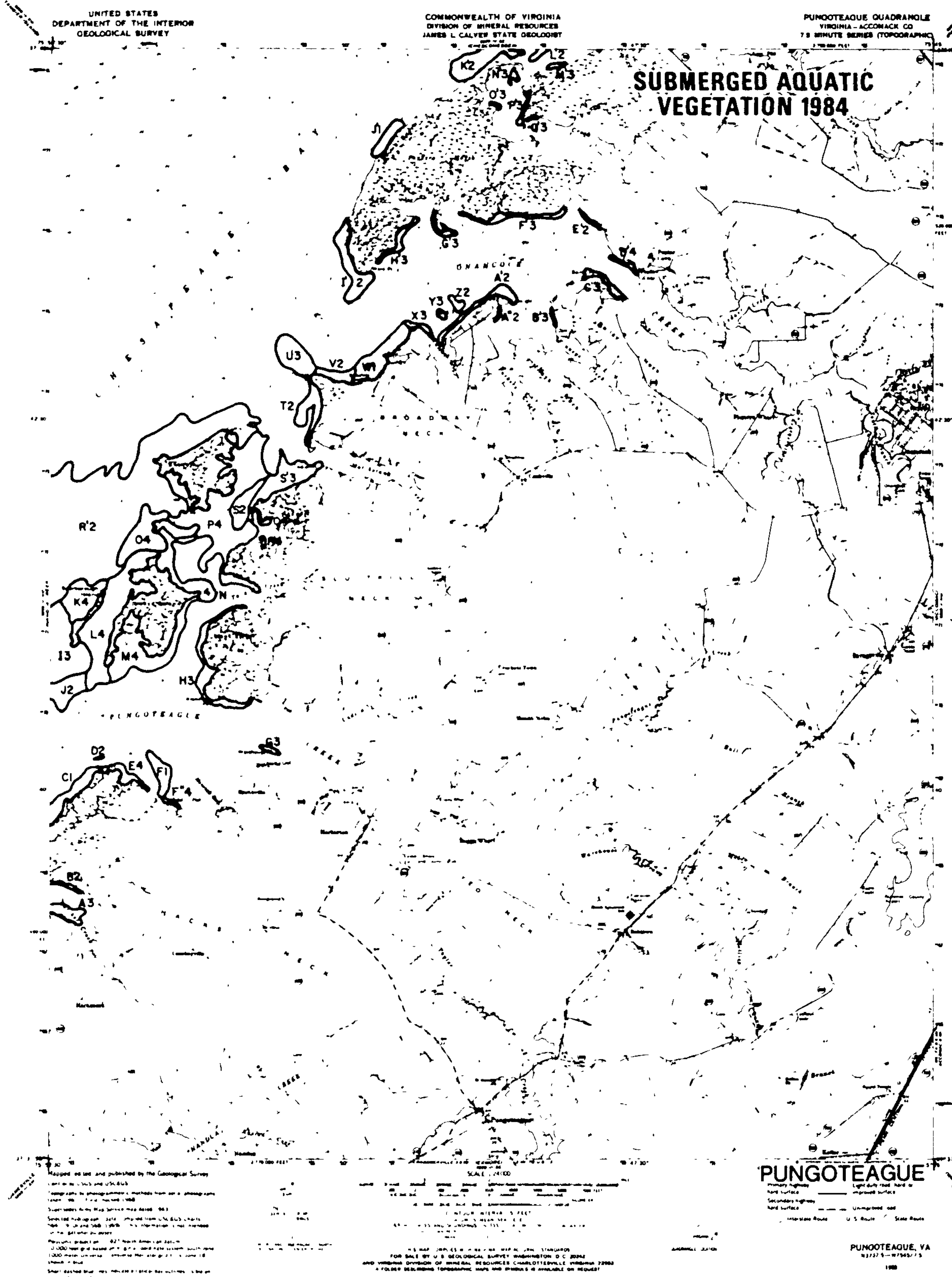
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
FLEETS BAY QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
Q2
R2
P2
O2
L3
M
N2
K
J2
J2
I4
H2
G1
F1
E3
FLEETS BAY
D1
C2
LITTLE BAY
FLEETS ISLAND
CHESAPEAKE BAY
FLEETS BAY
FLEETS BAY VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER STATE GEOLOGIST
NANDUA CREEK QUADRANGLE
VIRGINIA - ACCOMACK CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
C H E S A P E A K E
B A Y
N1
O3
M1
L2
J3
I2
H2
G4
F3
E3
B4
A2
C4
D2
NANDUA CREEK
NANDUA CREEK, VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
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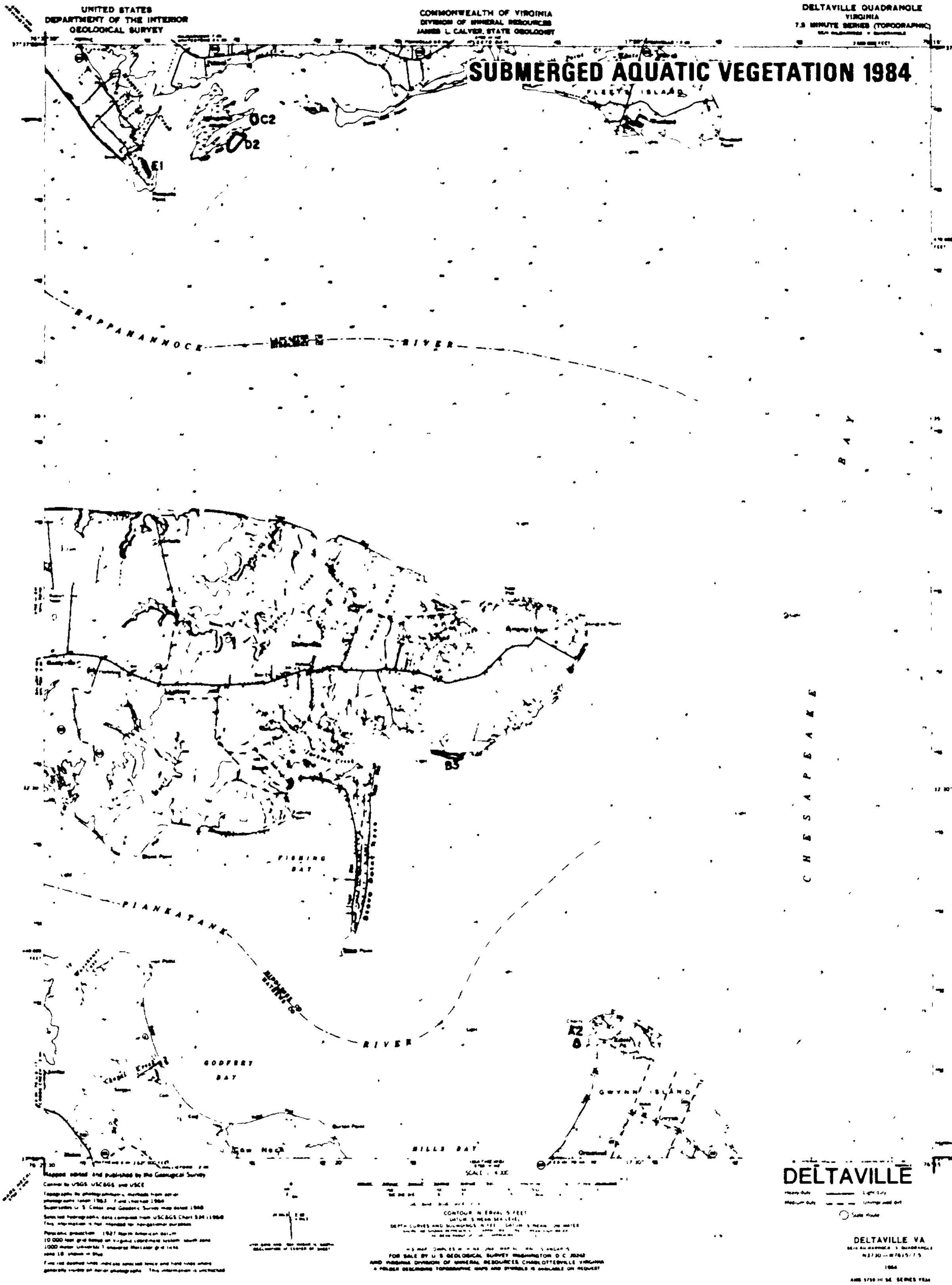
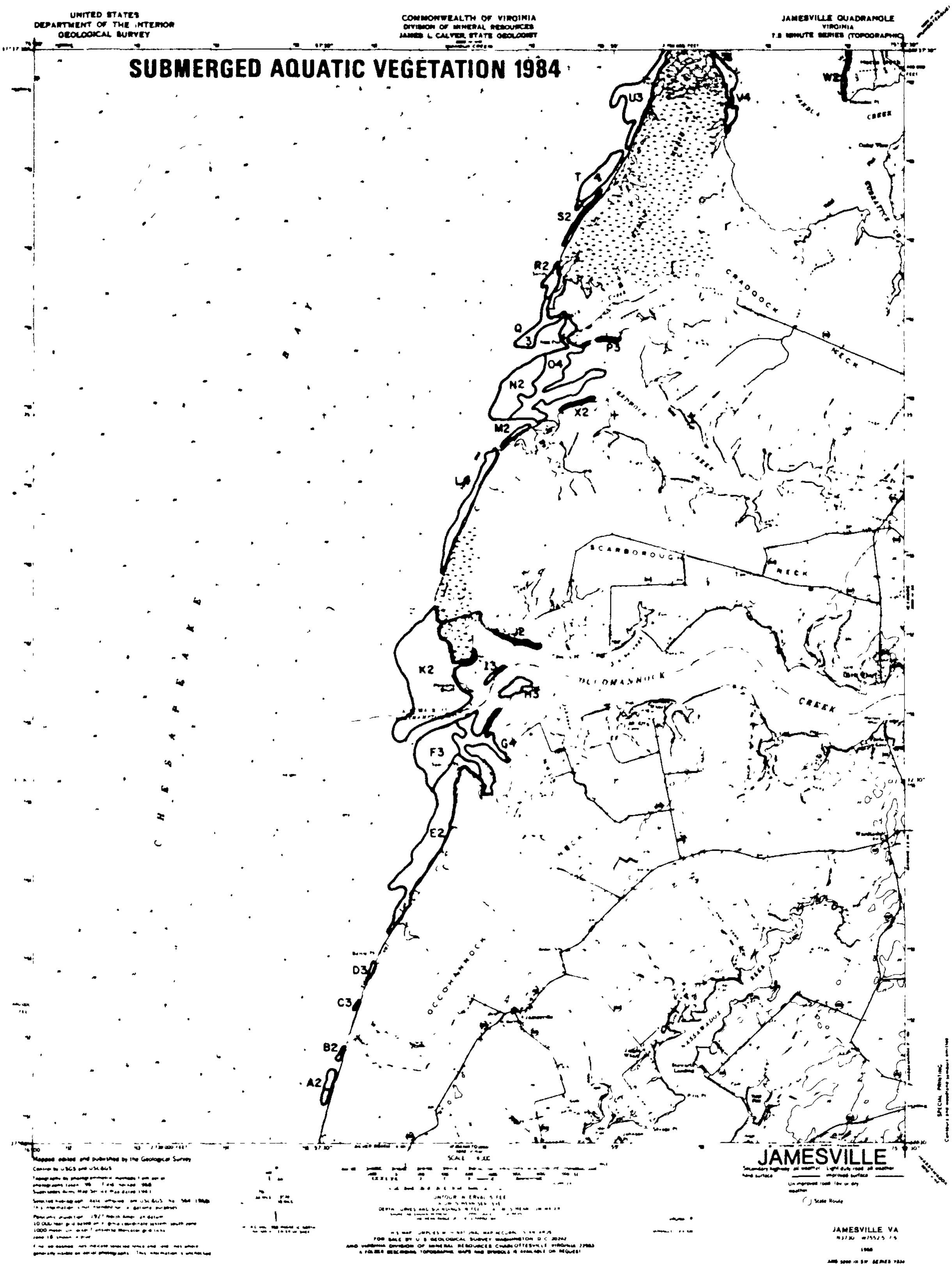
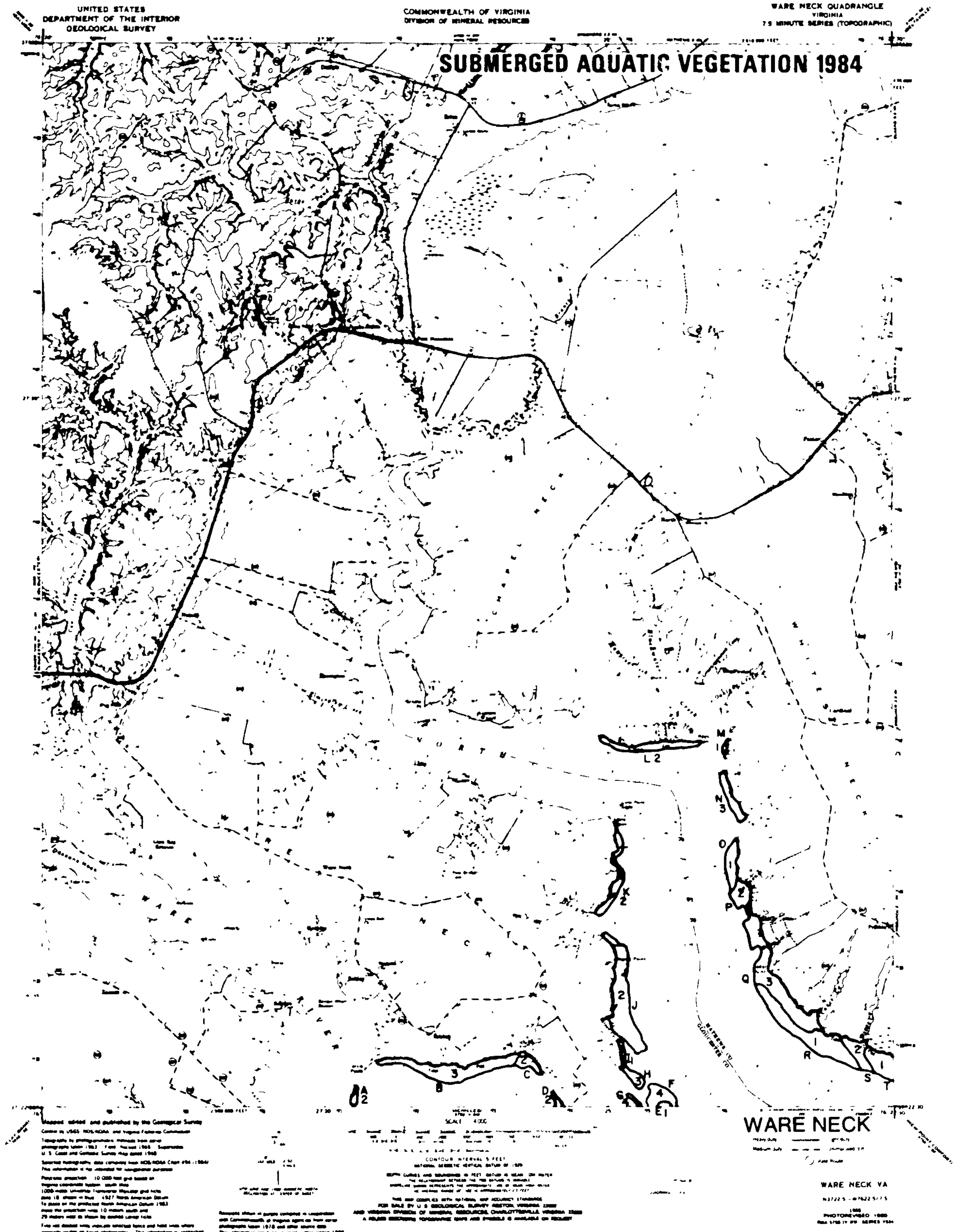
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER STATE GEOLOGIST
PUNGOTEAGUE QUADRANGLE
VIRGINIA - ACCOMACK CO.
SUBMERGED AQUATIC
VEGETATION 1984
ONANCOCK
BROADWATER NECK
PUNGOTEAGUE
PUNGOTEAGUE
PUNGOTEAGUE, VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER, STATE GEOLOGIST
DELTAVILLE QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
C2
D2
E1
RAPPAHANNOCK RIVER
BAY
CHESAPEAKE
B3
FISHING BAY
PIANKATANK RIVER
GODFREY BAY
GWYNN ISLAND
A2
HILLS BAY
DELTAVILLE
DELTAVILLE VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER, STATE GEOLOGIST
JAMESVILLE QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
U3
V4
W2
T
S2
R2
Q
3
P3
O4
N2
X2
M2
L4
J2
K2
I3
H3
G4
F3
E2
D3
C3
B2
A2
CHESAPEAKE
BAY
CRADDOCK
NECK
SCARBOROUGH
NECK
OCCOHANNOCK
CREEK
JAMESVILLE
JAMESVILLE VA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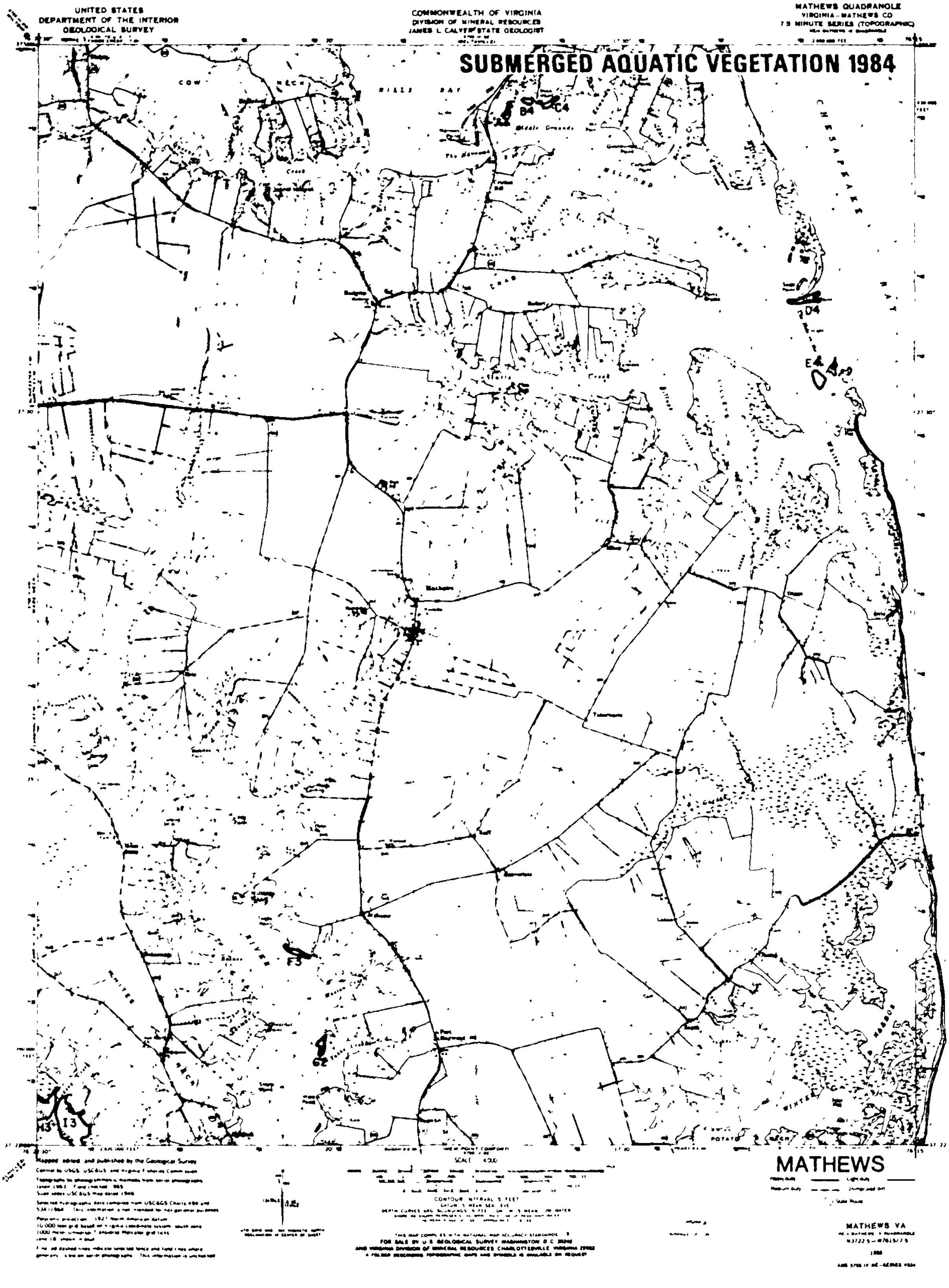
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
WARE NECK QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
WARE NECK
WARE NECK VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
MATHEWS QUADRANGLE
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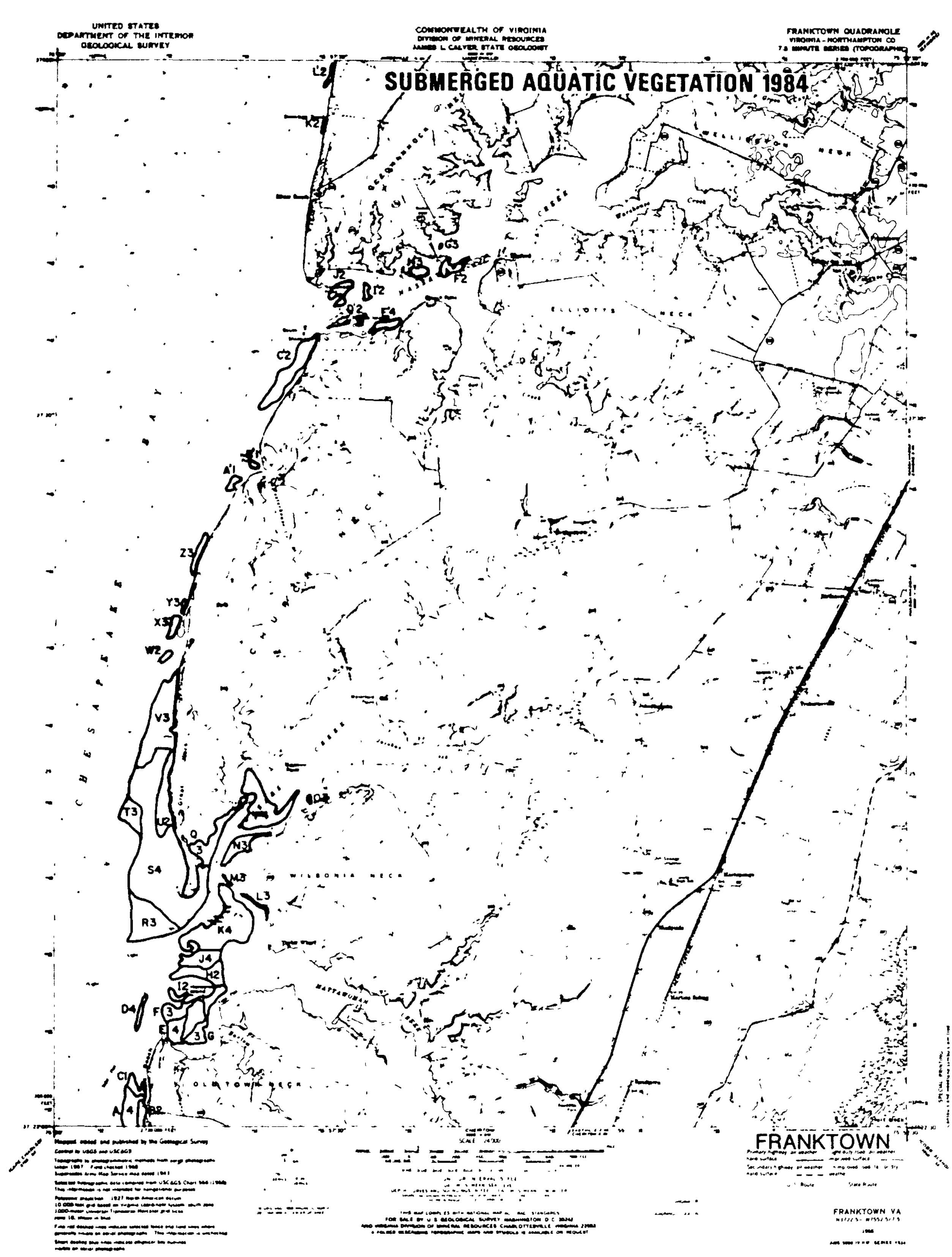
B4
C4
D4
E4
F3
G2
H3
I3
MATHEWS
MATHEWS VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER, STATE GEOLOGIST
FRANKTOWN QUADRANGLE
VIRGINIA - NORTHAMPTON CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
L2
K2
J2
I2
G3
H3
F2
G2
E4
C2
A1
Z3
Y3
X3
W2
V3
T3
U2
S4
O
3
N3
M3
L3
R3
K4
J4
H2
I2
D4
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E
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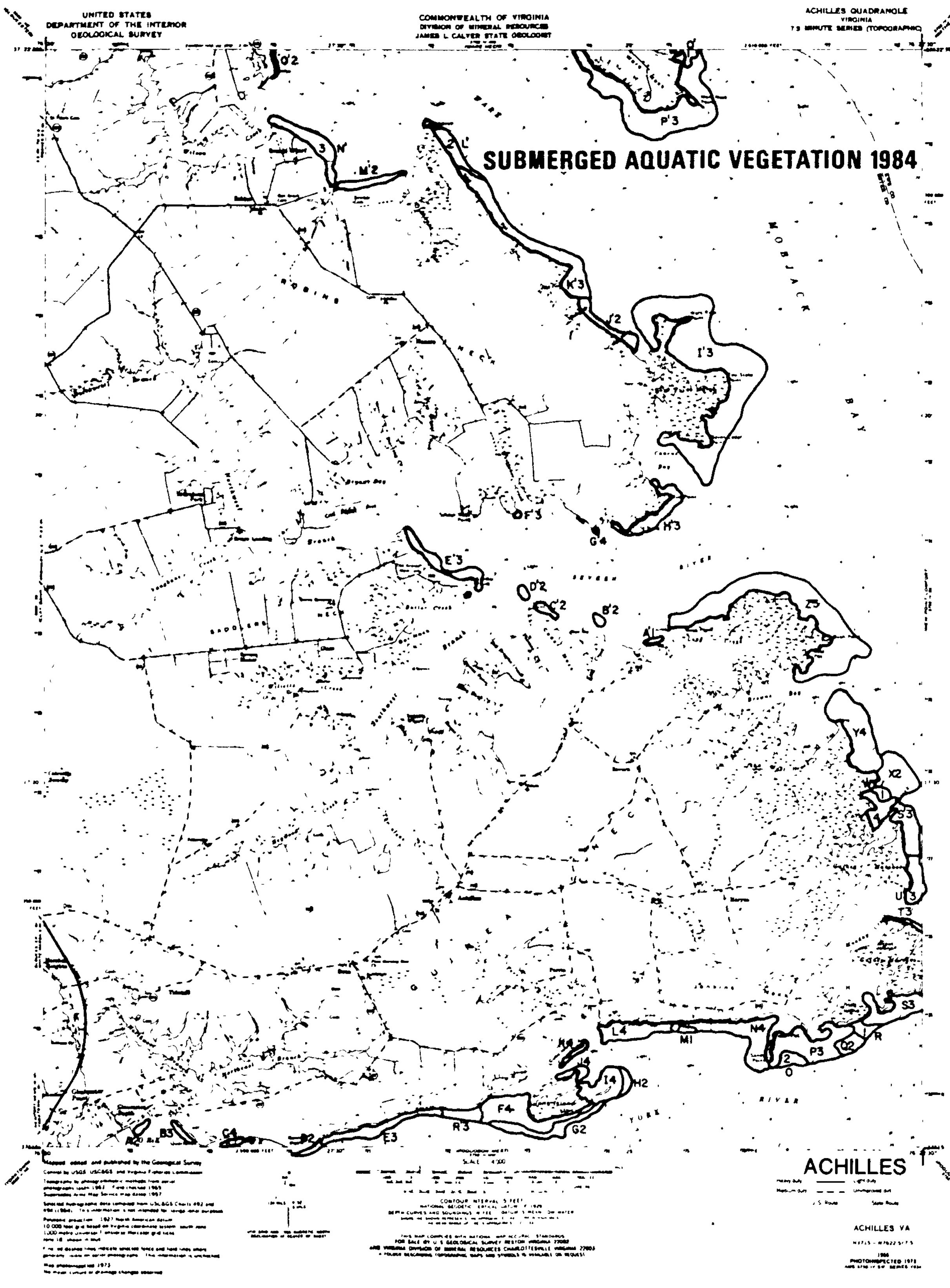
3
G
C1
A
4
B2
WILSONIA NECK
FRANKTOWN
FRANKTOWN, VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER STATE GEOLOGIST
ACHILLES QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
MOBJACK
BAY
YORK
RIVER
ACHILLES
ACHILLES VA
O'2
P'3
N'
M'2
L'
K'3
J'2
I'3
H'3
G4
F'3
E'3
D'2
C'2
B'2
A'
Z'3
Y4
X2
S3
U3
T3
L4
M1
N4
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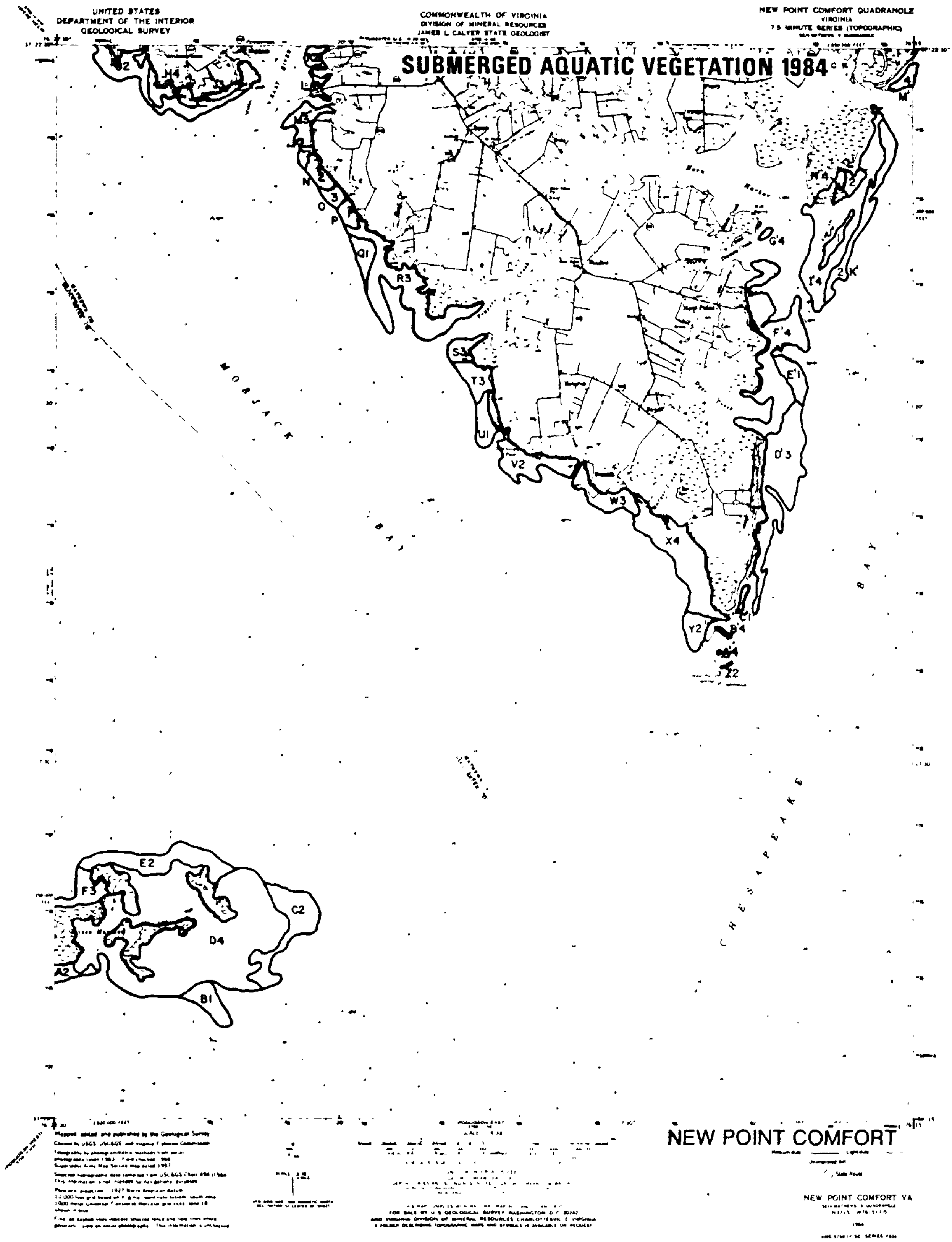
C4
B3
A2


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER STATE GEOLOGIST
NEW POINT COMFORT QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
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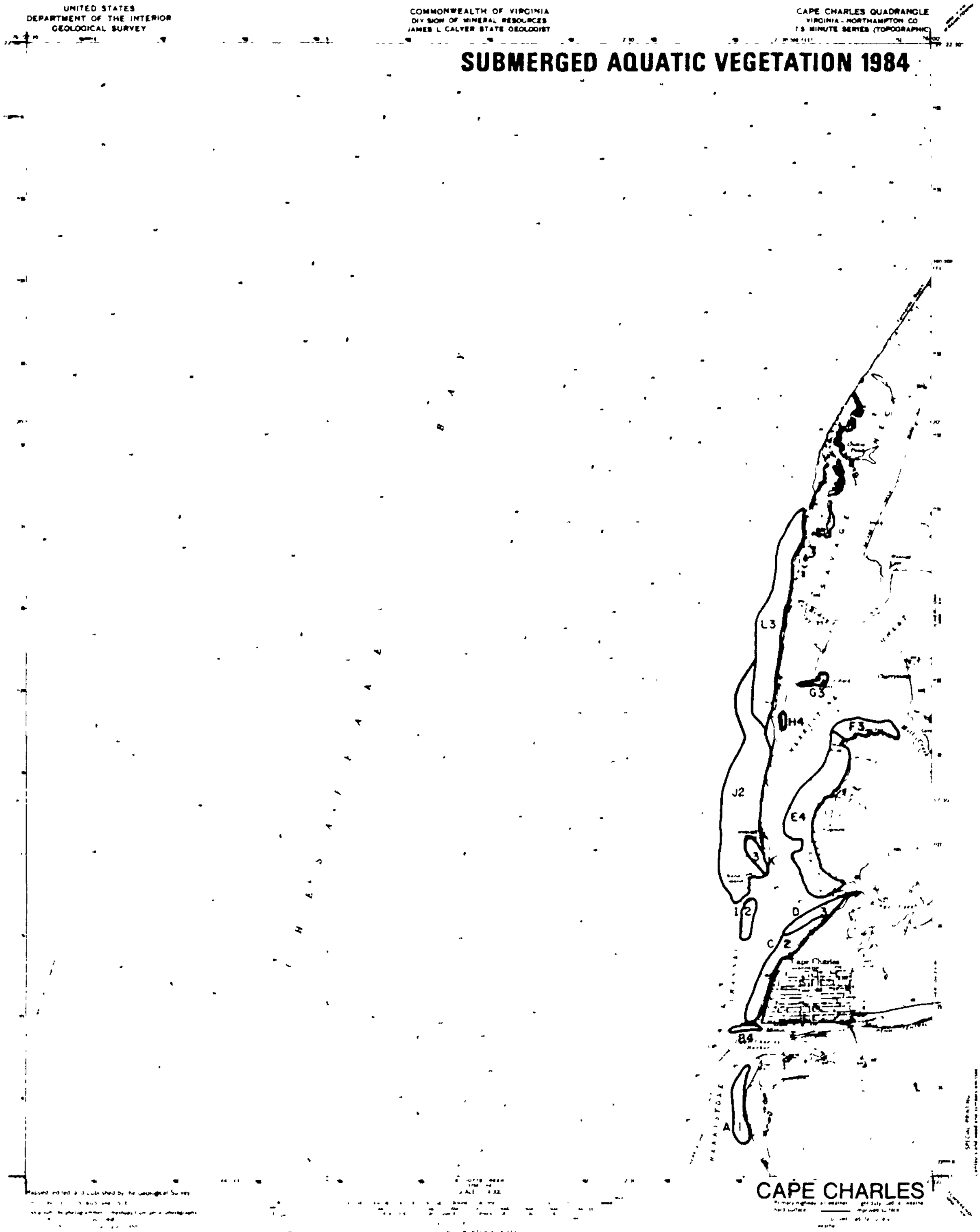
BAY
CHESAPEAKE
BAY
NEW POINT COMFORT
NEW POINT COMFORT VA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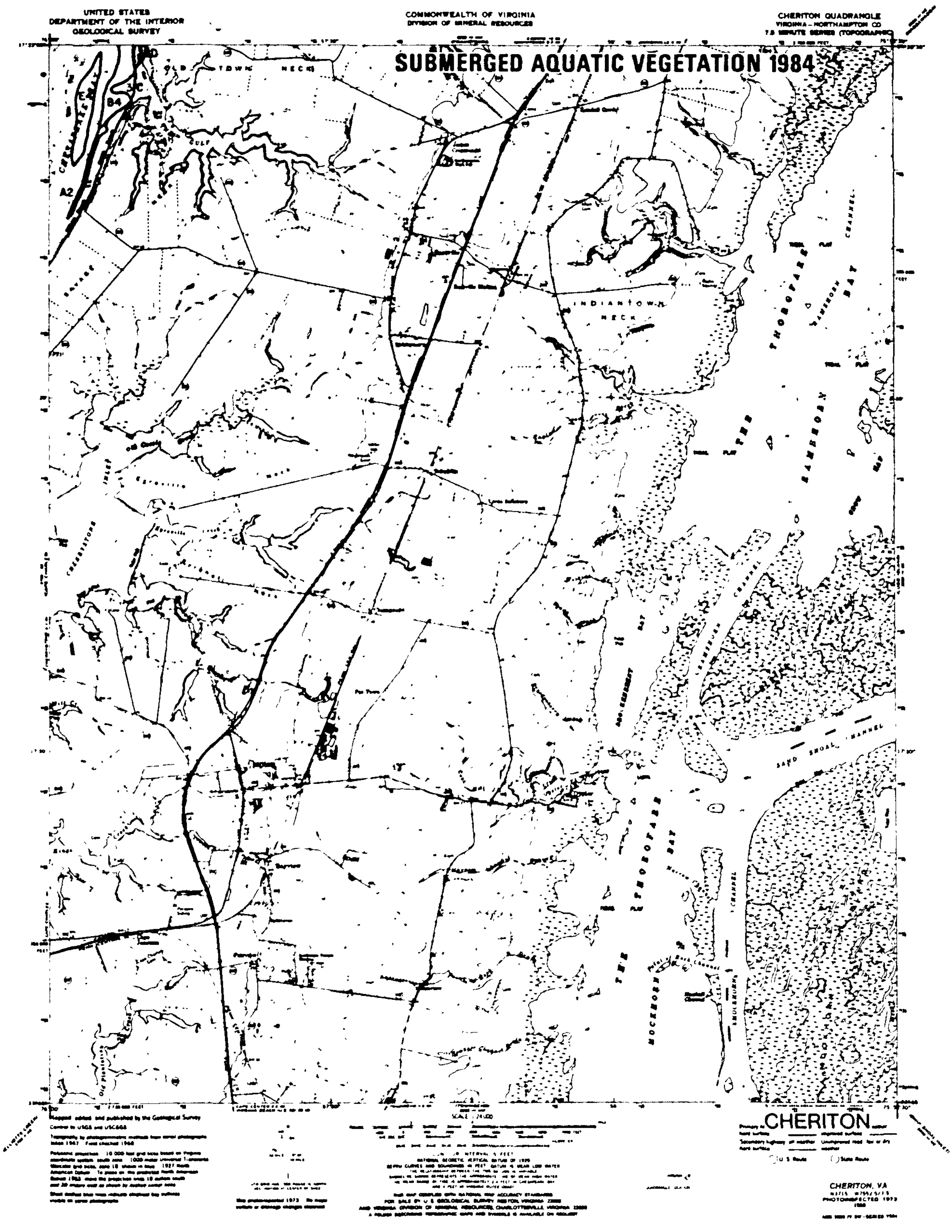
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER STATE GEOLOGIST
CAPE CHARLES QUADRANGLE
VIRGINIA - NORTHAMPTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
L3
G3
H4
F3
J2
E4
I2
D
C
2
A
CAPE CHARLES
CAPE CHARLES, VA.


UNITED STATES
DEPARTMENT OF THE INTERIOR
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COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
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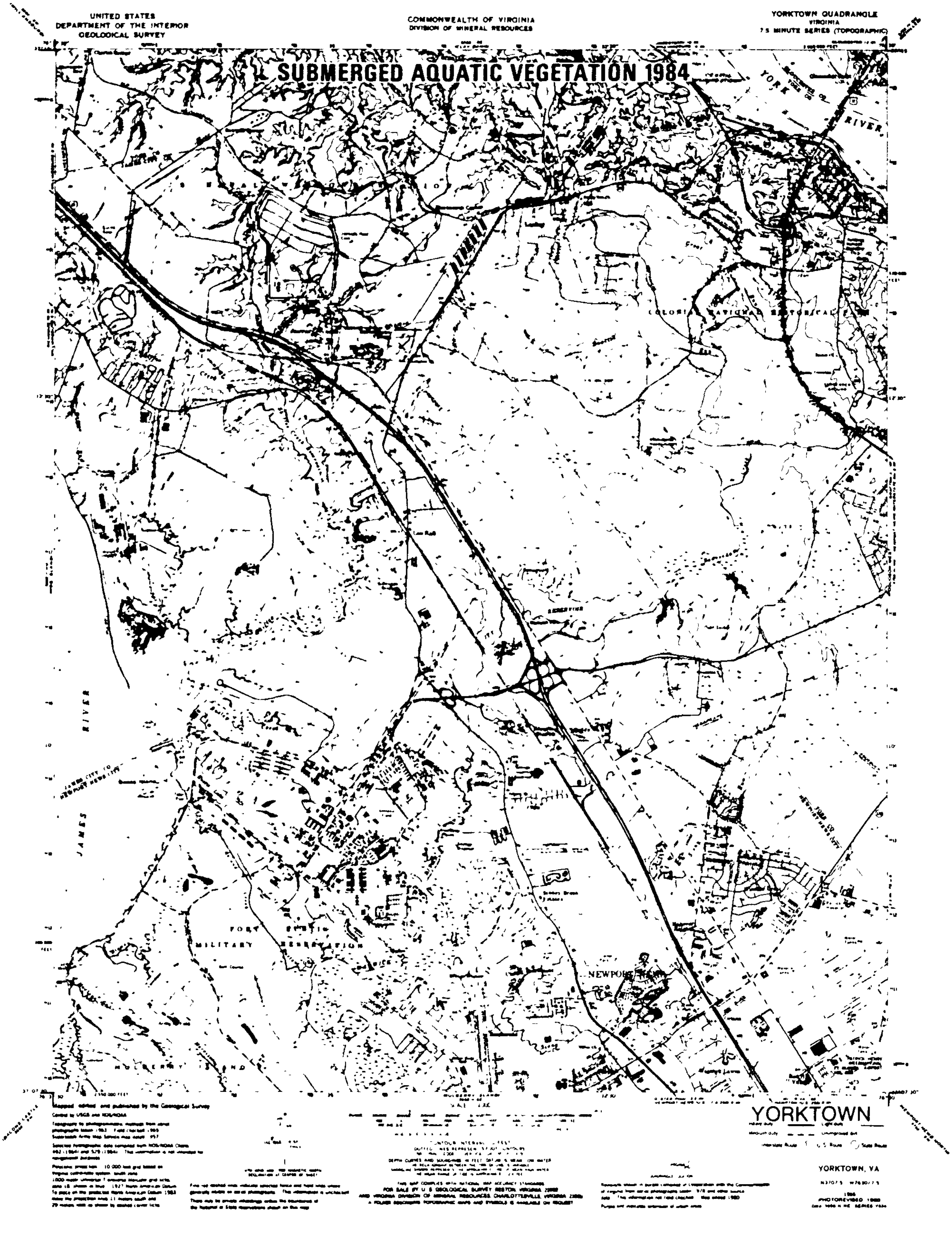
SAND SHOAL CHANNEL
CHERITON
CHERITON, VA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DEPARTMENT OF THE INTERIOR
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DIVISION OF MINERAL RESOURCES
YORKTOWN QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
YORK RIVER
COLONIAL NATIONAL HISTORICAL PARK
JAMES RIVER
FORT EUSTIS MILITARY RESERVATION
NEWPORT NEWS
MULBERRY ISLAND
YORKTOWN
YORKTOWN, VA


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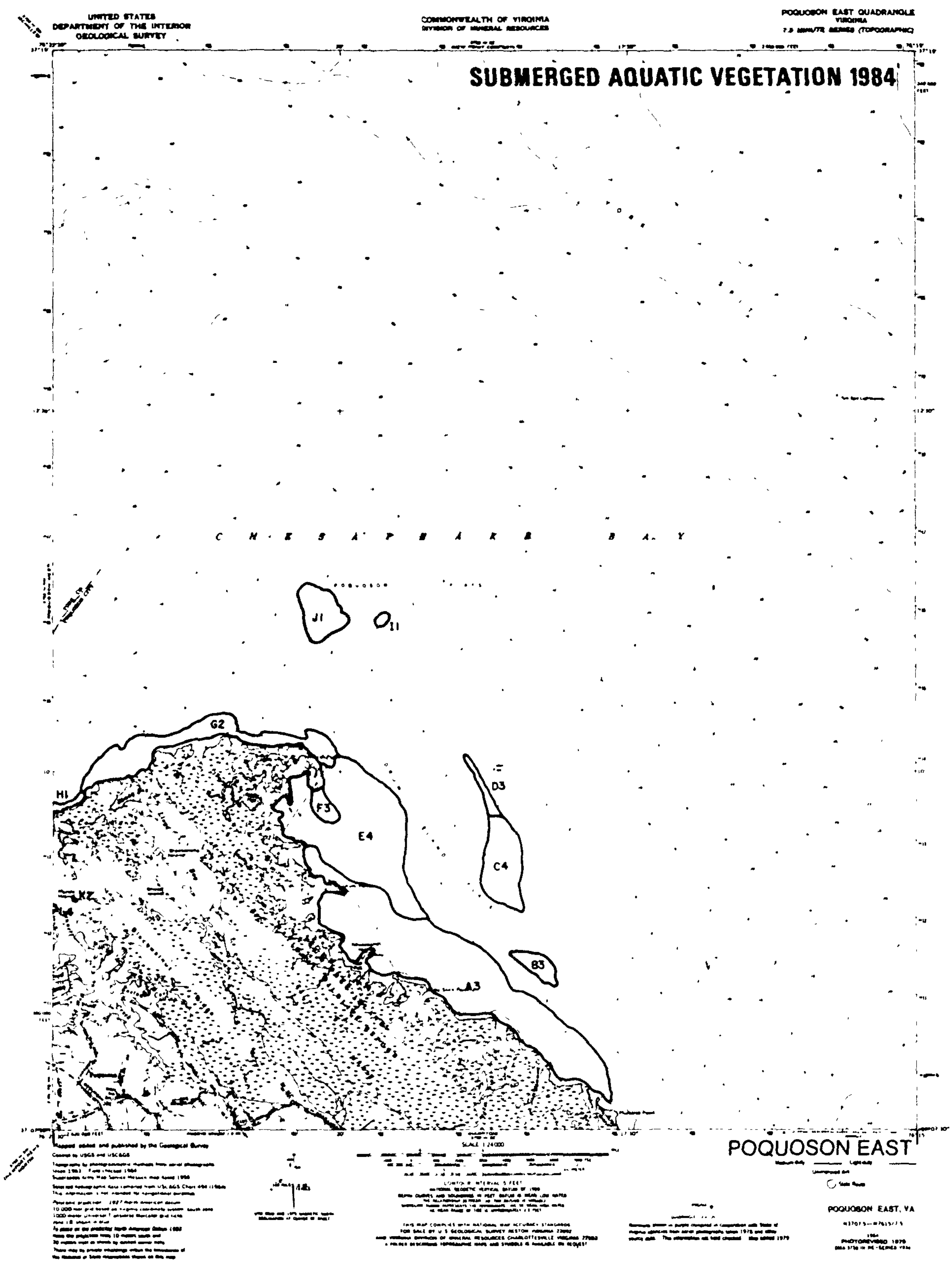
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
POQUOSON WEST QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
YORK RIVER
CHESAPEAKE BAY
W3
V3
I2
T2
S3
R1
O4
P2
N2
O2
M2
L3
K1
J1
I2
H4
G3
F1
E1
D2
POQUOSON WEST
POQUOSON WEST VA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DEPARTMENT OF THE INTERIOR
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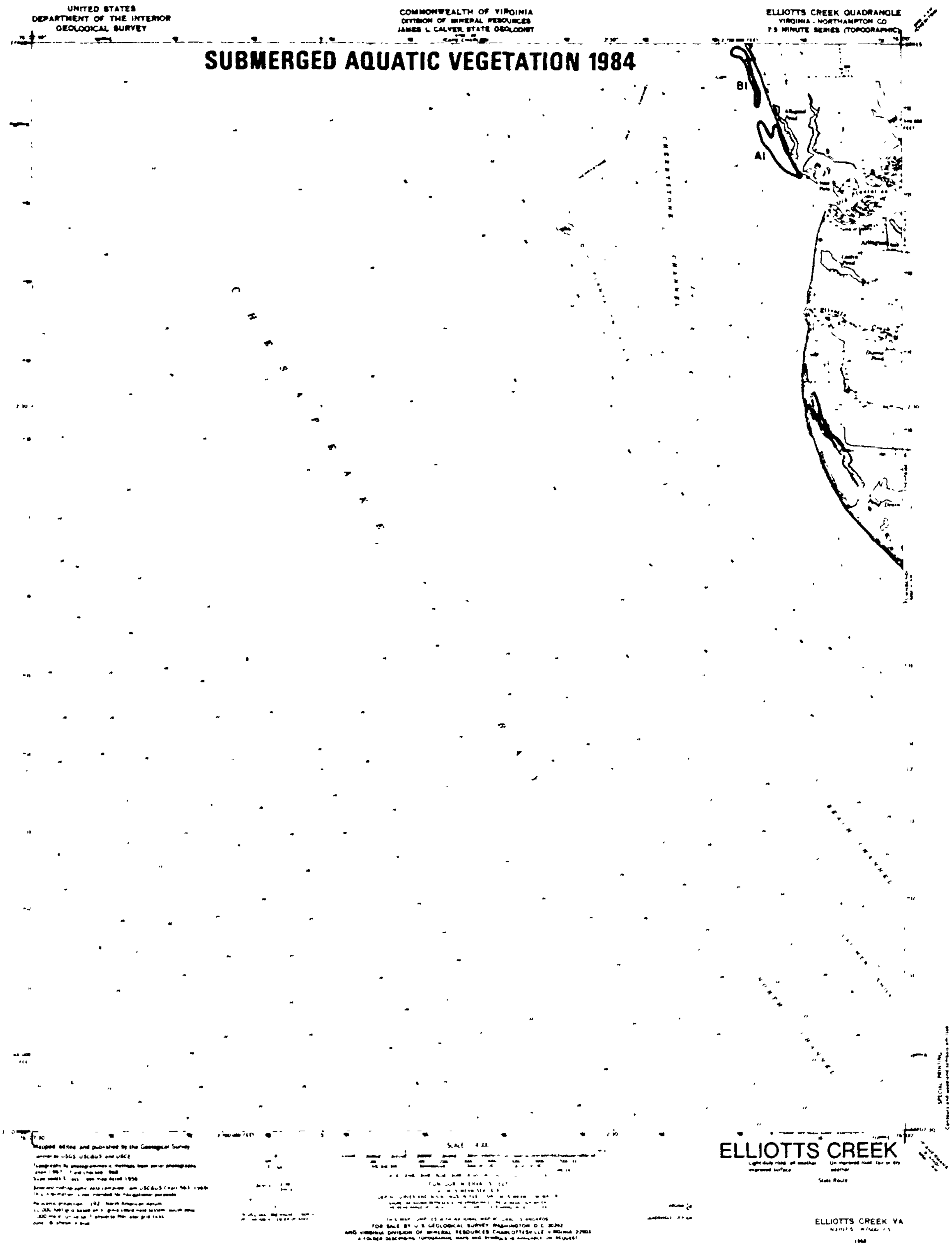
DIVISION OF MINERAL RESOURCES
POQUOSON EAST QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
C H E S A P E A K E B A Y
J1
I1
G2
H1
F3
E4
D3
C4
K2
B3
A3
SCALE 1:24000
CONTOUR INTERVAL 5 FEET
POQUOSON EAST
POQUOSON EAST, VA
PHOTOREVISED 1979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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER, STATE GEOLOGIST
ELLIOTTS CREEK QUADRANGLE
VIRGINIA - NORTHAMPTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
BI
AI
ELLIOTTS CREEK
State Route
ELLIOTTS CREEK, VA
SPECIAL PRINTING


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DEPARTMENT OF THE INTERIOR
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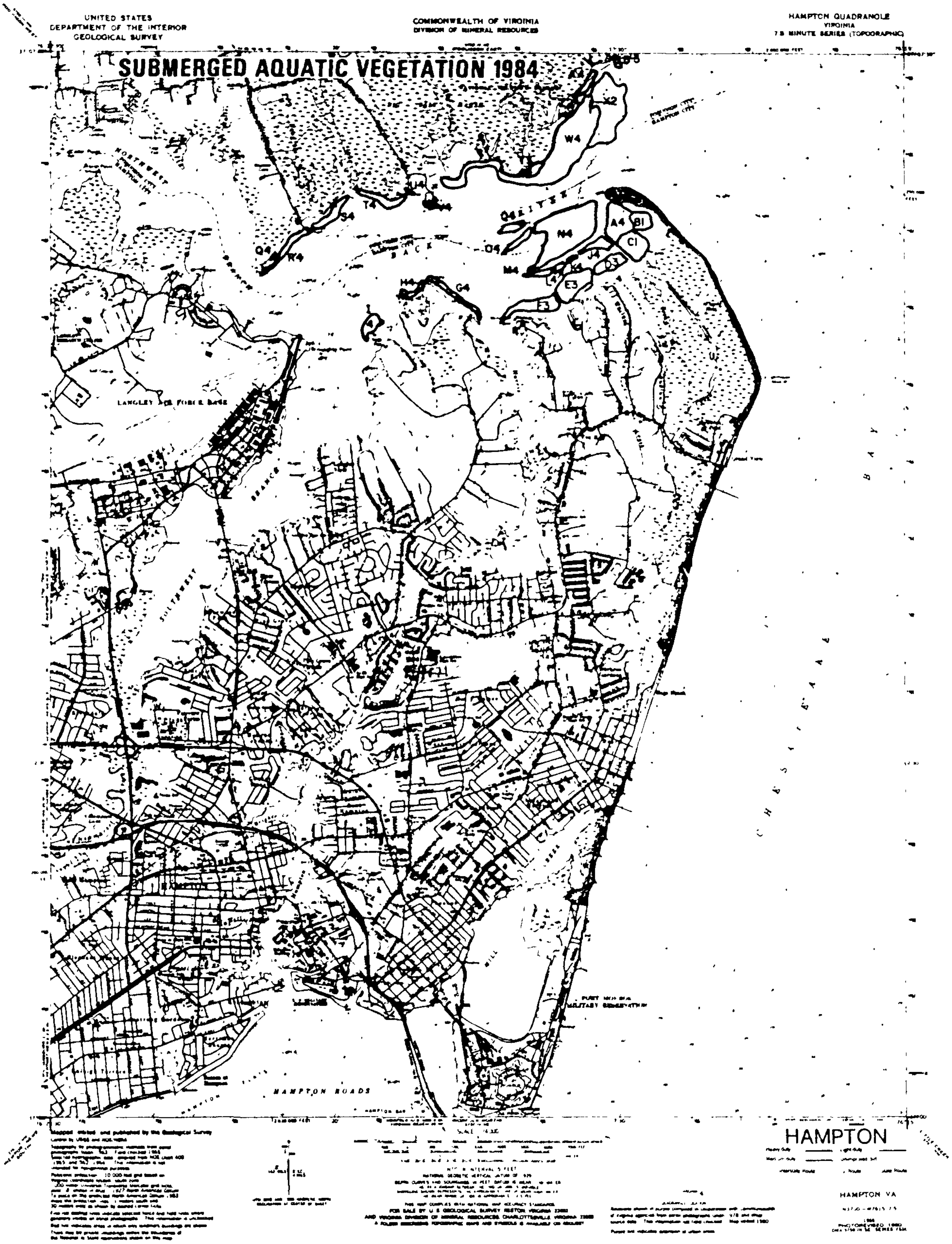
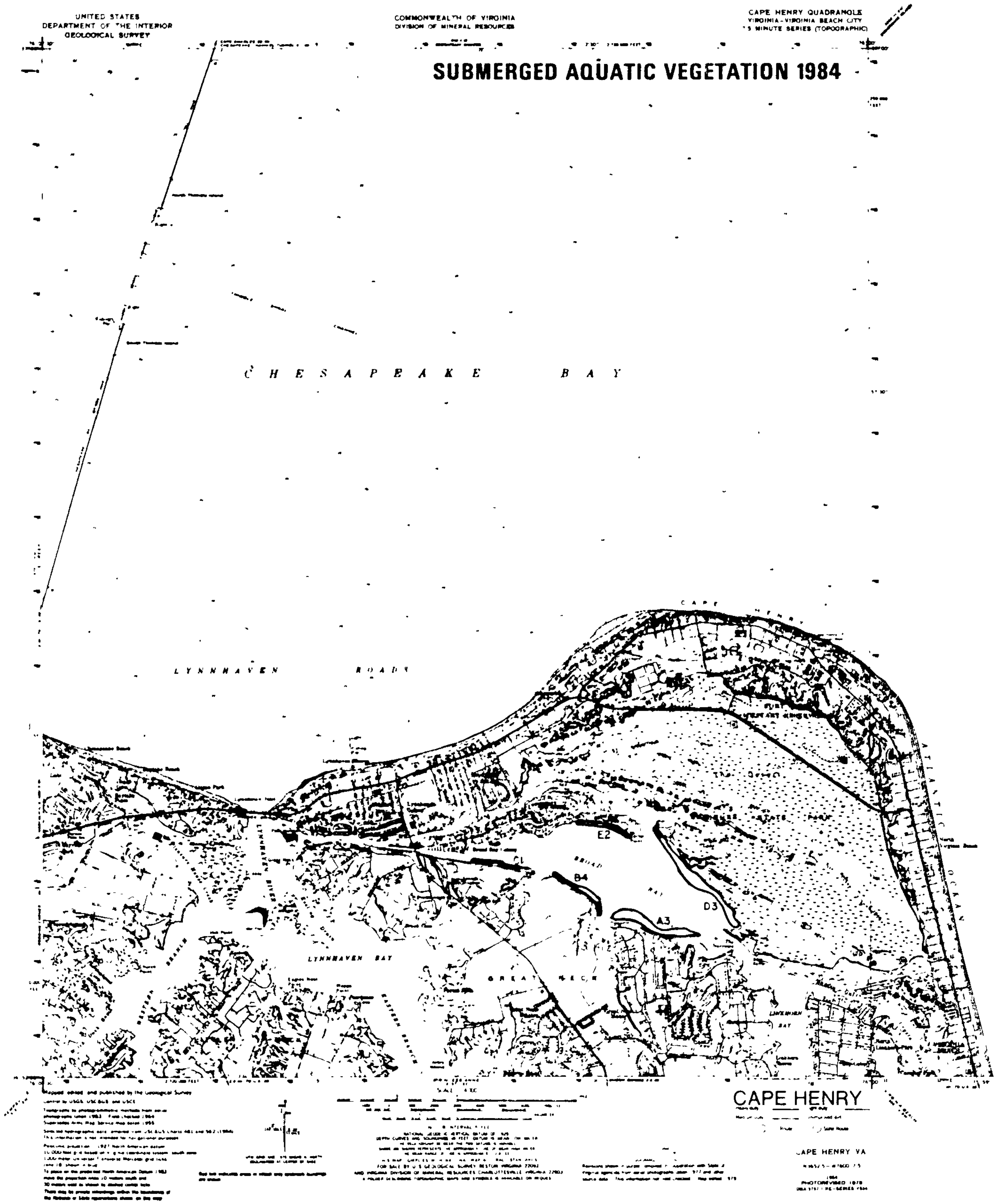
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
TOWNSEND QUADRANGLE
VIRGINIA - NORTHAMPTON CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
SMITH ISLAND
BAY
TOWNSEND
TOWNSEND VA
PHOTOREVISED 1980



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
HAMPTON QUADRANGLE
VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
X2
W4
T4
S4
Q4
R4
A4
B1
C1
N4
O4
M4
J4
H4
G4
E3
F3
LANGLEY AIR FORCE BASE
HAMPTON ROADS
HAMPTON
HAMPTON VA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
CAPE HENRY QUADRANGLE
VIRGINIA-VIRGINIA BEACH CITY
7.5 MINUTE SERIES (TOPOGRAPHIC)
SUBMERGED AQUATIC VEGETATION 1984
CHESAPEAKE BAY
LYNNHAVEN ROADS
CAPE HENRY
E2
C1
B4
D3
A3
LYNNHAVEN BAY
GREAT NECK
CAPE HENRY
CAPE HENRY VA