THE COASTAL WETLANDS OF MARYLAND

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and
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By

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Dedicated To The Memory of
Jack Sovern McCormick, 1929-1979
Wetlands Ecologist

FOREWORD

Maryland's coastal wetlands are extremely valuable habitats for many kinds of plants and animals. They supply vital nutrients to finfish, shellfish, crustaceans, and waterfowl. Many wetlands were lost through unregulated dredging, filling, and dumping prior to the passage of the Maryland Wetlands Act in 1970. The Act established a permit program to regulate wetland activities in accordance with the public policy of the State to preserve tidal wetlands, taking into account varying ecological, recreational, aesthetic, developmental, and economic values.

The first major task of the Department of Natural Resources in implementing the Wetlands Act was to map the upland boundary of the coastal wetlands to establish regulatory jurisdiction. This effort was completed under the technical direction of a contractor, Dr. Jack McCormick, during 1972. After several years it became evident to the Department that additional information on the types of wetland vegetation, the extent of each type, and the natural functions of each type would be of great value in making regulatory decisions. To meet this need, the present analysis was initiated during 1975.

The work that culminates in this report aimed to identify, measure, and analyze the coastal wetland vegetation of Maryland and to describe the habitat values of those wetlands systematically. Vegetation types were mapped in detail from aerial photographs, and the acreage of each type was tallied by county, by major watershed, and statewide. The available information on coastal wetland values was reviewed, and the existing literature was supplemented by original field data on above-ground standing crops. An innovative ranking scheme for the comparative evaluation of individual wetlands was devised and calibrated for freshwater, brackish, and saline conditions using the Maryland inventory.

The mapping, field verification, and measurement of productivity were accomplished during 1976 and 1977. Literature review and development of the evaluation scheme continued through 1978, as successive draft sections were critiqued by the Department and returned with comments to the contractor. Final revisions were underway at the time of the sudden and unanticipated death of Dr. McCormick during early 1979. The major tasks of checking quantitative tabulations, of finalizing cross-references, of laying out several appendices, and of general editing for consistency were performed by Elder A. Ghigiarelli, Jr., of the Department, from 1979 through 1981.

The results of the present work, as presented in this report and in the nearly 2,000 regulatory photomaps (scale, 1:2,400), are a source of pride for the Department and for the contractor. The detailed maps and acreage measurements establish the historical baseline against which regulators can compare proposed actions and scientists can assess natural and man-made changes. The vegetation types are described fully and are illustrated photographically for the benefit of future users. Relationships with previous classifications are indicated. The review of wetland values will benefit all those concerned with the coast of the mid-Atlantic states. The evaluation and comparative ranking of individual wetlands will provide food for thought to persons formulating methods for habitat evaluation. General readers will treasure Dr. McCormick's clear prose style and his ability to capture in words the key aspects of complex environmental relationships. Nowhere is this better illustrated than in his splendid account of seasonal changes in the freshwater tidal marsh.

The evaluation scheme provides a relative measure of the quality of a given wetland with reference to nearby wetlands and to other Maryland wetlands with similar salinity and other characteristics. The scheme is expected to provide valuable input into wetlands planning and to form a rational basis for comparing ecological values. The results, however, are not intended as the sole basis for regulatory decision-making by the Department.

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A Subsidiary of WAPORA, Inc.
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The work of the contractor was directed by Dr. Jack McCormick and by Horace A. Somes, Jr. Airphoto interpretation, field checking of mapped types, and collection and handling of standing crop samples were the responsibility of John W. Munro and Charles D. Rhodehamel. John Munro also took the report photographs. Acreage measurements from the vegetation types were made primarily by Judith Rhodehamel and Glen Davis. Graphics specialists, field assistants, and typists included William L. Bale, Jr., Jerome H. Gold, Connie Gibbons, Kenneth Cranston, Nancy Daoud, and Anne Pagano. The principal author of the final report was Dr. Jack McCormick. Horace Somes drafted sections of the report and handled day to day coordination into 1978. Minor editorial assistance was provided by Dr. James A. Schmid, formerly Vice President, Jack McCormick & Associates, Inc. (and presently with Schmid & Company, Consulting Ecologists).

INTRODUCTION

The Maryland Wetlands Act, which was approved during 1970, is administered by the Wetlands Permit Division of the Water Resources Administration, an agency of the Maryland Department of Natural Resources (DNR). The intent of the Act is to conserve the coastal (tidal) wetlands, and to ensure the wisest use of these valuable areas.

During 1971 and 1972, Jack McCormick & Associates (JMA), under contract to the Raytheon Corporation, delineated the inland boundary of the coastal (tidal) wetlands on photomaps. After public review, these maps were promulgated and established the area of regulatory jurisdiction. From September 1975 through March 1978, under contract to the Coastal Zone Management Program of DNR, JMA conducted a wetlands management study to refine and expand the existing information on the regulated coastal wetlands of Maryland. This project was funded, in part, by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration, United States Department of Commerce.

The purposes of the study were to develop detailed information on the vegetation of the coastal wetlands, and the location, extent, and values of different types of wetland vegetation, to aid DNR in its wetland management activites. Data on the values of various qualitative features of wetlands and quantitative estimates of the productivity of wetland vegetation will enable DNR to determine the relative value of specific wetlands in relation to local areas, as well as to the entire estuarine system of the State. These determinations, in turn, can be used to identify wetlands that are in need of special preservation and those that are most resistant to various types of human activities. With regard to its uses in the day to day activities of DNR, the following is a list of the benefits that resulted from the study:

- Identification and location of vegetation types in the coastal wetlands of Maryland;
- Aid in identifying public and private wetlands in tidewater areas;
- Knowledge of the vegetation types within a wetland area provides information on the physical features of the marsh, such as salinity, inundation, soil types, and drainage;
- The provision of additional information for specific wetland case work, including:
  —comparisons of local and regional extent of vegetation types,
  —identification of important waterfowl and wildlife areas on the basis of available food,
  —productivity-diversity information to aid in filling the gaps which existed, and
  —a literature review and value assessment to synthesize available information;
- A historical baseline has been established which will allow DNR to follow changes that will occur in wetland vegetation, wildlife and waterfowl habitat, wetland productivity, natural succession, erosion, and man-induced changes;
- Aid in relating vegetation types to mosquito breeding areas so that environmentally compatible mosquito control measures can be designed to eliminate problem areas;
- Aid in reviewing areas to be acquired by the public; and
- Vegetation type information aids in the siting of waterfowl and wildlife management ponds and impoundments.

The wetlands management study consisted of six principal tasks. The purpose and scope of each of these tasks were:

Task 1. Value Assessment
The object of this task was to assemble data on the ecological features and environmental processes of each vegetation type to serve as a basis for assessing the relative value of the individual vegetation types and of wetland areas. The characteristics that are assessed in this report are primary productivity, nutrient content of predominant plants, plant species diversity, water pollution abatement capacity, erosion control capacity, fish habitat values, wildlife habitat and food values, and sediment entrapment capacity. Information on various other aspects of differential values between types was sought, but was not found. The approach to this task was to conduct a search of the available published and unpublished information on coastal wetlands. In addition to material in the JMA library, resources that were utilized to assemble information included computer searches of the reports of the United States Fish and Wildlife Service and the National Technical Information Service.

Task 2. Vegetation Classification and Delineation
To provide a basis for management planning, for the development of regulatory strategies, and to facilitate comparative evaluations of the coastal wetland resources of Maryland, the distribution of thirty-two types of wetland vegetation and three unvegetated wetland types were mapped in the tidewater sections of sixteen counties. Areas of 0.25 acre or larger that are occupied by types were delineated. The mapping was conducted by interpretation of vegetation types recorded on natural-color stereoscopic aerial photographs (Anne Arundel, Baltimore, Caroline, Cecil, Dorchester, Harford, Kent, Prince George's, Queen Anne's, St. Mary's, Talbot, Wicomico, and

Worcester Counties) and on false-color infra-red and black and white infra-red aerial photographs (Charles, Calvert, and Somerset Counties). The vegetation types were delineated and identified by numerical symbols on approximately 2,000 mylar photomaps (scale 1:2,400, or 1 inch = 200 feet). These maps are on file at DNR and copies may be obtained from the Department.

Task 3. Productivity-Diversity Study
To provide more substantial data on which to base management and regulatory decisions, a representative estimate of the primary production and plant species diversity was obtained for appropriate wetland vegetation types. Available published and unpublished estimates of primary production and of plant species diversity were assembled for types of coastal wetland vegetation that occur in Maryland. For seventeen types, little or no information was found, and the standing crop in each of these types was sampled by six 0.25 meter square plots, three in each of two stands. The samples were collected and floristic observations were made during August 1976.

Task 4. Information Summary
The presence or absence of each type of wetland vegetation was recorded for each of the 2,000 photomaps. The acreages of types that were present on each map were determined by dot gridding, and these acreages were totaled, by vegetation type, for each major watershed, for each county, and for the State.

Task 5. Recommendations
Based upon the information gathered and the experience gained in the other tasks of the study, recommendations on policies and procedures were made for consideration by DNR to facilitate and expedite the rational management of the coastal wetland resources of Maryland.

Task 6. Acquisition of Photography
The objective of this task was to acquire approximately eighty aerial photographs (scale 1:12,000) of areas of wetlands that were not represented on existing photographs. Approximately 300 exposures of true color film were made during October 1976. Positive color contact prints were made from 140 of these exposures, and 80 of these were selected for the preparation of additional base photomaps for future wetland mapping by DNR.

Work on this contract was completed during March 1978. This project report was assembled to present and correlate the substantive results of the study. Specifically, it includes discussion of the wetland vegetation types, the detailed results of the value assessment, the productivity-diversity study, the information summary, and an environmental evaluation scheme for Maryland's coastal wetlands.

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Table 1. Types of tidal wetlands recognized in the coastal zone of Maryland

SHRUB SWAMPS		
11	Swamp rose	*Rosa palustris*
12	Smooth alder/Black willow	*Alnus serrulata/Salix nigra*
13	Red maple/Ash	*Acer rubrum/Fraxinus* spp.
SWAMP FORESTS		
21	Baldcypress	*Taxodium distichum*
22	Red maple/Ash	*Acer rubrum/Fraxinus* spp.
23	Loblolly pine	*Pinus taeda*
FRESH MARSHES		
30	Smartweed/Rice cutgrass	*Polygonum* spp./*Leersia oryzoides*
31	Spatterdock	*Nuphar advena*
32	Pickerelweed/Arrowarum	*Pontederia cordata/Peltandra virginica*
33	Sweetflag	*Acorus calamus*
34	Cattail	*Typha* spp.
35	Rosemallow	*Hibiscus* spp.
36	Wildrice	*Zizania aquatica*
37	Bulrush	*Scirpus* spp.
38	Big cordgrass	*Spartina cynosuroides*
39	Common reed	*Phragmites communis*
BRACKISH HIGH MARSHES		
41	Meadow cordgrass/Spikegrass	*Spartina patens/Distichlis spicata*
42	Marshelder/Groundselbush	*Iva frutescens/Baccharis halimifolia*
43	Needlerush	*Juncus roemerianus*
44	Cattail	*Typha* spp.
45	Rosemallow	*Hibiscus* spp.
46	Switchgrass	*Panicum virgatum*
47	Threesquare	*Scirpus* spp.
48	Big cordgrass	*Spartina cynosuroides*
49	Common reed	*Phragmites communis*
BRACKISH LOW MARSHES		
51	Smooth cordgrass	*Spartina alterniflora*
SALINE HIGH MARSHES		
61	Meadow cordgrass/Spikegrass	*Spartina patens/Distichlis spicata*
62	Marshelder/Groundselbush	*Iva frutescens/Baccharis halimifolia*
63	Needlerush	*Juncus roemerianus*
SALINE LOW MARSHES		
71	Smooth cordgrass, tall growth form	*Spartina alterniflora*
72	Smooth cordgrass, short growth form	*Spartina alterniflora*
OPEN WATER		
80	Pond	
SANDBAR/BEACH/MUDFLATS		
81	Mudflat	
91	Sandbar/Beach	
SUBMERGED AQUATIC VEGETATION		
101	Submerged aquatic plants	

Table 2. Areas occupied by the 35 mapped types of coastal wetland in Maryland expressed in acres and as a percentage of the total area that was mapped.

TYPE		ACRES	PERCENTAGE
SHRUB SWAMPS			
11	Swamp Rose	51	0.02
12	Smooth Alder/Black willow	524	0.20
13	Red maple/Ash	2,025	0.78
		2,600	1.00

1. THE COASTAL WETLANDS OF MARYLAND

1.1. INLAND (UPPER) BOUNDARY

The Maryland Wetlands Act of 1970 recognizes two categories of coastal wetlands. State wetlands are defined as "any land under the navigable waters of the state below the mean high tide, affected by the regular rise and fall of the tide. Wetlands of this category which have been transferred by the state by valid grant, lease, patent or grant confirmed by Article 5 of the Declaration of Rights of the Constitution shall be considered 'private wetland' to the extent of the interest transferred." Private wetlands are "any land not considered 'state wetland' bordering on or lying beneath tidal waters, which is subject to regular or periodic tidal action and supports aquatic growth. This includes wetlands, transferred by the state by a valid grant, lease, patent, or grant confirmed by Article 5 of the Declaration of Rights of the Constitution, to the extent of the interest transferred." The term "Regular or periodic tidal action" means "the rise and fall of the sea produced by the attraction of the sun and moon uninfluenced by wind or any other circumstance."

The inland boundary is the interface between the coastal (tidal) wetlands and upland areas or between coastal wetlands and wetlands that do not border on tidal waters. The boundary was established by the interpretation of aerial photography and by field inspections to validate vegetation determinations and to verify tidal association. The upper inland boundary was delineated on a series of approximately 2,000 aerial photomaps at a scale of 1:2,400 (1 inch = 200 feet).

1.2 WETLAND TYPES AND AREAS

The system that is utilized by the Department of Natural Resources to characterize and describe the coastal wetlands of the State of Maryland recognizes four forms of vegetation (shrub swamp, swamp forest, herbaceous marsh, and submerged plants), three categories of unvegetated wetlands (open water, mudflats, and beaches and sandbars), three ranges of salinity within the marshes (fresh, brackish, and saline), and two tidal ranges within the brackish and saline marshes (low, or regularly flooded, and high, or less frequently flooded). In total, thirty-five types of wetlands are distinguished (Table 1). Each type was assigned a two or three digit number, from 11 to 101, to identify it on the maps of the coastal wetlands of Maryland. The names of the thirty-one types of wetlands with subaerial vegetation indicate the species of plants which form the bulk of the cover, but no more than two taxa are used to characterize a particular type.

The various kinds of wetlands merge gradually from one to the other and, thus, form a continuum. At one extreme of this continuum are the saline wetlands that regularly are flooded by the water of the Atlantic Ocean, which contains salts at concentrations of 35 ppt (parts per thousand) or more. At the other extreme, the freshwater wetlands near the head of tide in the estuaries are never exposed to water with more than 0.5 ppt salt. The brackish wetlands occupy a large proportion of the area between these two extremes.

Definitions of the environmental limits of the brackish wetlands, and thus of the other two classes, necessarily must be arbitrary. The basic variable feature along the wetland continuum is salinity. But the salinity at a particular location varies seasonally, and it may change greatly, even during periods of several hours or a few days.

Physiognomy, or the general structure and appearance of the vegetation, is used to sort the shrub swamps (Types 11, 12, and 13) from the swamp forests (Types 21, 22, and 23), and to distinguish these two groups of woody vegetation types from the herbaceous marshes and the unvegetated wetlands. Salinity is not considered in the designation of these woody types, but all of the shrub swamps and two of the swamp forests (Types 21 and 22) commonly are restricted to freshwater areas of the wetland system. Loblolly pine swamp forests generally occur in the brackish segment of the system.

Nineteen of the 26 types of marsh vegetation are paired. That is, a particular type of vegetation may be designated as one numbered type or as another numbered type on the basis of relative salinity. For this regional inventory of the coastal wetlands of Maryland, the Department of Natural Resources assigned the vegetation types to the salinity classes on the basis of floristic composition (i.e., unpaired types), on the basis of spatial associations with other types (i.e., paired types were correlated with the unpaired types with which they occurred), and on the basis of geographic location.

All wetland vegetation in the principal seaside bays (Assawoman Bay, Chincoteague Bay, and so on) is considered to represent the saline wetland class. All stands of meadow cordgrass/spikegrass in the seaside bays, therefore, are assigned to Type 61 (saline) rather than to the paired Type 41 (brackish) on the basis of geographic location. Similarly, in the seaside bays, stands of marshelder/groundselbush are assigned to Type 62, rather than to Type 42; stands of needlerush are assigned to Type 63, rather than to Type 43; and stands of smooth cordgrass are assigned to Type 71 (tall) or Type 72 (short), rather than to Type 51.

No saline wetland is considered to occur outside the seaside bays. In Chesapeake Bay and its tributaries, therefore, any stand of a vegetation type that is represented by a saline/brackish pair is designated as the brackish member of that pair. For example, all stands of meadow cordgrass/spikegrass that are adjacent to Chesapeake Bay are characterized as Type 41 (brackish) rather than as the paired Type 61 (saline). Owing to the underlying geographic basis for these designations, no mixture of saline and brackish types was mapped.

Table 2. Areas occupied by the 35 mapped types of coastal wetland in Maryland expressed in acres and as a percentage of the total area that was mapped (concluded).

SWAMP FORESTS				
21 Baldcypress	4,154		1.59	
22 Red maple/Ash	11,391		4.36	
23 Loblolly pine	1,253		0.48	
		16,798		6.43
FRESH MARSHES				
30 Smartweed/Rice cutgrass	2,924		1.12	
31 Spatterdock	1,774		0.68	
32 Pickerelweed/Arrowarum	3,925		1.50	
33 Sweetflag	431		0.16	
34 Cattail	9,018		3.45	
35 Rosemallow	1,256		0.48	
36 Wildrice	776		0.30	
37 Bulrush	2,808		1.07	
38 Big cordgrass	1,904		0.73	
39 Common reed	747		0.29	
		25,563		9.78
BRACKISH HIGH MARSHES				
41 Meadow cordgrass/Spikegrass	31,072		11.89	
42 Marshelder/Groundselbush	10,559		4.04	
43 Needlerush	48,685		18.63	
44 Cattail	5,691		2.18	
45 Rosemallow	281		0.11	
46 Switchgrass	2,165		0.83	
47 Threesquare	18,965		7.26	
48 Big cordgrass	8,196		3.14	
49 Common reed	955		0.36	
	126,569		48.44	
BRACKISH LOW MARSHES				
51 Smooth cordgrass	25,079		9.59	
		151,648		58.03
SALINE HIGH MARSHES				
61 Meadow cordgrass/Spikegrass	2,304		0.88	
62 Marshelder/Groundselbush	1,780		0.68	
63 Needlerush	121		0.05	
	4,205		1.61	
SALINE LOW MARSHES				
71 Smooth cordgrass, tall	95		0.04	
72 Smooth cordgrass, short	9,449		3.61	
	9,544		3.65	
		13,749		5.26
OPEN WATER				
80 Ponds		5,556		2.13
MUDFLATS AND SANDBAR/BEACHES				
81 Mudflat	852		0.33	
91 Sandbar/Beach	945		0.36	
		1,797		0.69
SUBMERGED VEGETATION				
101 Submerged aquatic vegetation		42,309		16.19
UNTYPED WETLANDS		1,289[a]		0.49
Total Area of Mapped Types		261,309		100.00

[a]Untyped wetlands represent areas in which the vegetation could not be classified and delineated because of inadequate photographic coverage.

Distinctions between brackish marshes and fresh marshes, in contrast, are based on floristic composition and on the association between stands that are represented by paired types and stands of unpaired types. All stands of five unpaired types are considered to represent fresh marshes whenever they occur. These are: smartweed/rice cutgrass (Type 30), spatterdock (Type 31), pickerelweed/arrowarum (Type 32), sweetflag (Type 33), and wildrice (Type 36). Stands of fresh/brackish pairs that occur in wetlands that largely are characterized by unpaired types of fresh marsh vegetation are assigned to the fresh marsh member of the pair. For example, a stand of cattail that is surrounded principally by spatterdock and wildrice would be assigned to Type 34 (fresh) rather than to Type 44 (brackish). In contrast, if the stand of cattail is associated with meadow cordgrass (Type 41) and marshelder/groundselbush (Type 42), it would be assigned to Type 44 (brackish). Stands of rosemallow (Type 35/Type 45), *Scirpus* spp. (Type 37/Type 47), big cordgrass (Type 38/Type 48), and common reed (Type 39/Type 49) are characterized in a similar manner.

In certain localities, especially near the midpoint in the length of longer estuaries, the wetland complex is composed of both fresh marsh types and brackish marsh types. For example, wildrice (Type 36), which is a freshwater indicator, and smooth cordgrass (Type 51), which is a brackish to saline indicator, occur in mixture in many places. Other combinations of this nature that were observed and mapped are: threesquare (Type 47) and low-growth smooth cordgrass (Type 72); smartweed/rice cutgrass (Type 30) and smooth cordgrass (Type 51); and smartweed/rice cutgrass (Type 30) with pickerelweed/arrowarum (Type 32) and smooth cordgrass (Type 51).

Whenever the mapping required a mixture of vegetation types, i.e. 30/34, the first type is the predominant type. In this example, Type 30 (smartweed/rice cutgrass) is the predominant type with Type 34 (cattail) also being present.

Figures 4, 5, and 6 show examples of the vegetation type mapping that was performed on each of the approximately 2,000 photomaps. A sample map is shown representative of a freshwater wetland (Figure 4), a brackish wetland (Figure 5), and a saline wetland (Figure 6).

The results of measurements of the areas of the thirty-five types of wetlands that were mapped in the coastal region of the State are summarized in Table 2. More detailed analyses of these results are presented in Section 1.3.

SHRUB SWAMPS (TYPES 11, 12, 13)

Swamp rose and a variety of other shrubs, as well as sprouts of red maple and ash, cover 2,600 acres (1%) of the coastal wetlands of Maryland (Table 2). Individual shrub swamps range in size from a fraction of an acre to a hundred acres or more. These stands occur in the form of linear thickets along the upland margins of fresh and brackish marshes, as well as relatively extensive shrub swamps along the upper reaches of many tidewater streams.

Three types of shrub swamps are recognized in the coastal wetlands of Maryland. Swamp rose (Type 11, Figure 1) was mapped on 51 acres, most of which occurs in Anne Arundel County. Smooth alder/black willow swamps (Type 12, Figure 2) cover 524 acres of wetlands, and are developed most extensively in Cecil County and Prince George's County. The alder and the willow are more abundant on slightly elevated ground landward from the wetland boundary than they are in the wetlands. The most extensive type of shrub swamp, the red maple/ash (Type 13, Figure 3) occupies 2,025 acres (Table 2). This type represents an early stage of forest regrowth, and about half of its total area is in Dorchester County, where red maple/ash swamp forests (Type 22) are widespread.

Herbaceous plants that are prominent in fresh marshes form the undergrowth in the shrub swamps. The species that are known to occur in each of the shrub swamp types are listed in Table 3.

Three other kinds of tall shrubs are associated closely with saline and brackish marshes (Tables 7 and 9). Marshelder, groundselbush, and bayberry commonly occur at the upland margin of the wetlands, and may root on low levees or turf banks along tidal creeks and ditches that extend through coastal marshes. All three kinds of these shrubs form thickets on low islands in the marshes, and the marshelder may be abundant in sections of the wetland that are more frequently flooded. Stands of these shrubs, however, usually are a minor component of the wetland; only in a few places do they cover areas extensive enough to be termed swamps, so they are not included in this section.

SWAMP FORESTS (TYPES 21, 22, 23)

In the uppermost reaches of the estuaries, the coastal freshwater wetlands are forested. These tidewater swamp forests merge almost imperceptibly into inland swamp forests in many localities. The tidewater areas usually have more pronounced hummocks, and trees of the same age noticeably are smaller in the coastal wetlands than in areas that are removed from the influence of tides. The tidewater forests appear to develop autumnal color ear-

[1] The common and scientific names of the plants and animals that are mentioned in the text are correlated in Appendix 1.

Table 12. Ranges of salinities in waters in which submerged aquatic plants were observed by Stewart (1962). Scientific names are listed in Table 77.

	Saline	Brackish: Highly	Brackish: Moderately	Brackish: Slightly	Fresh
Brown algae	x				
Sealettuce	x	x	x		
Enteromorpha	x	x	x		
Eelgrass	x	x	x		
Red algae	x	x	x	x	
Wigeongrass	*	x	x	x	
Horned pondweed		x	x	x	x
Sago pondweed		x	x	x	x
Redhead pondweed		*	x	x	x
Eurasian watermilfoil		*	x	x	x
Common waterweed			x	x	x
Muskgrasses			x	x	x
Curlyleaf pondweed			*	x	x
Wildcelery				x	x
Southern naiad				x	x
Grassleaf pondweed				x	x
Coontail				x	x
Nuttall waterweed				*	x
Floating pondweed					x
Largeleaf pondweed					x
Leafy pondweed					x
Ribbonleaf pondweed					x
Robinson pondweed					x
Variableleaf pondweed					x
Pinnate watermilfoil					x
Slender watermilfoil					x
Waternymph					x
Waterstargrass					x
Nitella					x
Spirogyra					x
Northern naiad			*		x

The classifications used by Stewart (1962) and the equivalents used in this table are: coastal bays (saline); salt estuarine bays (highly brackish); brackish estuarine bays (moderately brackish); slightly brackish estuarine bays (slightly brackish); fresh estuarine bays (fresh).

*Asterisks indicate occurrences that were mentioned by Anderson (1972) that are outside the limits of salinity that were described by Stewart (1962). The extension of Nuttal waterweed is based on data from Phillip and Brown (1965). Spaghettigrass *(Codium fragile* ssp. *tomentosoides),* a filamentous green alga reported from Virginia (Hillson 1975), grows in salinities that range from 17.5 to 40 ppt (Good and others 1978).

During the early 1960's, Stewart (1962) reported that submerged vegetation was absent from the segment of the estuary of the Potomac River from the boundary of the District of Columbia downstream to Chicamuxen Creek, in Charles County, Maryland. There were, however, extensive beds of submerged plants in the fresh waters of the estuary from Chicamuxen Creek to Maryland Point. These waters were moderately turbid and, apparently as a result, the submerged vegetation was restricted to narrow bands in the shallow areas near the shores. Wildcelery, southern naiad, redhead pondweed, and common waterweed were the most common native plants.

Eurasian watermilfoil, an introduced species, first was observed in the Chesapeake Bay Region during the 1870's at a locality in the Potomac River south of Alexandria, Virginia (Ward 1881; Reed 1977). The plant drew little notice during the ensuing sixty years or so. Then it became aggressive and colonies appeared throughout the upper Potomac River estuary during the 1940's or 1950's. During the 1950's and early 1960's, Eurasian watermilfoil spread explosively throughout the Chesapeake Bay (Springer and Stewart 1959; Steenis and King 1964; Elser 1966; Bayley and others 1968, 1978). This spread was curtailed sharply about 1963, and since then the Eurasian watermilfoil has been declining in abundance throughout the region. This decline apparently is the result of the interaction of high turbidities and disease (Elser 1966, 1967; Bean and others 1972, 1973; Southwick and Pine 1975).

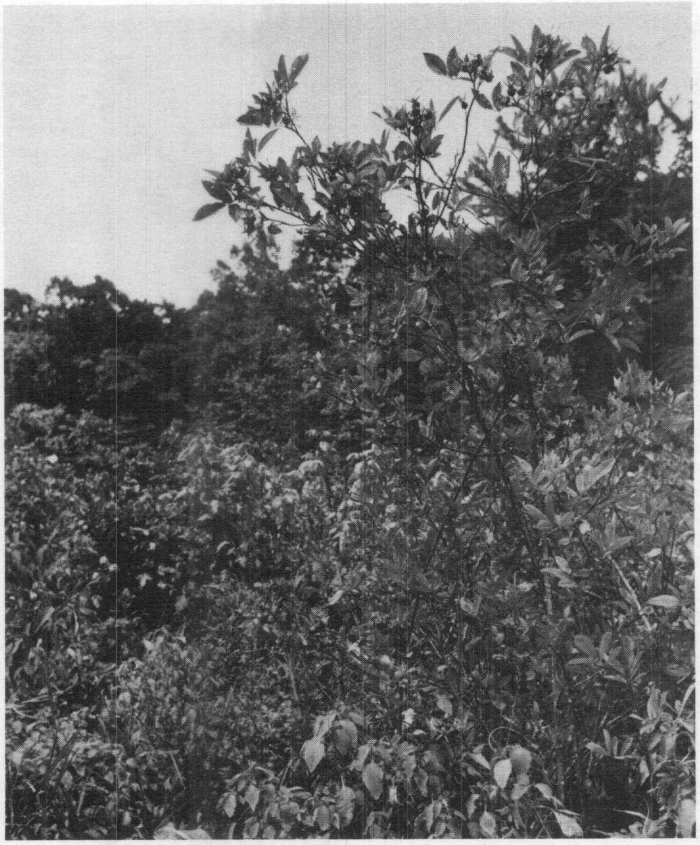
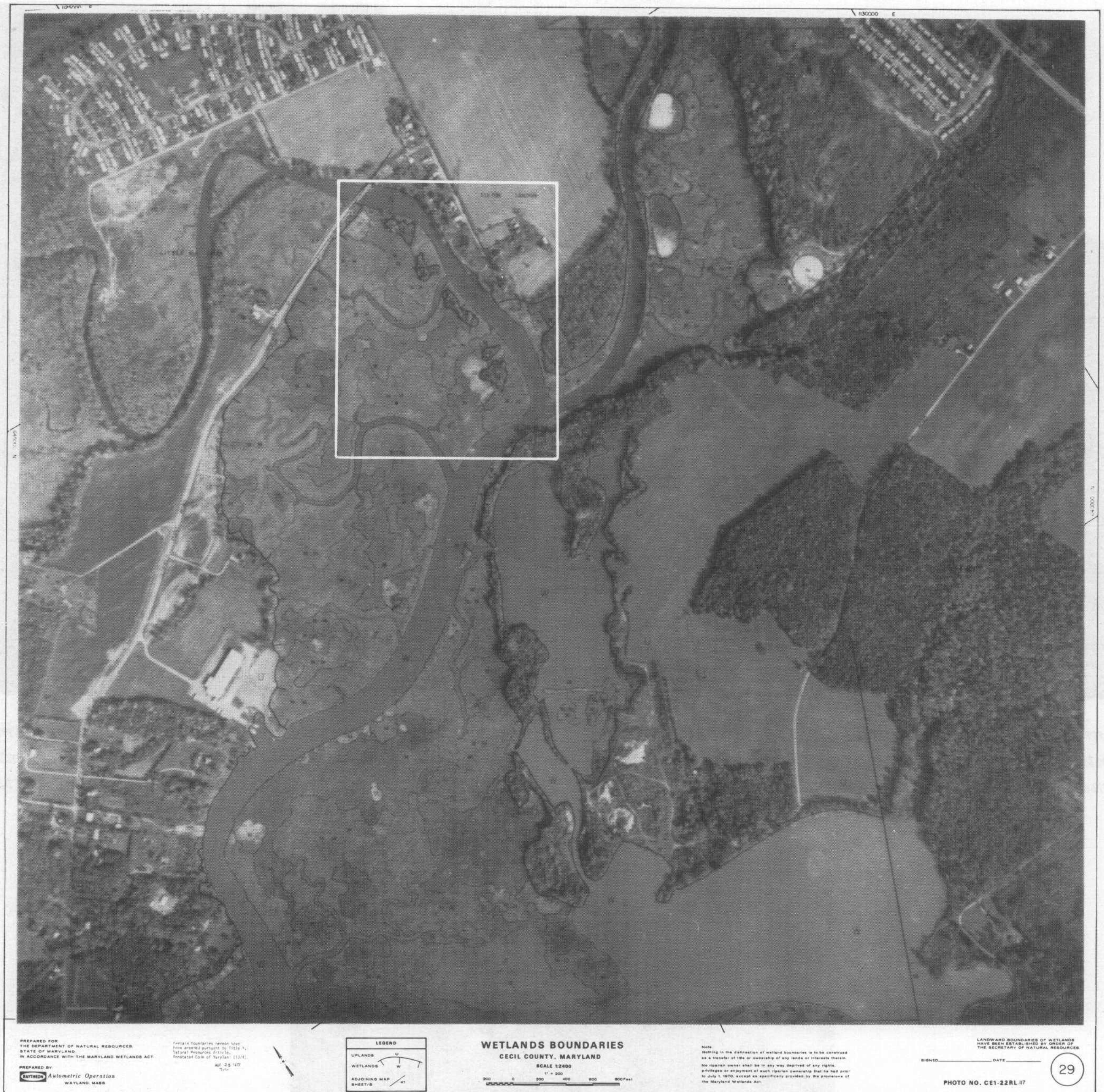


Figure 1. Swamp rose shrub swamp (Type 11) along Hunting Creek in Caroline County. Fresh marsh plants formed an herb layer in this stand.

Figure 2. Smooth alder/black willow shrub swamp (Type 12) along the Choptank River in Caroline County. Only black willow was present in this stand. Cattail marsh (Type 44) is in the background.

Figure 3. Red maple/ash shrub swamp (Type 13) along Hunting Creek in Caroline County. Only red maple was present in this stand. Spatterdock marsh (Type 31) is in the foreground.



VEGETATION TYPING INDEX

SHRUB SWAMP CATEGORY

11 ROSA PALUSTRIS
SWAMP ROSE

12 ALNUS SERRULATA / SALIX NIGRA
SMOOTH ALDER / BLACK WILLOW

13 ACER RUBRUM / FRAXINUS SPP.
RED MAPLE / ASH

WOODED SWAMP CATEGORY

21 TAXODIUM DISTICHUM
BALDCYPRESS

22 ACER RUBRUM / FRAXINUS SPP.
RED MAPLE / ASH

23 PINUS TAEDA
LOBLOLLY PINE

FRESH MARSH CATEGORY

30 POLYGONUM SPP. / LEERSIA ORYZOIDES
SMARTWEED / RICE CUTGRASS

31 NUPHAR ADVENA
SPATTERDOCK

32 PONTEDERIA CORDATA / PELTANDRA VIRGINICA
PICKERELWEED / ARROWARUM

33 ACORUS CALAMUS
SWEETFLAG

34 TYPHA SPP.
CATTAIL

35 HIBISCUS SPP.
ROSEMALLOW

36 ZIZANIA AQUATICA
WILDRICE

37 SCIRPUS SPP.
BULRUSH

38 SPARTINA CYNOSUROIDES
BIG CORDGRASS

39 PHRAGMITES COMMUNIS
COMMON REED

BRACKISH HIGH MARSH CATEGORY

41 SPARTINA PATENS / DISTICHLIS SPICATA
MEADOW CORDGRASS / SPIKEGRASS

42 IVA FRUTESCENS / BACCHARIS HALIMIFOLIA
MARSHELDER / GROUNDSELBUSH

43 JUNCUS ROEMERIANUS
NEEDLERUSH

44 TYPHA SPP.
CATTAIL

45 HIBISCUS SPP.
ROSEMALLOW

46 PANICUM VIRGATUM
SWITCHGRASS

47 SCIRPUS SPP.
THREESQUARE

48 SPARTINA CYNOSUROIDES
BIG CORDGRASS

49 PHRAGMITES COMMUNIS
COMMON REED

BRACKISH LOW MARSH CATEGORY

51 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS

SALINE HIGH MARSH CATEGORY

61 SPARTINA PATENS / DISTICHLIS SPICATA
MEADOW CORDGRASS / SPIKEGRASS

62 IVA FRUTESCENS / BACCHARIS HALIMIFOLIA
MARSHELDER / GROUNDSELBUSH

63 JUNCUS ROEMERIANUS
NEEDLERUSH

SALINE LOW MARSH CATEGORY

71 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS, TALL GROWTH FORM

72 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS, SHORT GROWTH FORM

OPEN WATER CATEGORY

80 POND

MUD / SANDBAR / BEACH CATEGORY

81 MUDFLAT

91 SANDBAR / BEACH

SUBMERGED AQUATICS CATEGORY

101 SUBMERGED AQUATIC VEGETATION

PREFIX "B"
AERIAL IMAGERY INDICATES THE MARSH HAD BEEN BURNED. THE VEGETATION SIGNATURES AND BOUNDARIES ARE DISTORTED.

VEGETATION CLASSIFICATIONS AND DELINEATIONS PREPARED BY
JACK McCORMICK & ASSOCIATES, INC. - BERWYN, PA.
A SUBSIDIARY OF WAPORA, INC.
UNDER THE DIRECTION OF THE MARYLAND DEPARTMENT OF NATURAL RESOURCES AND PARTIALLY FUNDED BY THE OFFICE OF COASTAL ZONE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION.

Figure 4. Sample wetlands photomap showing vegetation typing in a freshwater wetland at the tidal head of Elk River at Elkton Landing, Cecil County. The numerous types and their mixed assemblage reveal the high floristic diversity and random distribution of vegetation which are characteristic of freshwater wetlands. The figure on the right, which shows the area outlined in the above figure, depicts the actual size and detail of the vegetation typing. The scale is identical to that of the wetlands photomaps (1:2400, or 1″ = 200′).


ELKTON LANDING
W
U
34
33
W
34
30 / 34
30 / 34
30 / 34
12
34
W
34
34 / 30
34
33
W
30 / 34
34
34 / 30
30 / 34
U

VEGETATION TYPING INDEX

SHRUB SWAMP CATEGORY

11 ROSA PALUSTRIS
SWAMP ROSE

12 ALNUS SERRULATA / SALIX NIGRA
SMOOTH ALDER / BLACK WILLOW

13 ACER RUBRUM / FRAXINUS SPP.
RED MAPLE / ASH

WOODED SWAMP CATEGORY

21 TAXODIUM DISTICHUM
BALDCYPRESS

22 ACER RUBRUM / FRAXINUS SPP.
RED MAPLE / ASH

23 PINUS TAEDA
LOBLOLLY PINE

FRESH MARSH CATEGORY

30 POLYGONUM SPP. / LEERSIA ORYZOIDES
SMARTWEED / RICE CUTGRASS

31 NUPHAR ADVENA
SPATTERDOCK

32 PONTEDERIA CORDATA / PELTANDRA VIRGINICA
PICKERELWEED / ARROWARUM

33 ACORUS CALAMUS
SWEETFLAG

34 TYPHA SPP.
CATTAIL

35 HIBISCUS SPP.
ROSEMALLOW

36 ZIZANIA AQUATICA
WILDRICE

37 SCIRPUS SPP.
BULRUSH

38 SPARTINA CYNOSUROIDES
BIG CORDGRASS

39 PHRAGMITES COMMUNIS
COMMON REED

BRACKISH HIGH MARSH CATEGORY

41 SPARTINA PATENS / DISTICHLIS SPICATA
MEADOW CORDGRASS / SPIKEGRASS

42 IVA FRUTESCENS / BACCHARIS HALIMIFOLIA
MARSHELDER / GROUNDSELBUSH

43 JUNCUS ROEMERIANUS
NEEDLERUSH

44 TYPHA SPP.
CATTAIL

45 HIBISCUS SPP.
ROSEMALLOW

46 PANICUM VIRGATUM
SWITCHGRASS

47 SCIRPUS SPP.
THREESQUARE

48 SPARTINA CYNOSUROIDES
BIG CORDGRASS

49 PHRAGMITES COMMUNIS
COMMON REED

BRACKISH LOW MARSH CATEGORY

51 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS

SALINE HIGH MARSH CATEGORY

61 SPARTINA PATENS / DISTICHLIS SPICATA
MEADOW CORDGRASS / SPIKEGRASS

62 IVA FRUTESCENS / BACCHARIS HALIMIFOLIA
MARSHELDER / GROUNDSELBUSH

63 JUNCUS ROEMERIANUS
NEEDLERUSH

SALINE LOW MARSH CATEGORY

71 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS, TALL GROWTH FORM

72 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS, SHORT GROWTH FORM

OPEN WATER CATEGORY

80 POND

MUD / SANDBAR / BEACH CATEGORY

81 MUDFLAT

91 SANDBAR / BEACH

SUBMERGED AQUATICS CATEGORY

101 SUBMERGED AQUATIC VEGETATION

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Figure 5. Sample wetlands photomap showing vegetation typing in a brackish wetland on a peninsula separating Marshy Creek and Cabin Creek on Prospect Bay in Queen Anne's County. The figure on the right, which shows the area outlined in the above figure, depicts the actual size and detail of the vegetation typing. The scale is identical to that of the wetlands photomaps (1:2400, or 1" = 200').


MARSHY CREEK
51
43
42
41
43/47
U
42
W
42
41
41
49
43
43
42
51
41
43
51
80
43
41
W
41/47

VEGETATION TYPING INDEX

SHRUB SWAMP CATEGORY

11 ROSA PALUSTRIS
SWAMP ROSE

12 ALNUS SERRULATA / SALIX NIGRA
SMOOTH ALDER / BLACK WILLOW

13 ACER RUBRUM / FRAXINUS SPP.
RED MAPLE / ASH

WOODED SWAMP CATEGORY

21 TAXODIUM DISTICHUM
BALDCYPRESS

22 ACER RUBRUM / FRAXINUS SPP.
RED MAPLE / ASH

23 PINUS TAEDA
LOBLOLLY PINE

FRESH MARSH CATEGORY

30 POLYGONUM SPP. / LEERSIA ORYZOIDES
SMARTWEED / RICE CUTGRASS

31 NUPHAR ADVENA
SPATTERDOCK

32 PONTEDERIA CORDATA / PELTANDRA VIRGINICA
PICKERELWEED / ARROWARUM

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SWEETFLAG

34 TYPHA SPP.
CATTAIL

35 HIBISCUS SPP.
ROSEMALLOW

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WILDRICE

37 SCIRPUS SPP.
BULRUSH

38 SPARTINA CYNOSUROIDES
BIG CORDGRASS

39 PHRAGMITES COMMUNIS
COMMON REED

BRACKISH HIGH MARSH CATEGORY

41 SPARTINA PATENS / DISTICHLIS SPICATA
MEADOW CORDGRASS / SPIKEGRASS

42 IVA FRUTESCENS / BACCHARIS HALIMIFOLIA
MARSHELDER / GROUNDSELBUSH

43 JUNCUS ROEMERIANUS
NEEDLERUSH

44 TYPHA SPP.
CATTAIL

45 HIBISCUS SPP.
ROSEMALLOW

46 PANICUM VIRGATUM
SWITCHGRASS

47 SCIRPUS SPP.
THREESQUARE

48 SPARTINA CYNOSUROIDES
BIG CORDGRASS

49 PHRAGMITES COMMUNIS
COMMON REED

BRACKISH LOW MARSH CATEGORY

51 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS

SALINE HIGH MARSH CATEGORY

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MEADOW CORDGRASS / SPIKEGRASS

62 IVA FRUTESCENS / BACCHARIS HALIMIFOLIA
MARSHELDER / GROUNDSELBUSH

63 JUNCUS ROEMERIANUS
NEEDLERUSH

SALINE LOW MARSH CATEGORY

71 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS, TALL GROWTH FORM

72 SPARTINA ALTERNIFLORA
SMOOTH CORDGRASS, SHORT GROWTH FORM

OPEN WATER CATEGORY

80 POND

MUD/SANDBAR/BEACH CATEGORY

81 MUDFLAT

91 SANDBAR / BEACH

SUBMERGED AQUATICS CATEGORY

101 SUBMERGED AQUATIC VEGETATION

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Figure 6. Sample wetlands photomap showing vegetation typing in a saline wetland area on Wallops Neck in Worcester County. The large area of Type 72 (smooth cordgrass, short form) indicates that much of this wetland is low saline marsh. Higher elevations of the wetland are indicated by Types 61 (meadow cordgrass/spikegrass) and 62 (marshelder/groundselbush). The figure on the right, which shows the area outlined in the above figure, depicts the actual size and detail of the vegetation typing. The scale is identical to that of the wetlands photomaps (1:2400, or 1" = 200').

72/61
WALLOPS
NECK
61
62
72/61
72/61
72
72
72
72/61
72/61
CATBIRD
61
72
72/61
61/72
61/72
CREEK
72
61
72
72
61/72
62
62
72
61/72
61
61
72
72
72/61
72
W
72/61
80

lier and, from the air, the crowns of the trees appear to be more compact and lower than are those in adjacent inland swamps.

Three types of swamp forest occupy a total of 16,798 acres in the coastal wetlands of Maryland (Tables 1, 2). Baldcypress forests (Type 21) cover 4,154 acres in Worcester County (3,595 acres) and Somerset County (559 acres), and constitute one of the fifteen plant associations that were mapped in Maryland by Brush and others (1976). The baldcypress is a winterbare, needleleaf tree. It forms small, nearly pure stands in a few places, but it grows more commonly in narrow fringes along the margins of such streams as the Pocomoke River (Figure 7). The canopies of most stands that were mapped as Type 21 are composed principally of broadleaf trees, with 20% or more of the cover contributed by baldcypress (Table 4).

The most extensive (11,391 acres) and most widely distributed (15 of the 16 tidewater counties) swamp forest in coastal wetlands of the State is the red maple/ash type (Type 22). The principal trees in this broadleaf forest type are red maple, green ash, blackgum, and sweetbay (Figure 8). In Dorchester County, red maple/ash swamp forests cover 5,727 acres of tidewater wetlands. Forests of this type also are prominent in Worcester County (2,400 acres) and Wicomico County (1,304 acres).

The loblolly pine swamp forest type (Type 23) generally occupies sites that are adjacent to brackish marshes, and the undergrowth in the pine forests may be a continuation of the marsh vegetation (Figure 9). Many stands of loblolly pine are open and savannalike, with widely spaced trees, but elsewhere the stands are more dense. In some stands, broadleaf trees are mixed with the pine, whereas many other stands are nearly pure pine forests. In total, Type 23 was mapped on 1,253 acres (Table 2). It is developed most extensively in Dorchester County (806 acres), and is represented about equally in Somerset County (181 acres) and Wicomico County (171 acres).

FRESH MARSHES (TYPES 30 THROUGH 39)

The fresh marshes, which comprise nearly 25,600 acres of the coastal wetlands of Maryland (Table 2), are composed of a great variety of plants (Table 5). As shown in succeeding sections of this report, the number of species of plants in the coastal wetlands declines as the salinity of the water increases, so the freshwater wetlands exhibit the greatest floristic diversity, the brackish wetlands are of intermediate diversity (Table 7), and the saline wetlands are least diverse (Table 9). The vegetation in saline wetlands and in brackish wetlands also tends to be banded; that is, the different types of vegetation occur in a more or less predictable sequence from the shore to the upland edge of the wetland. In contrast, most of the different types of vegetation in freshwater wetlands are distributed more randomly, and do not occur in a regular spatial sequence or in a repetitive areal relation one to the other. There is some evidence, however, that the various types of fresh marsh vegetation do occur on sites that differ from one another by almost imperceptible changes in the elevation of the surface of the wetland (Whigham and Simpson 1975).

Table 3. Floristic components of shrub swamp types in the coastal wetlands of Maryland. Numbers and symbols in table refer to footnoted sources.

Type Name	Rose	Alder/ Willow	Maple/ Ash
Type Number	11	12	13
Trees			
Red maple			X
Green ash			X
Sweetbay	1		
Blackgum	1		1
Shrubs and Vines			
Smooth alder	1	X	
Buttonbush	1	3	
Winterberry		3	
Silky dogwood			1
Poison ivy			1
Swamp rose	X	3	1
Blackberry			1
Black willow		X	
Bullbrier	2		
Shrubform herbs			
Rosemallow	1, 2		1
Forbs (Broadleaf herbs)			
Waterhemp	1		1
Beggarticks	1		
Dodder	1		
Spotted touch-me-not	1		1
Spatterdock	1		
Royal fern	1		1
Arrowarum	1		1
Smartweeds	1		1
Pickerelweed	1		
Waterdock	1		
Grasses and grasslike plants			
Rice cutgrass	1		
Narrowleaf cattail	1		
Common cattail	2		

X Genus or species utilized to designate type
1. Jack McCormick & Associates, Inc., field notes (MD)
2. Thompson 1974 (MD)
3. Chrysler 1910 (MD)

Table 4. Floristic components of swamp forests in the coastal wetlands of Maryland. Numbers and symbols in table refer to footnoted sources.

Type Name	Baldcypress	Maple/ Ash	Pine
Type Number:	21	22	23
Trees			
Red maple	1, 2	X	
Black alder	2		
Bluebeech	2		
Southern white cedar	2		
Fringetree	2		
Persimmon			1
Green ash	1, 2	X	
American holly	2		
Red cedar	2		
Sweetgum	1, 2		1
Sweetbay	1, 2	1	
Blackgum	1, 2	1	
Swamp blackgum	2		
Pond pine	2		
Loblolly pine	1, 2		X
Willow oak	1		
Baldcypress	X		
Shrubs			
Smooth alder	1	1	
Groundselbush	2		
Buttonbush	2		
Sweet pepperbush	1, 2	1	
Silky dogwood	2	1	
Strawberrybush	2		
Winterberry	2		
Virginia willow	2		
Fetterbush	2		
Spicebush	1, 2		
Maleberry	2		
Bayberry	1	1	
Red chokeberry	2		
Pinxterflower	2		
Clammy azalea	1, 2	1	
Black willow	1		
Highbush blueberry	1	1	
Witherod	2		
Southern arrowwood	1, 2		
Possumhaw	2		
Blackhaw	2		
Woody vines			
Crossvine	2		
Trumpetcreeper	2		
Japanese honeysuckle	2		
Virginia creeper	2		

Type Name	Baldcypress	Maple/ Ash	Pine
Type Number:	21	22	23
American mistletoe	1, 2		
Poison ivy	1, 2	1	
Greenbrier	1	1	1
Laurelleaf greenbrier	2		
Redberry greenbrier	2		
Muscadine	2		
Shrubform Herbs			
Water willow	1, 2		
Rosemallow		1	
Forbs (Broadleaf herbs)			
Waterhemp		1	
Groundnut	2		
Swamp milkweed	2		
Aster	2		
Burmarigold		1	
Beggarticks	2		
Rayless burmarigold	2		
Boghemp	2		
Turtlehead	2		
Spotted cowbane	2		
Swamp dodder	2		
Whorled yam	2		
Yerba-de-tago	2		
Catesby gentian	2		
Water pennywort	2		
Spotted touch-me-not	1, 2	1	
Blueflag	2		
Cardinalflower	2		
Seedbox	2		
Reddot bugleweed	2		
Climbing hempweed	2		
Spatterdock	1, 2	1	
Goldenclub	2		
Cowbane	2		
Arrowarum		1	
Smartweed	1	1	
Halberdleaf tearthumb	2		
Waterpepper	2		
Arrowleaf tearthumb	2		
Pickerelweed	2		
Cutleaf coneflower	2		
Lizardtail	2		
Waterparsnip	2		
Goldenrod			1

Table 4. Floristic components of swamp forests (Concluded).

Type Name	Baldcypress	Maple/ Ash	Pine
Type Number:	21	22	23
Forbs (Broadleaf herbs), Continued			
Muskratweed	1, 2	1	
Grasses and grasslike plants			
Longhair sedge	2		
Weak sedge	2		
Follicled sedge	2		
Swollen sedge	2		
Hop sedge	2		
Softstem sedge	2		
Reedgrass	2		
Peat mannagrass	2		
Eastern cutgrass	2		
Switchgrass			1
Hornrush	2		
Common reed			1
Meadow cordgrass			1
Ferns			
Cinnamon fern	2	1	
Royal fern	2	1	
Resurrection fern	2		
Netted chainfern	2		
Mosses			
Sphagnum	2		

X Genus or species utilized to designate type
1. Jack McCormick & Associates, Inc., field notes (MD)
2. Beaven and Oosting 1939 (MD)

Figure 7. Baldcypress swamp forest (Type 21) along the Pocomoke River in Worcester County. Spatterdock marsh (Type 31) occurs between the swamp and the open water of the River.

The common components of freshwater marshes form stands of medium to tall grasses or grasslike plants (wildrice, big cordgrass, common reed, threesquares, bulrushes, cattails, and sweetflag), masses of broad, erect leaves that extend above the muck surface of the marsh and are nearly inundated daily during periods of high water (spatterdock, arrowarum, burreeds, pickerelweed, arrowheads, and white waterlily), stands of tall, single-stemmed herbaceous plants (burmarigolds, waterhemp, spotted touch-me-not), low to rather tall, erect or matted herbaceous thickets (smartweeds, tearthumbs, burmarigolds), low stands of tangled grasses (rice cutgrass), and shrublike thickets (rosemallow, water willow). Although there is a wide range in stature, the predominant plants of freshwater marshes generally are taller than those in saline and highly brackish marshes. Measurements of 27 species are presented in Table 6.

The appearance of the freshwater tidal marshes constantly is changing. From June through August, they are lush and green. In September, many kinds of plants change to shades of yellow and brown, and begin to deteriorate rapidly. There may be a burst of flowering during late September and early October, but by November much of the vegetation has withered. From late November through March, large portions of the intertidal areas appear to be barren mudflats. Throughout the winter, tawny stands of cattails and common reed form island-like clumps that are scattered over the surfaces of the marshes and along their margins. During April the leaves of perennials begin to appear above the muck, and seedlings of annual plants develop in profusion.

Spatterdock and arrowarum apparently lack any mechanism to insure dormancy throughout the winter. New shoots appear from both of these plants whenever the temperature remains above freezing for several consecutive days. During the next cold snap, however, these shoots wither.

The first real evidence of renewed plant life in the freshwater marshes is the emergence of the leaves of spatterdock early in April. Within a few days, new leaves of arrowarum also extend upward through the muck from long-lived rhizomes; seeds of wildrice germinate during the last half of April, and a haze of green seedlings spreads over the marsh surface. By the end of April, the leaves of spatterdock and arrowarum are well developed, and they form a low, relatively uniform canopy over much of the wetland.

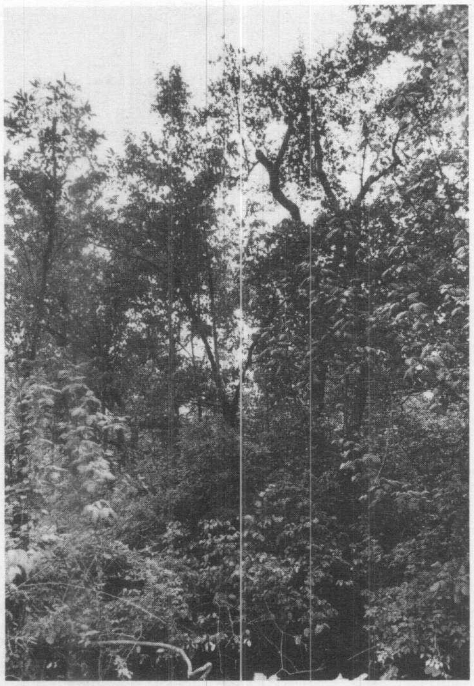

Figure 8. Red maple/ash swamp forest (Type 22) along Hunting Creek in Caroline County. Only red maple was present in this stand. Shrub swamp plants form an undergrowth.

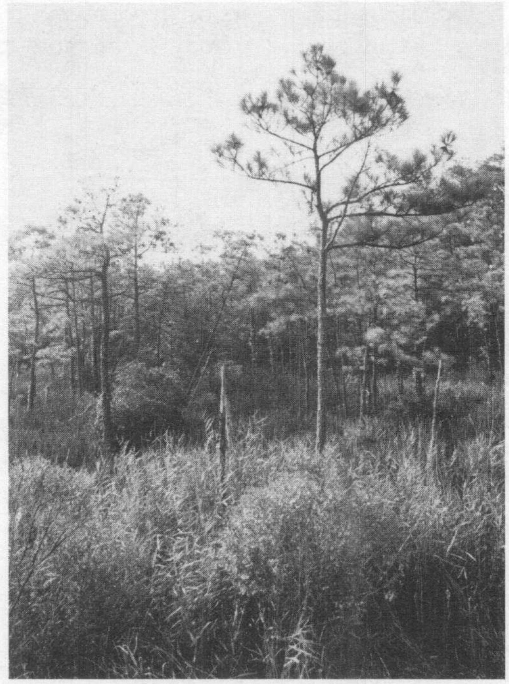

Figure 9. Loblolly pine swamp forest (Type 23) on Blackwater National Wildlife Refuge in Dorchester County. A common reed marsh (Type 39) is the foreground. Common reed also extends into the swamp forest as an undergrowth.

The leaves of sweetflag and cattail also emerge early, grow rapidly, and are developed fully by mid-June. Flower clusters that will mature in autumn begin to form on the cattail plants during June.

By early July, wildrice plants are 6 to 10 feet tall, and they become particularly conspicuous as panicles of flowers open later in the month. Many other kinds of plants that germinated during the period from late April through early June previously have been obscured by the earlier growth, but by late July or early August they also begin to tower above the arrowarum and the large leaves of spatterdock in many parts of the marsh. Touch-me-not, smartweeds, tearthumbs, burmarigolds, Walter millet, and waterhemp are among the most common of these plants.

Table 5. Floristic components of fresh marsh types in the coastal zone of Maryland and other Middle Atlantic States. Numbers and symbols in the body of the table refer to footnoted sources.

											Supplementary Types						
	Smartweed/ Rice cutgrass	Spatterdock	Pickerelweed/ Arrowarum	Sweetflag	Cattail	Rosemallow	Wildrice	Bulrush	Big cordgrass	Common reed	Waterhemp	Burmarigold	Reed canarygrass	Spiked loosestrife	Giant ragweed	Arrowhead	Goldenclub
	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3L	3R	3S	3G
Shrubs and Vines																	
Groundselbush					11												
Buttonbush										5							
Marshelder					11												
Virginia creeper										3							
Multiflora rose										5							
Swamp rose					11												
Shrubform Herbs																	
Rosemallow	X		1		X	X		9, 11	3, 4	X				5			9
Seashore mallow					11												
Spiked loosestrife														X			
Forbs (Broadleaf herbs)																	
Waterhemp	3			X	4		X				X	X			5	6, 7	
Water plantain					7		5										

Table 5. Floristic components of fresh marsh types in the coastal zone of Maryland and other Middle Atlantic States. Numbers and symbols in the body of the table refer to footnoted sources (continued).

	Smartweed/ Rice cutgrass	Spatterdock	Pickerelweed/ Arrowarum	Sweetflag	Cattail	Rosemallow	Wildrice	Bulrush	Big cordgrass	Common reed	Supplementary Types: Waterhemp	Burmarigold	Reed canarygrass	Spiked loosestrife	Giant ragweed	Arrowhead	Goldenclub
	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3L	3R	3S	3G
Forbs (Broadleaf herbs) Continued																	
Giant ragweed											6				X		
Swamp milkweed	1				13			11	4	7							
Burmarigolds	3, 9	3				3						X					
Spanishneedles												6					
Leafybract beggarticks												6					
Swamp beggarticks	5											5					
Black beggarticks												6					
Smooth burmarigold		6			4, 7		7, 13				6	X				7	
Waterhemlock					12												
Bindweed										3, 6							
Field bindweed										7							
Hedge bindweed					4, 13												
Dodders	3, 5			3										5			
Marsh fern					11												
Joe-pye-weed					7												
Stiff marsh bedstraw	1																
Spotted touch-me-not	X	9	X	3, 7	X	3	5		4	X	7	4, 7			5	6, 7	9
Red morningglory					7					7							
Creeping primrosewillow														5			
Small duckweed														5			
Waterpurslane	11																
European bugleweed														5			
Climbing hempweed			1		7					7							
Spatterdock	1, 5	X	6, 7		9, 4	3	6, 8				6, 7	7			5	6, 7	9
White waterlily			12														
Sensitive fern	11				11,12					7							
Goldenclub																	X
Arrowarum	X	X	X	X	X	3, 12	X		4	X	6, 7	4, 7			5	6, 7	9, 12
Clearweed	1, 5				7					5, 7							
Smartweeds	X	9	3	X	9, 7	9, 3	3		3		7	2					
Halberdleaf tearthumb	1, 11		12	3, 7	4, 13				4	4, 6	6, 7	X				6, 7	12
Swamp smartweed														5			
Common smartweed	5																
Mild waterpepper	11																
Pinkweed				6							6					6	
Ladysthumb					7						7	7				7	
Dotted smartweed	1, 5	7	6, 7	6, 7	4, 6		8		4	6, 7	6, 7	X			5	6, 7	
Arrowleaf tearthumb	X		12		X		13			5	6, 7	7				6	12
Pickerelweed	1	6	X		4, 5	12	X										
Mock bishopweed	1																
Waterdock									3								
Arrowheads				3												X	
Duckpotato	5	6, 7	X	7	X		X		4		7	X				6, 7	12
Bittersweet nightshade					7					12							
Burreeds	9				9												

Table 5. Floristic components of fresh marsh types in the coastal zone of Maryland and other Middle Atlantic States. Numbers and symbols in the body of the table refer to footnoted sources (concluded).

	Smartweed/ Rice cutgrass	Spatterdock	Pickerelweed/ Arrowarum	Sweetflag	Cattail	Rosemallow	Wildrice	Bulrush	Big cordgrass	Common reed	Supplementary Types: Waterhemp	Burmarigold	Reed canarygrass	Spiked loosestrife	Giant ragweed	Arrowhead	Goldenclub
	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3L	3R	3S	3G
Branching burreed	5						5										
Great burreed	1																
Grasses and grasslike plants																	
Sweetflag			12	X	11, 12						6						12
Sedges		9			9												
Broadwing sedge			12														
Fringed sedge			12														
Spreading sedge			12														
Umbrella sedges					4				4			4					
Walter millet											6	6				6	
Common spikerush	1																
Autumn sedge	5																
Yellow iris	5		12														
Blueflag			12														
Rushes	5				11			9									
Sharpfruit rush	1																
Rice cutgrass	X		1						3								
Reed canarygrass													X		5		
Common reed										X							
Bulrushes			9					X									
Common threesquare	1		1														
Woolgrass	1		1														
Stout bulrush								11									
Softstem bulrush	9, 1				12		12	9									
Smooth cordgrass								11		4							
Big cordgrass			1						X								
Cattails	9		9	3	9	9, 3		9									9, 12
Narrowleaf cattail	1		6		X			11		6							
Blue cattail					8												
Southern cattail					10												
Common cattail	5				X				4								
Wildrice	9, 5	X	9	3	4	9	X					4, 7				7	

Tabulated numerals represent the following sources; parenthetical abbreviations indicate the states in which investigations were conducted; an "X" indicates that the taxon is used to designate the type or was reported in three or more sources. Supplementary types were not mapped, and some may not occur in Maryland. The giant ragweed type was mentioned by Chrysler (1910) and a photograph of a stand on Curtis Bay, Anne Arundel County was included in his report.

1. Anderson and others 1968 (MD)
2. Good and others 1975 (NJ)
3. Jack McCormick & Associates, Inc., field notes (MD)
4. Johnson 1970 (MD)
5. McCormick 1970 (PA)
6. McCormick and Ashbaugh 1972 (NJ)
7. McCormick Mss. (NJ)
8. Whigham and Simpson 1975 (NJ)
9. Shima, Anderson, and Carter 1976 (MD)
10. Stewart 1962 (MD)
11. Williamson 1974 (MD)
12. Thompson 1974 (MD)
13. Chrysler 1910 (MD)

Table 6. Maximum heights of plants in freshwater tidal wetlands in the estuary of the Delaware River (McCormick 1977a). Measurements are of individuals in sample plots and may not be extremes for the locality. Data from Oldmans Creek, New Jersey, were recorded by 0.5 m classes; those at Tinicum Marsh, Pennsylvania, were recorded to the nearest 0.01 m.

	Tinicum Marsh		Oldmans Creek	
	Feet	Meters	Feet	Meters
Common reed	16.08	4.90	11.5	3.5
Giant ragweed	12.47	3.80	8.2	2.5
Narrowleaf cattail	11.65	3.55	9.8	3.0
Wildrice	10.89	3.32	14.8	4.5
Common cattail	10.83	3.30		
Halberdleaf tearthumb	9.84	3.00	8.2	2.5
Spiked loosestrife	9.19	2.80		
Waterhemp	8.37	2.55	8.2	2.5
Smooth burmarigold			8.2	2.5
Arrowarum	8.04	2.45	4.9	1.5
Common smartweed	7.71	2.35		
Swamp beggarticks	6.73	2.05		
Spotted jewelweed	6.73	2.05	6.6	2.0
Sweetflag			6.6	2.0
Walter millet			6.6	2.0
Pinkweed			6.6	2.0
Arrowleaf tearthumb			6.6	2.0
Pickerelweed	6.23	1.90	6.6	2.0
Spatterdock	6.07	1.85	6.6	2.0
Swamp smartweed	5.41	1.65		
Yellow iris	4.92	1.50		
Dotted smartweed	4.92	1.50	6.6	2.0
Duckpotato	4.92	1.50		
Branching burreed	4.59	1.40		
Primrosewillow	3.77	1.15		
Chestnutsedge	2.95	0.90		
Clearweed	0.59	0.18		

About mid-July, the leaves of spatterdock, arrowarum, and sweetflag begin to yellow, then brown and die. Small sap-sucking insects or beetles may appear in abundance on the spatterdock leaves, and probably contribute to their weakening and death. Otherwise, the phenomenon seems to be controlled internally. A new flush of leaves appears from these plants by late September, and this second set of leaves persists until killing frosts occur. In many areas, however, annual plants, particularly smartweeds, develop rapidly about the time that sweetflag stands are drying back. They form dense, matted growths that obscure the sweetflag during the remainder of the growing season.

Plants in the central parts of large stands of wildrice commonly are battered by rain, strong winds, and high tides by late August. Although the lodged plants become yellowish, most of them remain alive until the fruits mature and drop. Rice plants on the banks of tidal channels and in areas adjacent to other types of vegetation remain erect and green until late September.

The plants which produce abundant crops of seeds that are most attractive to wildlife—wildrice, Walter millet, tearthumbs, and smartweeds—reach the peak of fruiting during the period from mid-August to mid-September. Birds of many species flock to the marshes at this time and consume large numbers of seeds from the plants or from the mud where many of the seeds fall. Although the birds and other types of wildlife are efficient harvesters, a small percentage of the seeds escapes their predation. Seeds that are not washed away or buried develop into new plants the following spring. For example, stands of wildrice produce more than 150 million seeds per acre. In spring, however, fewer than a million seedlings per acre germinate from the muck soils (Whigham 1975; Whigham and Simpson 1977).

Stands of pickerelweed are inconspicuous during the early summer. During August or September, however, the relatively tall leaves of the plants become tinted with purple, and the stands are distinctive and conspicuous features of the wetland landscape. As most of the marsh plants begin to wither and turn yellowish or brown, the brilliant golden flowers of the burmarigolds unfold. Massive displays of these flowers dominate many parts of the wetland, and signal the end of the growing season. The period of bloom lasts from late September through mid-October.

By early November, severe frosts kill most of the remaining leaves. Much of the plant material is decomposed or has been carried away by the tides; and large sections of the intertidal areas once again appear barren.

Several previous authors have commented on the gradient of diversity from saline to freshwater areas. Anderson and others (1968) noted that the flora of one marsh on the Patuxent River, in contrast to another marsh farther downstream, "reflected the decreasing salinity. . .by an increase in species complexity." Gabriel and de la Cruz (1974) observed that the diversity of species of plants "increases dramatically from saline toward freshwater conditions. . ." They further concluded that "distinct lateral zonation is correspondingly reduced from saline to freshwater habitats." In other words, the vegetation types in saline and brackish wetlands generally occur in rather predictable patterns, and in a relatively consistent sequence from the shore to the uplands. Similar observations were made by Eleuterius (1972). In contrast, the distribution of different types of vegetation in freshwater wetlands often appears to be random, and no repetitive geographical sequence can be discerned from locality to locality.

According to Eleuterius (1972), there is a seasonal variation in the occurrence, or at least in the conspicuousness, of certain species of plants in reaction to shifts in the salinity gradient in estuaries. "During the spring and early summer the plants generally found in fresh and low salinity marshes extended deep into the brackish and upper saline marsh regions." He attributed this penetration of freshwater species into normally brackish or saline regions to the abundance of fresh water in the estuary during the spring. By mid-summer, saline and brackish waters extended farther upstream in the estuaries, and this "prevented the growth of some species and allowed the growth of others. . ." This kind of floristic response by rooted plants to seasonal variations has not been reported from localities in Maryland.

Eleuterius (1972) also observed that the response of vegetation to the gradient of salinities in an estuary can best be interpreted as a continuum. There are no sharp delineations in the broad pattern of species distribution; rather, there are gradual changes in the floristic composition of the vegetation as one progresses from saline to freshwater habitats. This is produced by a two-way penetration of species of plants into the estuary. A group that is most typical of freshwater habitats, particularly spatterdock, arrowarum, and various smartweeds, extends downstream from the head of the estuary into brackish areas. A second group that is most characteristic of saline habitats, among which smooth cordgrass is notable, extends upstream in the estuary from areas adjacent to the sea into brackish sites.

In saline and brackish water areas, similar changes in the floristic composition of the vegetation may occur between the edge of the water and the upland boundary of the wetland. Such gradients are particularly sharp in areas that are underlain by porous sands, and in which fresh groundwater is discharged continuously along the upland boundary.

Ten types of vegetation are recognized for the purposes of mapping in the fresh coastal marshes of Maryland (Table 1). Eight of these types typically are represented by more or less pure stands of the species for which each is named. The cattail type (Type 34) is the most prevalent of these pure types. Its stands were mapped on 9,018 acres, or on approximately 35% of the total area of fresh marshes (Table 2). The pickerelweed/arrowarum type (Type 32), which commonly is formed principally by arrowarum, is the second most widespread vegetation type in the fresh marshes. It covers 3,925 acres, or about 15% of the total area of the fresh coastal marshland in the State. The other pure types, in the order of areal extent, are: common threesquare (Type 37; 2,808 acres), big cordgrass (Type 38; 1,904 acres), spatterdock (Type 31; 1,774 acres), wildrice (Type 36; 776 acres), common reed (Type 39; 747 acres), and sweetflag (Type 33; 431 acres).

Stands that are characterized as the smartweed/ rice cutgrass type (Type 30, Figure 10) may be composed almost wholly of one or several species of smartweeds or tearthumbs. Many stands that were mapped as this type, however, are formed by variable mixtures of smartweeds, tearthumbs, rice cutgrass, arrowarum, waterhemp, beggarticks, burmarigolds, dodders, and the spotted touch-me-not. The aggregate area covered by these stands is 2,924 acres, so the type is the third most prevalent grouping and occupies about 11.5% of the fresh marsh area.

Stands of rosemallow (Type 35) include a mixture of herbaceous plants. Smartweeds, burmarigolds, spotted touch-me-not, arrowarum, and cattails have been reported from the few stands that have been examined (Table 5). This vegetation grouping occurs on 1,256 acres, and covers 5% of the fresh marsh area.

Scattered plants of arrowarum, pickerelweed, arrowhead, burmarigold, spotted touch-me-not, smartweeds, and wildrice may grow in stands of spatterdock (Type 31), but most of the stands virtually are pure (Figure 11). Spatterdock commonly occupies sites that are elevated only slightly above the level of mean low water. The stands, therefore, are covered during almost every period of high water; the sites they occupy are submerged relatively deeply; and each period of inundation is rather long.

The mature rhizomes, or rootstalks, of spatterdock are about 2 inches thick. The plant spreads by the elongation and branching of these underground stems. Based on evaluations of aerial photographs and direct inspections from aircraft, it appears that a single plant, within 15 to 20 years, may cover an area of several thousand square feet. Each of the larger stands of the spatterdock type appear to be formed by the coalescence of several to many of these vegetatively multiplied clones. The individual clones retain their identity by virtue of their nearly circular shapes and subtle differences in the colors of their leaves. Extensive stands, thus, have scalloped perimeters; each rounded scallop represents the outer edge of one of the component clones in the stand. Smaller stands that are formed by the fusion of only a few clones resemble rows of overlapping circles of various sizes. In marshes in the estuary of the Delaware River, there are approximatley 400 to 550 thousand erect leaves of spatterdock per acre in these stands (McCormick, 1970; McCormick and Ashbaugh 1972).

Figure 10: Smartweed/rice cutgrass fresh marsh (Type 30) along Hunting Creek in Caroline County. Only smartweeds were present in this stand. A spatterdock marsh (Type 31) occupies the near background.

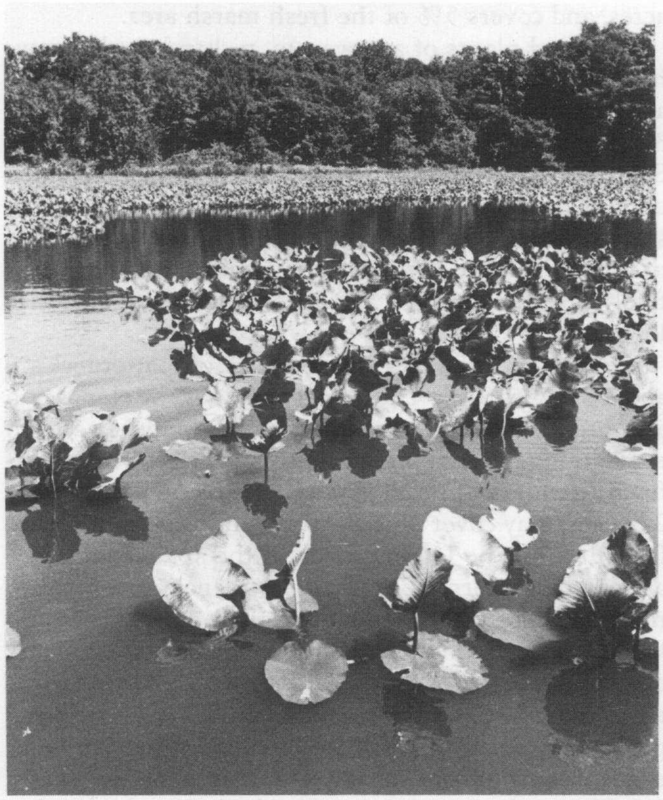

Figure 11. Spatterdock fresh marsh (Type 31) along Hunting Creek in Caroline County.

Stands of arrowarum (Type 32), in which pickerelweed may be a common associate, occur in many wetland areas as fringes of varying width along the banks of tidewater creeks and guts (Figure 12). In these sites, the surface is covered during most periods of high water; the water is relatively deep; and the duration of flooding is long. The arrowarum type also grows on more elevated sections of the wetlands and, in these areas, commonly intergrades with such other types of fresh marsh vegetation as the smartweed/rice cutgrass type (Type 30).

During the spring and early summer, before the annual plants of the marsh have grown very tall, stands of sweetflag (Type 33) appear to be pure or to be mixed with arrowhead or other perennial plants (Figure 13). By middle or late summer, however, the irislike leaves of sweetflag may be lodged by rain, wind, and high tides, and water smartweed, pinkweed, waterhemp, and other kinds of annuals that have developed to full stature may overtop and nearly obscure the sweetflag (McCormick and Ashbaugh 1972).

Narrowleaf cattail is the principal component of tidewater stands of the cattail type (Type 34). Arrowarum is the most constant associate in these stands, but spotted touch-me-not, water smartweed, arrowhead, smartweeds, rosemallow, rice cutgrass, and big cordgrass also may be present (Figure 14). Common cattail is associated with the narrowleaf cattail in some stands, and it may be relatively abundant in stands near the upper, inland boundary of the wetands. Little information is available on the occurrences of southern cattail and the blue cattail, but both have been reported to grow in fresh or slightly brackish tidal marshes in Maryland (Table 5).

Stands of the rosemallow type (Type 35) include variable mixtures of burmarigolds, spotted touch-me-not, smartweeds, arrowarum, and cattails (Figure 15). Although it is a perennial herb, and it dies back to the ground each winter, the rosemallow has a shrubby growth form. Plants of this kind, which include the water willow, are known as half shrubs, or shrublike herbs.

Figure 12: Pickerelweed/arrowarum fresh marsh (Type 32) along Hunting Creek in Caroline County. This stand is composed predominantly of arrowarum.

Figure 13: Sweetflag marsh (Type 33) along the Chester River in Queen Anne's County. Arrowhead forms a scattered undergrowth in this stand.

Figure 14. Cattail fresh marsh (Type 34) along Hunting Creek in Caroline County. Smartweed (Type 30) also occurs in this stand.

The wildrice type (Type 36) is conspicuous and widely distributed in the fresh coastal wetlands of the Middle Atlantic Region (Figure 16). Unlike the other predominant grasses of the coastal wetlands, wildrice is an annual. The plants germinate from seeds during the spring; they grow to heights as great as 11 feet by August (Table 6); then they produce seeds and die.

Scattered plants of arrowhead, spatterdock, pickerelweed, and arrowarum, singly or in various combinations, commonly form a discontinuous undergrowth in stands of wildrice (Figure 16). In wetlands that occupy sites within the transition zone between the freshwater and brackish segments of the estuaries, smooth cordgrass may grow along the banks of the channels of tidewater creeks and guts that extend through stands of wildrice.

Stands of the bulrush type (Type 37) are formed principally by common threesquare (Figure 17). Softrush, arrowarum, and cattail are associated species in most stands of the type.

Big cordgrass grows in nearly pure stands (Type 38) in narrow bands along the creeks and tidal guts that cross or extend into wetlands (Figure 18). Narrowleaf cattail grows with the big cordgrass in some areas, particularly where the stands are broader than usual. Arrowarum and pickerelweed also may be associated with big cordgrass, but these plants generally are limited to sites at the edges of creeks and guts.

Common reed (Type 39) also forms tall, dense, virtually pure stands (Figure 19). This perennial grass commonly develops on sites that have been disrupted by such actions of man as the placement of fill or dredged material, the excavation of the wetland surface, or the introduction of toxic pollutants or high concentrations of nutrients. The rhizomes, or underground stems, of common reed elongate rapidly. An inch-long fragment of rhizome may lodge in a barren area and begin to grow. Within a few months, this minute fragment may produce new rhizomes, culms, and leaves that cover several square meters of the soil surface.

Figure 15. Rosemallow fresh marsh (Type 35) along Hunting Creek in Caroline County. Smartweed, cattail, and spotted touch-me-not also are present in this stand.

HIGH AND LOW BRACKISH MARSHES (TYPES 41 THROUGH 51)

Needlerush (Type 43, Figure 22), meadow cordgrass/spikegrass (Type 41, Figure 20), and threesquare (Type 47, Figure 26) cover 38.5%, 24.5%, and 15.0%, respectively, of the 126,569 acres of wetlands that are characterized as high brackish marshes (Table 2). Olney threesquare is predominant in most of the areas that are covered by the threesquare type, but common threesquare and stout bulrush may be abundant in the more landward sections of the marshes.

The shrubby marshelder/groundselbush type (Type 42, Figure 21), which forms 8.3% of this habitat complex, occupies sites along the upland margin of the wetlands, on natural levees and turf banks, and on the surfaces of the wetlands. In the latter sites, which are subject to more frequent inundation than are the other sites, the stands are composed principally of marshelder.

Stands of big cordgrass (Type 48) line the banks of many tidewater creeks and guts, and cover a total of about 8,196 acres (6.5%) of the high brackish marshes (Figure 27). Other types of vegetation that compose the high brackish marshes, in the order of their areal abundance, are: cattail (Type 44, Figure 23), switchgrass (Type 46, Figure 25), common reed (Type 49, Figure 28), and rosemallow (Type 45, Figure 24). Species of plants that have been reported to be components of the various types of brackish wetland vegetation in the Middle Atlantic Region are listed in Table 7. Most of these species, but not necessarily all of them, are present in stands of these types in Maryland.

Figure 16. Wildrice fresh marsh (Type 36) along Hunting Creek in Dorchester County. Pickerelweed and rosemallow are visible in the foreground.

Figure 17. Bulrush fresh marsh (Type 37) along Hunting Creek in Caroline County.

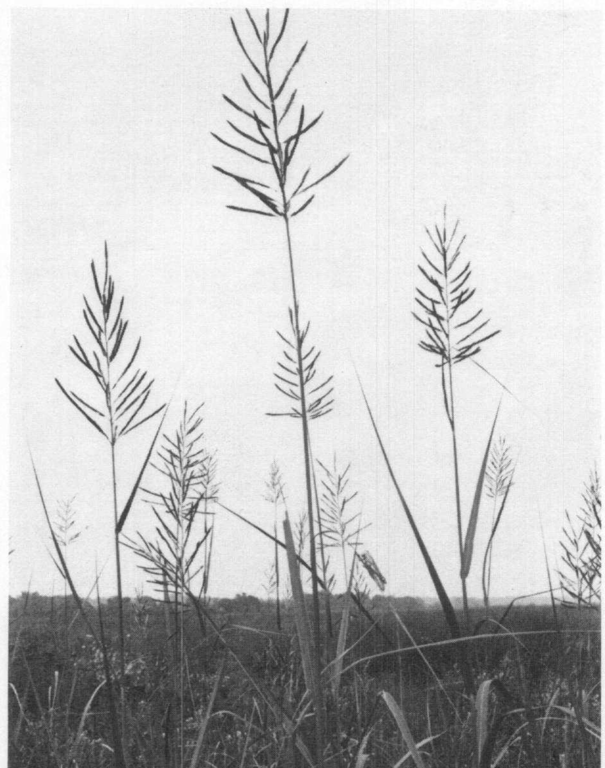

Figure 18. Big cordgrass fresh marsh (Type 38) along Hunting Creek in Caroline County.

Figure 19. Common reed fresh marsh (Type 39) along the Choptank River in Caroline County.

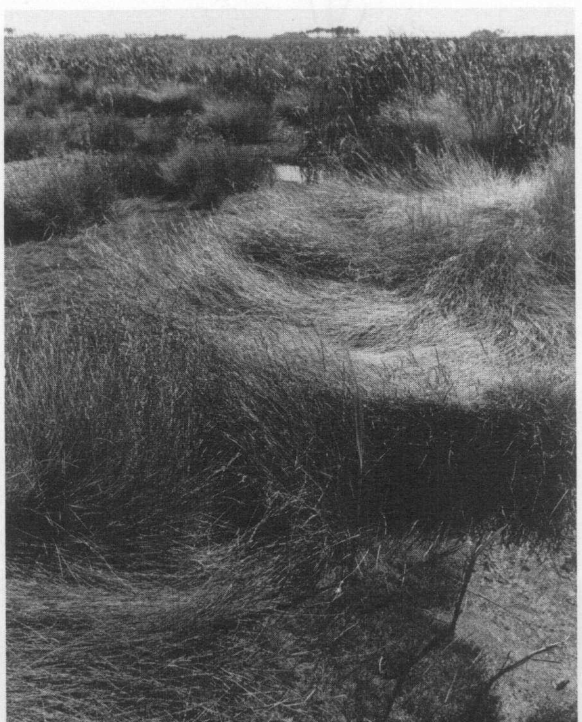

Figure 20. Meadow cordgrass/spikegrass brackish high marsh (Type 41) near Savannah Lake in Dorchester County. A cattail brackish high marsh, (Type 44) forms the background.

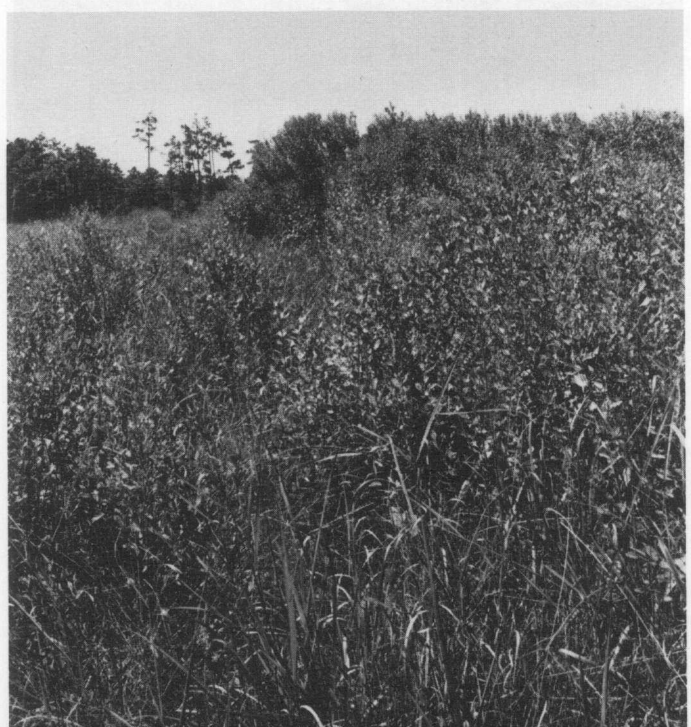

Figure 21. Marshelder/groundselbush brackish high marsh (Type 42) near Elliott Island in Dorchester County. This stand contained a mixture of smooth cordgrass, switchgrass, and myrtles.

Figure 22. Needlerush brackish high marsh (Type 43) near Elliott Island in Dorchester County.

Low brackish marsh sites occupy approximately 25,079 acres in the coastal wetland region of Maryland (Table 2). The low marsh sites, therefore, compose about 16.5% of the total area of brackish wetlands, and high marsh sites compose the remaining 83.5%. The two classes of sites differ in relative elevation, so that low marsh sites are partly or wholly inundated during most periods of high water, and in the kinds of vegetation they support. Stands of smooth cordgrass (Type 51) are considered to characterize the low marsh (Figure 29), and no stand of this species was included in the high marsh complex.

In the low brackish marshes, the smooth cordgrass generally is of a short to intermediate height. Particularly in Somerset County, however, stands of a tall growth form, equivalent to Type 71 in the saline wetlands, occur in small, but discrete stands, and in narrow bands between tidal channels and stands of needlerush on high brackish wetland sites. The stands of the tall form are most extensive on South Marsh Island and Smith Island, and the channel fringe stands are conspicuous near Cedar Island and around Tangier Sound.

With the exception of the marshelder/groundselbush type (Type 42) and the rosemallow type (Type 45), the types of vegetation in the brackish wetlands are represented in most places by nearly pure stands of the predominant species. In stands of marshelder and groundselbush, the undergrowth commonly is formed by meadow cordgrass. Spikegrass, switchgrass, smooth cordgrass, big cordgrass, Olney threesquare, seaside goldenrod, rosemallow, and other herbaceous plants also may be present. Near the upland edge of the marshes, bayberry, blackberry, and poison ivy also may be associates (Table 7). Switchgrass, Olney threesquare, narrowleaf cattail, and various smartweeds have been reported to be associates of the rosemallow.

There is a considerable variation in the salinity of the soil in brackish wetlands, but the pH of the soil varies little from place to place (Table 8). Meadow cordgrass and spikegrass generally occupy the most saline soils, and narrowleaf cattail, among the types investigated, grows on the least saline sites.

Figure 23. Cattail brackish high marsh (Type 44) near Savannah Lake in Dorchester County. Rosemallow is scattered through this stand.

Figure 25. Switchgrass brackish high marsh (Type 46) near Elliott Island in Dorchester County. A red maple swamp forest (Type 22) is conspicuous in the right background, and a loblolly pine swamp forest (Type 23) forms the distant background.

Figure 24. Rosemallow brackish high marsh (Type 45) along Transquaking River in Dorchester County. Associated plants in this stand included smooth cordgrass, switchgrass, and meadow cordgrass.

Figure 26. Threesquare brackish high marsh (Type 47) near Elliott Island in Dorchester County. A loblolly pine swamp forest (Type 23) forms the background.

Figure 27. Big cordgrass brackish high marsh (Type 48) along Hunting Creek in Dorchester County. Smooth cordgrass marsh (Type 51) forms a narrow band in foreground.

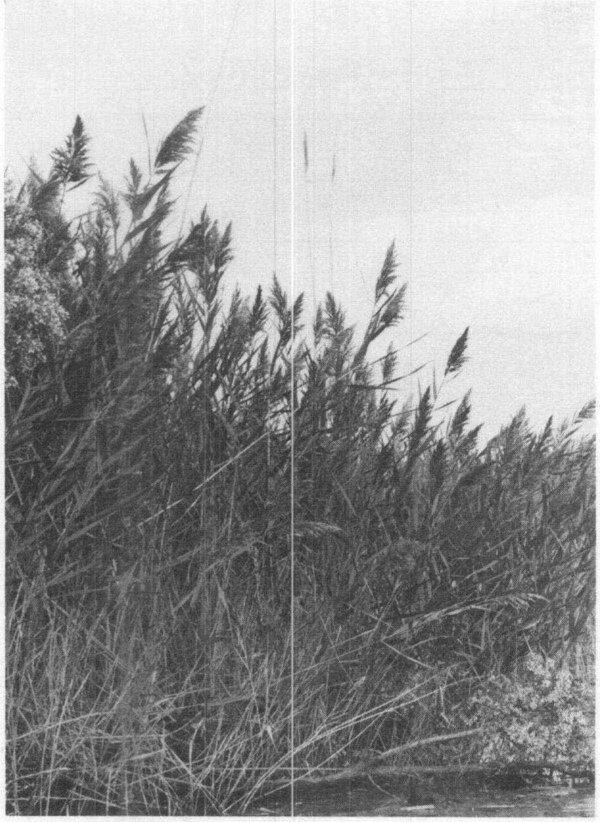

Figure 28. Common reed brackish high marsh (Type 49) on Eastern Neck Island in Kent County.

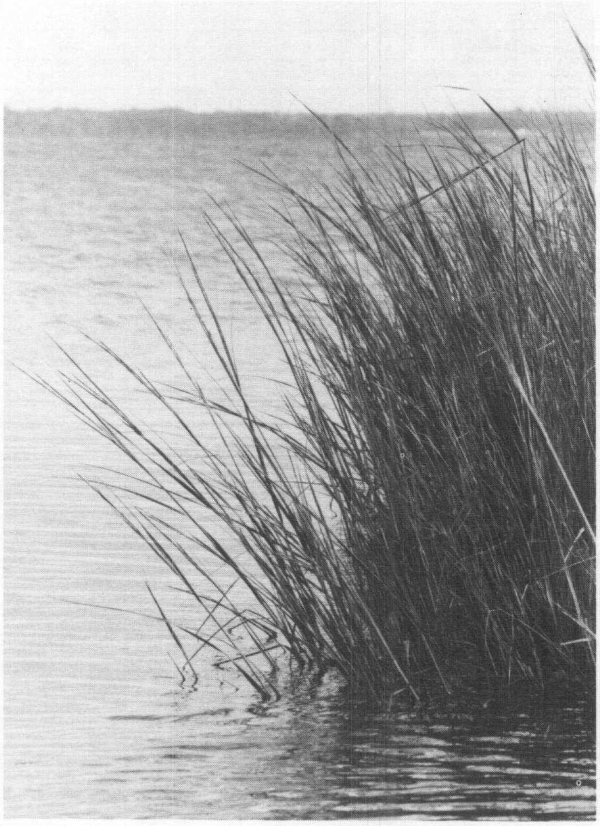

Figure 29. Smooth cordgrass brackish low marsh (Type 51) on Eastern Neck Island in Kent County.

Table 7. Floristic components of brackish marsh types in the coastal zone of Maryland and other Middle Atlantic States.

	Meadow Cordgrass/ Spikegrass	Marshelder/ Groundselbush	Needlerush	Cattail	Rosemallow	Switchgrass	Threesquare	Big Cordgrass	Common reed	Smooth cordgrass
	41	42	43	44	45	46	47	48	49	51
Trees										
Red maple						7				
Persimmon		4, 11								
Shrubs and Vines										
Groundselbush	4, 11	X								
Marshelder	X	X		9, 10		7	10		4	10
Bayberry	11	4, 11				7				
Waxmyrtle		11								
Poison ivy		4, 11				7				
Swamp rose		11								
Blackberry		4, 11								
Southern arrowwood						7				
Shrublike Herbs										
Rosemallow	9, 11	X		X	X	9	X	12	4	
Seashore mallow	11	9, 11	11	4			10			9, 11
Forbs										
Waterhemp	9, 11						12		4	X
Groundnut						1				
Swamp milkweed						1	1	12		
Annual marsh aster	11		11							
Perennial marsh aster	11, 12	11	11							11
Hastate orach							12			
Spreading orach	11	11	11					1		2,11
Dodder		11, 12								
Searocket	11									
Seaside gerardia	11, 12									
Purple gerardia		12								2
Carolina sealavender										12
Nash sealavender	11		11							11
Bugleweed										8
Narrowleaf loosestrife	X		11				X			11
Climbing hempweed		11, 12								
Arrowarum				1		1		1		
Camphorweed	8, 12	9, 12					12			9
Marsh fleabane	4, 11		11	4			3		4	11, 12
Smartweeds					4				4	4
Mild waterpepper	9	9		9						
Dotted smartweed		11								2
Arrowleaf tearthumb	12					1				
Pickerelweed										4
Mock bishopweed	12					1				
Waterdock									4	
Marshpink	11, 12	11, 12	11							
Slender glasswort	11									11
Duck potato										8
Seaside goldenrod	X	X	11			7	10, 12			11, 12
Marsh wildbean		12						12		
American germander								1		
Marsh fern				11		9				

Table 7. Floristic components of brackish marsh types in the coastal zone of Maryland and other Middle Atlantic States (concluded).

	Meadow Cordgrass/ Spikegrass	Marshelder/ Groundselbush	Needlerush	Cattail	Rosemallow	Switchgrass	Threesquare	Big Cordgrass	Common reed	Smooth cordgrass
	41	42	43	44	45	46	47	48	49	51
Grasses and Grasslike Plants										
Hair sedge	10									
Broadwing sedge										2
Stretched sedge	11									
Strawcolor umbrella sedge	11						12			
Spikegrass	X	X	11	4, 10		9	X			8, 10
Reedgrass		11								
Walter millet	4			4						4
Creeping spikerush						1				
Dwarf spikerush										2
Beaked spikerush							6			
Narrow plumegrass							4			
Chestnut sedge	11		11			11				
Rushes		9			4					
Sharpfruit rush						1				
Blackrush	11									
Needlerush	10, 11		X				4			11
Switchgrass	4, 11	X		10	4	X	4			4
Common reed	4, 10								X	
Bulrushes	10					7				
Twopart rush	11									
Common threesquare	11		11	1, 11			1	1		11
Olney threesquare	X	X	10	X	4	9	X	10	4	8, 10
Stout bulrush	10, 11		11				2, 12	12		11
Softstem bulrush										2
Giant bristlegrass		11			11					
Knotroot bristlegrass	11	11	11							
Smooth cordgrass	X	9, 10	10, 11	9, 10			X	8, 10	4	X
Big cordgrass		9, 10		9				X	4	4, 9
Meadow cordgrass	X	X	X	4		9	X	10	4	10, 11
Gamagrass						4				
Narrowleaf cattail		10		X	4					
Common cattail				5						
Wildcelery										2
Wildrice										4

Tabulated numerals represent the following sources; parenthetical abbreviations indicate the states in which investigations were conducted; an "X" indicates that the taxon is used to designate the type or was reported in three or more sources. Supplementary types were not mapped, and some may not occur in Maryland.

1. Anderson and others 1968 (MD)
2. Flowers 1973 (MD)
3. Good 1965 (NJ)
4. Jack McCormick & Associates, Inc., field notes (MD)
5. Johnson 1970, corrected (MD)
6. Stearns and others 1940 (DEL)
7. McCormick 1952 (NJ)
8. Connell 1940 (DEL)
9. Jenkins and Williamson 1973 (MD)
10. Williamson 1974 (MD)
11. Thompson 1974 (MD)
12. Chrysler 1910 (MD)

Table 8. Salinity and pH of water in soils that support the characteristic plants in brackish coastal wetlands in Delaware (Daigh, MacCleary, and Stearns 1938).

	Salinity[1]		pH
	Optimum	Range	Mean
Narrowleaf cattail	5.35	0.12 - 32.79	5.06
Olney threesquare	9.85	2.71 - 18.30	4.75
Smooth cordgrass	17.14	1.86 - 46.19	4.93
Meadow cordgrass	21.89	4.48 - 55.62	4.97
Spikegrass	29.56	9.96 - 67.54	5.10

[1]Salinities were calculated from chlorinity, in parts per thousand, by the formula: Salinity (ppt) = 0.030 + (1.8050 x chlorinity).

Many of the extensive brackish marshes on the Eastern Shore are burned intentionally during November and December of each year. The fires generally are set in stands of meadow cordgrass (Type 41), needlerush (Type 43), cattail (Type 44), threesquares (Type 47), big cordgrass (Type 48), and common reed (Type 49), in which flammable dead plant materials persist after the growing season is completed.

Observations from the ground and from aircraft during 1976 revealed that marsh burning is practiced most extensively in Dorchester County (approximately 57,400 acres during 1975/1976) and Somerset County (12,200 acres). The sections of Dorchester County in which burned marshes were prominent included the Taylors Island Wildlife Management Area, Bishops Head, Fishing Bay, and the Blackwater National Wildlife Refuge, Elliot Island, and nearby areas in the wetlands of the Blackwater River. In Somerset County, fires had been set in the marshes at Deal Island, Dames Quarter, Fairmount Neck, Jersey Island, and Johnson Creek.

On such publicly-owned tracts as the Deal Island Wildlife Area, which is burned during alternate years, fire is used as a tool for the management of wildlife habitats. The removal of the dead leaves and culms of the plants that grew during the previous summer will expose the new shoots, which develop during the following spring, so that they will be available more readily to waterfowl.

Fires also may be set on privately-owned marshes in an effort to improve conditions for waterfowl, muskrats, and other kinds of wildlife. They also are used to promote the growth of meadow cordgrass and common threesquare, to eliminate needlerush, to control insects, to improve access for trapping, and to minimize the potential for accidental fires. Many of the marsh fires, perhaps most of them, however are set by arsonists for unknown reasons (Jack McCormick & Associates, Inc., interviews by field personnel, 1976 and 1977).

Regardless of the perceived reasons of the owners, managers, and arsonists who set these fires, intentionally-set fires and accidental fires oxidize the large mass of organic material that is produced by the marsh vegetation. Thus, the fires remove potentially significant amounts of detritus and nutrients from the estuarine food web. Apparently no investigation has been conducted to determine the net cost or benefit of marsh burning in relation to the overall natural or economic productivity of the estuarine system of the Chesapeake Bay region.

In regard to the 1975/1978 Wetlands Management Study, the burning of the brackish marshes complicated the identification and the delineation of vegetation types. Wetlands that had been burned during the current year and during the previous year were recorded on some of the aerial photographs that were taken during the late autumn. The wetlands that had been burned recently appear as brown to black areas on the photographs, and little or no vegetation is distinguishable within them. In areas that have been burned earlier, vegetation is visible on the photographs, but it differs strikingly in appearance from similar vegetation on unburned wetlands. This variation apparently is produced by the absence of dead plant material on the ground in the burned areas. Whatever the cause, however, the unique textures and colors of the vegetation of different types in the burned marshes made difficult their correlation with similar types in unburned marshes.

The types of vegetation on all of the areas of burned marsh were identified and the extent of each stand was delineated by the interpretation of the aerial photographs, by ground inspections, and by inspections from aircraft. To denote these areas, and to serve as a reminder that the accuracy of the mapping in such areas may be less than that in unburned areas, the letter "B" was prefixed to the symbol for each type of vegetation in burned marshes.

HIGH AND LOW SALINE MARSHES (TYPES 61, 62, 63, 71 AND 72)

In Maryland, saline coastal wetlands are recognized in the seaside bays of Worcester County. Stands of smooth cordgrass characterize the low marsh sites and cover 9,544 acres, or 69.4% of the total area of the saline wetlands (Table 2). On 95 acres along the margins of bays and tidal channels, the grass grows to heights of 2 to 4 feet or more (Type 71, Figure 33). Farther back on the marsh surface, a shorter form of the smooth cordgrass, which generally does not exceed 1 foot in height (Type 72, Figure 34) covers nearly 9,450 acres. Plants of the tall and short growth forms are genetically indistinguishable and reflect environmental differences in their habitats (Mobberly 1956; Mooring and others 1971; Shea and others 1975). Glassworts, which have fleshy stems and minute, scale-like leaves, commonly are scattered through the two cordgrass zones.

Landward from these areas, where the marsh surface is a few inches higher in elevation, meadow cordgrass and spikegrass (Type 61) form the vegetation on about 55% of the high marsh (Figure 30). These grasses grow in mixed stands, or either may occur in nearly pure stands. On about 3% of the area of the high saline wetlands, particularly on the bayside of Fenwick Island, stands of the needlerush (Type 63) cover areas near the upland margins or extend from the edge of the bay nearly to the uplands (Figure 32).

Two shrubby plants, the bayberry and the groundselbush (Type 62), cover 42% of the saline high wetlands (Table 2). These shrubs occur in mixture near the upland border of the saline marshes and on higher ground that is adjacent to, or scattered through the wetlands. Marshelder may occur with the other two shrubs near the upland edge of the wetland, but it also grows on parts of the high marsh that are flooded more frequently (Figure 31). In most wetland areas, meadow cordgrass forms a dense ground cover beneath these shrubs.

Tall stands of smooth cordgrass are subject to regular and deep flooding on nearly every high tide (Lagna 1975). Similarly, some stands of needlerush also are regularly flooded. Parts of the stands of short form smooth cordgrass also may be inundated frequently, but other sections are covered only by spring tides and wind-driven tides. Similarly, stands of meadow cordgrass and spikegrass generally are covered only by the higher tides of each month. The shrubby stands of marshelder and groundselbush are inundated by the highest of the spring tides and also by storm tides. Regardless of the frequency of flooding, the soil beneath all of these types is perennially saturated, and the water table usually is within a few inches of the surface.

Figure 31. Marshelder/groundselbush saline high marsh (Type 62) at Coffman Marsh in Worcester County. This stand contained only marshelder. Meadow cordgrass and spikegrass occur in the undergrowth of this stand. A needlerush marsh (Type 63) is visible in the background.

Figure 30. Meadow cordgrass/spikegrass saline high marsh (Type 61) at Coffman Marsh in Worcester County. Marshelder is visible in the left background, and smooth cordgrass, short growth form (Type 72) is in the right background.

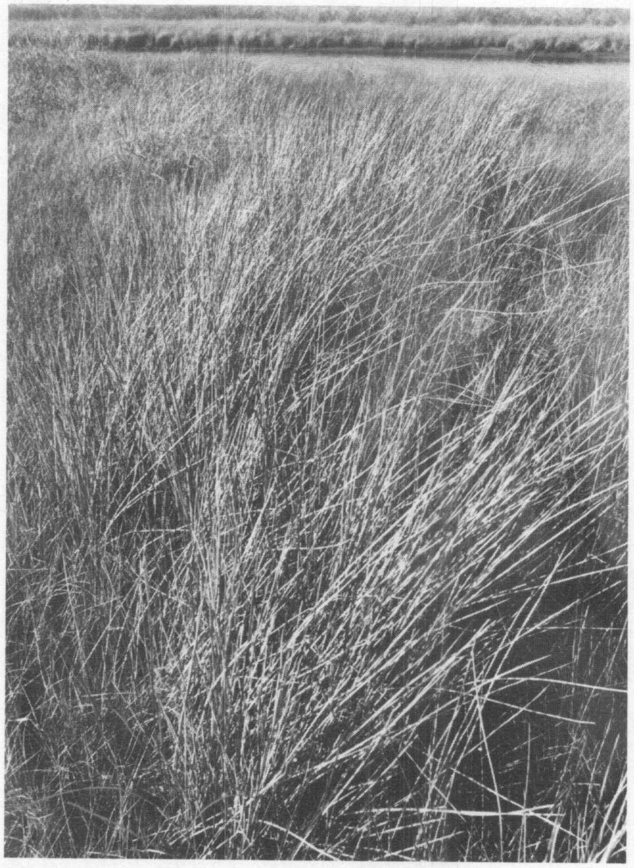

Figure 32. Needlerush saline high marsh (Type 63) near Ocean City in Worcester County.

Figure 34. Smooth cordgrass, short growth form, saline low marsh (Type 72) on Assateague Island in Worcester County. A shallow salt pond (Type 80) occupies the central area.

Figure 33. Smooth cordgrass, tall growth form, saline low marsh (Type 71) near Purnell Pond in Worcester County.

Species of plants that have been reported as components of the vegetation types of saline wetlands are listed in Table 9. Two floristic investigations of saline wetlands also are summarized in Table 10. Studies of this last type merely indicate that certain species were observed in saline habitats, but they do not indicate the vegetation types in which the species occur. Although such floristic studies cannot be used to compile lists for the individual types of vegetation, they do indicate the potential diversity of species in saline habitats. Fifty taxa are included in Table 10.

There are various environmental gradients in a saline wetland. Flooding generally is most regular, of longest duration, and of greatest depth along the shores of the seaside bays and tidal channels near inlets between the barrier islands. Fresh water enters from the inland margin of the wetland as runoff, and the soil moisture in marginal areas may be brackish to fresh. In areas that are flooded frequently, the salinity of the soil moisture parallels the salinity of the water in the adjacent bay. The intermediate areas of high marsh, between the low marsh, which is flooded frequently, and the sections of the high marsh that receive runoff from the uplands, commonly are the most saline owing to the concentration of salts by evaporation and transpiration. Salinity is at an extreme in pans. These are slight depressions which support temporary ponds, but which may be coated by crystallized salts during dry spells.

The relatively low diversity of species in saline wetlands reflects the environmental gradients which act to sort the species that are available and to limit their ranges. Many pans are barren or are occupied only by glassworts, orach, or marsh fleabane. Smooth cordgrass forms nearly pure stands over a large proportion of the saline wetlands. The meadow cordgrass-spikegrass zone also is not particularly rich in species.

The diversity of species increases near the upland periphery of the wetlands, but this increase appears to be less pronounced in the saline wetlands of Maryland than it is in similar habitats in other sections of the Middle Atlantic Region (Good 1965). The increased diversity is a product of both the greater variety of vegetation types which may occur along the upper boundary of the wetland and the larger number of species of which certain of those types are composed.

Most of the vegetation of the saline coastal marshes persists in a withered condition through the winter. The predominant plants are perennials, and new growth begins to appear through the dead remains of the last season of growth during late April or early May. Flowering begins rather late in the summer and continues into autumn. In southern New Jersey, Good (1965) recorded the earliest flowering of the most important and most conspicuous plants: meadow cordgrass (1 July), big cordgrass (14 July), smooth cordgrass and spikegrass (15 August), sealavender (24 August), and marshelder and groundselbush (1 October). Seed production is at a maximum during September and October, but only a few kinds of wildlife concentrate their feeding on this resource (Tables 27 and 39).

Table 9. Floristic components of saline marsh types in the coastal zone of Maryland and other Middle Atlantic States.

						Supplementary Types	
	Meadow Cordgrass/ Spikegrass	Marshelder/ Groundselbush	Needlerush	Smooth cordgrass, tall form	Smooth cordgrass, short form	Spreading orach	Smooth cordgrass/ meadow cordgrass
	61	62	63	71	72	7A	7M
Trees							
Red maple		5					
Red cedar		5					
Shrubs and woody vines							
Groundselbush	7	X					
Sea oxeye	7						
Marshelder	X	X					
Bayberry		5					
Shining sumac		5					
Poison ivy		5					
Forbs							
Waterhemp				2			
Annual marsh aster	2						
Perennial marsh aster	X			2, 6	6		
Spreading orach	6			2		X	
Seaside gerardia	2, 6				6		
Carolina sealavender	X			X	X	1	
Seaside plantain					6		
Camphorweed	2			2			
Stinking fleabane	2						
Marsh fleabane	1			1		1	
Dwarf glasswort					6		
Slender glasswort	X			X	X		
Perennial glasswort	5						

Table 9. Floristic components of saline marsh types in the coastal zone of Maryland and other Middle Atlantic States (Concluded).

	Meadow Cordgrass Spikegrass	Marshelder/ Groundselbush	Needlerush	Smooth cordgrass, tall form	Smooth cordgrass, short form	Supplementary Types: Spreading orach	Supplementary Types: Smooth cordgrass/ meadow cordgrass
	61	62	63	71	72	7A	7M
Saltwort	5						
Seaside goldenrod	1			2			
Common sandspurrey					6		
Marsh sandspurrey				2	6		
Maritime arrowgrass					6		
Grasses and grasslike plants							
Bushy broomsedge		5					
Spikegrass	X		4	7	6, 7		1
Chestnutsedge	7						
Blackrush	2, 6		4				
Needlerush			X				
Switchgrass		5					
Smooth cordgrass	X			X	X	1	X
Meadow cordgrass	X	3		1, 6			X

Tabulated numerals represent the following sources; parenthetical abbreviations indicate the states in which investigations were conducted; an "X" indicates that the taxon is used to designate the type or was reported in three or more sources. Supplementary types were not mapped, and may not occur in Maryland.

1. Good 1965 (NJ)
2. Higman 1972 (MD)
3. Jack McCormick & Associates, Inc., field observations (MD)
4. McCormick 1952 (NJ)
5. Martin 1959; Small and Martin 1958 (NJ)
6. Miller and Egler 1950 (CT)
7. Kerwin and Pedigo 1971 (VA)

Table 10. Plants observed in saline marshes on Assateague Island, Maryland and Virginia (Higgins and others 1971), and in New Jersey (Stone 1911).

	Assateague[a]	New Jersey
Shrubs		
Groundselbush	X	X
Marshelder	X	X
Shrublike herbs		
Rosemallow	X	
Seaside mallow	X	X
Forbs		
Waterhemp		X
Seabeach pigweed	X	
Smooth heath aster	X	
Annual marsh aster	X	X
Southern annual marsh aster	X	
Perennial marsh aster	X	X
Seabeach orach	X	
Hastate orach	X	X

	Assateague[a]	New Jersey
Forbs (Continued)		
Common meadowbeauty	X	
Marshpink	X	X
White marshpink	X	
Dwarf glasswort	X	X
Slender glasswort	X	X
Perennial glasswort	X	X
Saltwort	X	
Smooth saltwort	X	
Seapurslane	X	
Seaside goldenrod	X	X
Marsh sandspurry	X	
Matted seablite		X
Tall seablite	X	X
American germander	X	
Maritime arrowgrass		X

Table 10. Plants observed in saline marshes on Assateague Island, Maryland and Virginia (Concluded).

	Assateague[a]	New Jersey		Assateague[a]	New Jersey
Hairy seablite	X	X	Grasses and grasslike plants		
Sea oxeye	X		Bermudagrass	X	X
Searocket	X		Beach umbrella sedge		X
Coastblite		X	Tufted meadowgrass		X
Seaside gerardia		X	Spikegrass	X	X
Purple gerardia	X		Creeping spikerush	X	
Sea milkwort		X	Dwarf spikerush	X	X
Lilaeopsis		X	Beaked spikerush		X
Carolina sealavender	X		Purple lovegrass	X	
Seedbox	X		Chestnutsedge	X	X
Cutleaf waterhorehound	X		Bristly rush	X	
Seaside plantain		X	Flatleaf rush	X	
Marsh plantain		X	Blackrush	X	X
Camphorweed		X	Needlerush	X	
Marsh fleabane	X		Torrey rush	X	
Whorled milkwort	X		Spreading alkaligrass		X
Seabeach knotweed	X		Common threesquare	X	X
Pinkweed	X		Stout bulrush		X
Shore knotweed		X	Smooth cordgrass	X	X
Bushy knotweed		X	Big cordgrass		X
Seaside crowfoot		X	Marsh cordgrass	X	X

[a]This list is drawn from Appendix II of Higgins and others (1971), but is selected and modified by reference to habitat lists on pages 19, 20, and 21 and by information in Table 1 of the source. Because the term "pan" is used variously to include interdune swales as well as tidal marsh features, species listed only from such habitats are omitted. Because fresh, nontidal marshes also are present, species listed only from "marshes" also are omitted here. Other species were excluded because information in Appendix II conflicted with habitat associations listed elsewhere in the source.

UNVEGETATED WETLANDS (TYPES 80, 81, AND 91)

Three types of wetland that are recognized in the coastal zone of Maryland generally are devoid of rooted plants. One of these types comprises relatively small bodies of water that are surrounded by vegetated wetlands, have no major connection to tidal waters, and which support no detectable submerged vegetation. These are categorized as ponds (Type 80; Figure 35).

The two numbered types of unvegetated, intertidal wetlands are mudflats (Type 81) and beaches/sandbars (Type 91). Mudflats and sandbars are shoals that are exposed during at least some periods of low water slack. They differ in that mudflats are composed of clay, silt, and organic material (Figure 36), whereas sandbars are composed predominantly of sand, pebbles, or shells (Figure 37).

Beaches are features of the shore, and their upper, landward edges generally are continued by higher ground that is not a part of the wetlands. A beach may be composed of sand, a mixture of sand and shells, pebbles, cobbles, or other material.

The main area of the beach, which is situated approximately between the low water line and the mean high water line, lacks rooted plants. The upper beach, which is the section that lies between the mean high water line and the extreme high water line, usually supports scattered plants. The species of plants that are known to occur in this habitat in the Middle Atlantic States are listed in Table 11.

Many areas of the Atlantic Ocean, Assawoman Bay and other seaside bays, Chesapeake Bay, and a host of smaller bays, and tidewater rivers, creeks, guts, and ditches also are unvegetated wetlands. These areas are not assigned to a numbered type on the photomaps, but they are distinctive and easily recognized. They were not surveyed or measured during the present investigation because they are incompletely covered by the aerial photographs that were taken during 1971. Those photographs were intended to record the locations of the vegetated wetlands, particularly the private wetlands, and to facilitate the delineation of the upper or inland boundary of the coastal wetlands. The photographic inventory, therefore, was not extended to areas of deeper water or to waters remote from the shores because those areas are State wetlands that are subject not only to the Wetlands Act, but also to the more powerful controls that are associated with public ownership.

SUBMERGED AQUATIC VEGETATION (TYPE 101)

At least 24 species of flowering plants and seven kinds of macroscopic algae characteristically grow beneath the surface of the water in the tidewater rivers and creeks, marsh ponds, and bays of the coastal region (Table 77; Figure 38). They form sparse to dense, relatively small to extensive stands, but are subject to cataclysmic fluctuations in their populations (Elser 1967; Steenis, Stotts, and Rawls 1971; Southwick and Pine 1975; Maldeis 1978; Bayley and others 1978). Areas covered by luxurious stands of submerged plants one year may be nearly barren the next year. The stands may redevelop within a few months; they may require several years; or they may fail to redevelop. The plants are significant as food producers and their stands serve as habitats for vertebrates and invertebrates, as well as sediment stabilizers (Gosner 1968; Orth 1975).

The bottom in areas covered by submerged flowering plants commonly is composed of soft mud. The mud, however, may represent sediment trapped by the plants rather than the condition of the bottom when it first was colonized by the plants (Good and others 1978). Submerged plants grow in a zone that extends approximately from the level of mean low water to a maximum depth of about 8 to 10 feet (2.4 to 3.5 m) below mean low water in areas with relatively clear water. Where the water is constantly turbid or intensely colored, the depth to which the plants extend is reduced and, in very turbid waters, submerged plants may be unable to survive at any depth.

Most of the submerged flowering plants, as well as three of the algae, grow in areas of fresh water (Table 12). Only ten species of flowering plants and two kinds of algae, however, appear to be restricted to freshwater areas. Eelgrass, wigeongrass, and various species of red algae are known to occur from slightly brackish areas to saline coastal bays. Sealettuce, a leaflike green alga, and enteromorpha, another leafy green alga, range from moderately brackish waters to those with the salinity of seawater. Brown algae are restricted to the saline waters of Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague Bays. The northern naiad has been recorded from a moderately brackish station on the Patuxent River (Anderson 1969, 1972) and from the fresh to autumnally brackish Susquehanna Flats (Bayley and others 1978).

Figure 35. Pond (Type 80) on Deal Island in Somerset County. A mixed stand of meadow cordgrass and threesquare (Types 41 and 47) occupies the foreground and background.

Figure 36. Mudflat (Type 81) along the Manokin River in Somerset County. Stands of smooth cordgrass (Type 51) and marshelder/groundselbush (Type 42) form the background.

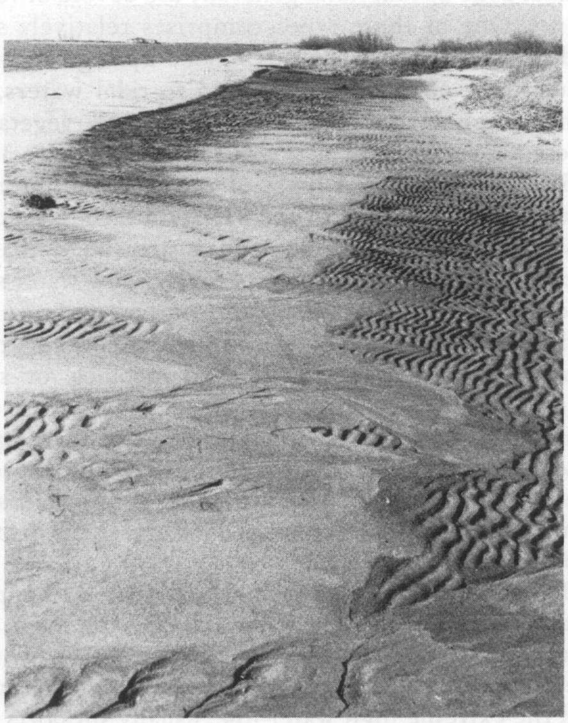

Figure 37. Beach/sandbar (Type 91) along the Manokin River in Somerset County. Smooth cordgrass (Type 51) and marshelder/groundselbush (Type 42) form the background.

Figure 38. Submerged aquatic plants (Type 101) along the Little Choptank River in Dorchester County. Marshelder/groundselbush (Type 42), meadow cordgrass (Type 41), and smooth cordgrass (Type 51) brackish marsh vegetation occupies the foreground. This is an aerial plot in which the offshore mottled pattern reflects the presence of submerged aquatic vegetation.

Table 11. Plants that occur on the beaches of Assateague Island, Maryland and Virginia (Higgins and others 1971), and in New Jersey (Stone 1911). All species listed are forbs (broadleaf herbaceous plants).

	Assateague	New Jersey
Seabeach pigweed	X	X
Seabeach sandwort	X	X
Seabeach orach		X
Searocket	X	X
Seabeach knotweed		X
Saltwort	X	X
Seapurslane		X
Beach cocklebur		X

Historically, the upper sections of the estuary of the Potomac River were occupied by luxuriant and diverse stands of various submerged plants. Deterioration of the quality of the water and other conditions that are related to human activities apparently have resulted in the destruction of most stands of submerged vegetation during the past few decades (Stewart 1962). Accelerated erosion of soil from the watersheds of the upper Potomac River, gravel-mining in or adjacent to the channel of the River at Dyke Marsh, Smoot Cove, and nearby locations, the roiling of sediments by increasing numbers of introduced European carp, the discharge of untreated or inadequately treated sewage effluents, and contaminated storm runoff from rapidly spreading, urbanized areas have increased the turbidity of the waters of the estuary. Pollutants from these sources also depleted the dissolved oxygen in the waters of the estuary, and promoted extensive growths of blue-green algae. Toxic substances that were released as these blue-green algae decayed are believed to have damaged or killed many submerged plants (Keating 1978). Still further deterioration of the submerged vegetation occurred during a prolonged drought from 1930 to 1932, and probably during subsequent droughts, when brackish water encroached upstream in the River at least to the mouth of Occoquan Bay. Also during the 1930's, the introduced waterchestnut, an aggressive, annual floating plant, increased in abundance with explosive rapidity in many localities. The coarse growths of waterchestnut produced dense shade and, thus, resulted in the elimination of submerged plants from areas it occupied (Gwathmey 1945).

Table 12. Ranges of salinities in waters in which submerged aquatic plants were observed by Stewart (1962). Scientific names are listed in Table 77.

	Saline	Brackish: Highly	Brackish: Moderately	Brackish: Slightly	Fresh
Brown algae	X				
Sealettuce	X	X	X		
Enteromorpha	X	X	X		
Eelgrass	X	X	X		
Red algae	X	X	X	X	
Wigeongrass	*	X	X	X	X
Horned pondweed		X	X	X	X
Sago pondweed		X	X	X	X
Redhead pondweed		*	X	X	X
Eurasian watermilfoil		*	X	X	X
Common waterweed			X	X	X
Muskgrasses			X	X	X
Curlyleaf pondweed			*	X	X
Wildcelery				X	X
Southern naiad				X	X
Grassleaf pondweed				X	X
Coontail				X	X
Nuttall waterweed				*	X
Floating pondweed					X
Largeleaf pondweed					X
Leafy pondweed					X
Ribbonleaf pondweed					X
Robinson pondweed					X
Variableleaf pondweed					X
Pinnate watermilfoil					X
Slender watermilfoil					X
Waternymph					X
Waterstargrass					X
Nitella					X
Spirogyra					X
Northern naiad			*		X

The classifications used by Stewart (1962) and the equivalents used in this table are: coastal bays (saline); salt estuarine bays (highly brackish); brackish estuarine bays (moderately brackish); slightly brackish estuarine bays (slightly brackish); fresh estuarine bays (fresh).

*Asterisks indicate occurrences that were mentioned by Anderson (1972) that are outside the limits of salinity that were described by Stewart (1962). The extension of Nuttal waterweed is based on data from Phillip and Brown (1965). Spaghettigrass *(Codium fragile* ssp. *tomentosoides)*, a filamentous green alga reported from Virginia (Hillson 1975), grows in salinities that range from 17.5 to 40 ppt (Good and others 1978).

During the early 1960's, Stewart (1962) reported that submerged vegetation was absent from the segment of the estuary of the Potomac River from the boundary of the District of Columbia downstream to Chicamuxen Creek, in Charles County, Maryland. There were, however, extensive beds of submerged plants in the fresh waters of the estuary from Chicamuxen Creek to Maryland Point. These waters were moderately turbid and, apparently as a result, the submerged vegetation was restricted to narrow bands in the shallow areas near the shores. Wildcelery, southern naiad, redhead pondweed, and common waterweed were the most common native plants.

Eurasian watermilfoil, an introduced species, first was observed in the Chesapeake Bay Region during the 1870's at a locality in the Potomac River south of Alexandria, Virginia (Ward 1881; Reed 1977). The plant drew little notice during the ensuing sixty years or so. Then it became aggressive and colonies appeared throughout the upper Potomac River estuary during the 1940's or 1950's. During the 1950's and early 1960's, Eurasian watermilfoil spread explosively throughout the Chesapeake Bay (Springer and Stewart 1959; Steenis and King 1964; Elser 1966; Bayley and others 1968, 1978). This spread was curtailed sharply about 1963, and since then the Eurasian watermilfoil has been declining in abundance throughout the region. This decline apparently is the result of the interaction of high turbidities and disease (Elser 1966, 1967; Bean and others 1972, 1973; Southwick and Pine 1975).

Changes in the extent and composition of the submerged vegetation on the Susquehanna Flats, at the northern end of Chesapeake Bay, were followed closely by Bayley and others (1978) from 1958 through 1975. The changes appear to be similar to those which occurred in the upper estuary of the Potomac River several decades earlier.

During the late 1950's, submerged native vegetation was luxuriant on the Susquehanna Flats (Stewart 1962). Wildcelery and southern naiad ordinarily were the most abundant plants at depths that ranged from 1.5 to 8 feet. Muskgrasses, which are algae, generally were predominant in shallower areas, particularly where the bottom was formed by compacted sand. Pondweeds of several species, coontail, waternymph, common waterweed, waterstargrass, nitella, and spirogyra also grew in the area, and were most abundant at depths that ranged from 1.5 to 6 feet.

Eurasian watermilfoil was found at 1% of the stations that were considered to be suitable for plant growth on the Susquehanna Flats during 1958. By 1961, the aggressive introduced plant was encountered at 89% of the stations (Bayley and others 1978). The extent of the predominant native species of submerged plants remained relatively constant during this period of rapid colonization by the Eurasian watermilfoil. During 1962, however, the beds of milfoil spread and became more dense, and the extent of all of the native species declined dramatically.

Subsequent to 1962, the population of Eurasian watermilfoil declined more or less regularly from year to year. Concurrently, stands of the native wildcelery, naiads, and common waterweed increased in number and size. By 1966, the population of wildcelery was judged to be more than half as great as its pre-1962 levels, and from 1966 to 1971 wildcelery was more abundant than Eurasian watermilfoil.

The general trend toward recovery that was observed during the mid- and late 1960's was restricted primarily to areas in which the water was less than 4.5 feet deep at times of mean low water. The factors that were responsible for the reduction in the amount of submerged vegetation in areas of deeper water are unknown. It appears, however, that the increased turbidity of the water, with the concomitant reduction in the penetration of light, may be the primary deterrent to the survival of submerged plants in these habitats.

The recovery of the submerged vegetation was terminated abruptly by the effects of tropical storm Agnes which passed through the Chesapeake Bay region during June 1972 (Anderson and others 1973). The populations of all the submerged plants on the Susquehanna Flats virtually were annihilated and they remained low throughout the remainder of the period of observations (Bayley and others 1978).

Prior to the regional decline that followed tropical storm Agnes, the abundance of submerged aquatic plants varied greatly from place to place in the fresh estuarine bay marshes of the Upper Chesapeake Region (Stewart 1962). Submerged vegetation was sparse and scattered in the extensive marshes along the upstream section of the Blackwater River, apparently as a result of the intense color of the water. Elsewhere in Dorchester County, sago pondweed occurred in most marsh areas, and other kinds of submerged plants were common locally. In Savannah Lake, which is a large marsh pond, wildcelery, redhead pondweed, sago pondweed, pinnate watermilfoil, and slender watermilfoil formed extensive, mixed beds. Wildcelery, southern naiad, common waterweed, curlyleaf pondweed, grassleaf pondweed, coontail, and stoneworts were the principal species of submerged plants that occurred in the marshes along the "necks" of Baltimore County and Harford County.

The two principal areas of slightly brackish estuarine bays that were recognized by Stewart (1962) are: the estuary of the Potomac River, from Cobb Island to Maryland Point in Charles County, including the Wicomico River, the Port Tobacco River and Nanjemoy Creek; and the western shore of Chesapeake Bay, from Pinehurst in Anne Arundel County, to Leges Point on Gunpowder Neck in Harford County. The latter area includes the Patapsco River, Back River, Middle River, and Seneca Creek and the downstream section of the Gunpowder River. Minor areas are: the upstream sections of the estuaries of the Magothy River and the Severn River and the eastern shore of Chesapeake Bay in Kent County, from Swan Point to Worton Point.

Except for sections that have been polluted severely with domestic or industrial wastes, the shallower parts of all of these areas support luxuriant stands of submerged plants. In some places, beds of submerged plants had been destroyed, at times, by waterfowl, by clam-dredging operations or by control measures designed to clear areas for swimming or boating. Redhead pondweed, wildcelery, and wigeongrass were the most abundant plants. Sago pondweed, grassleaf pondweed, horned pondweed, southern naiad, common waterweed, stoneworts, and several kinds of red algae also were relatively common and widely distributed. Curlyleaf pondweed and coontail occurred in a few, scattered patches. In the Potomac estuary, Eurasian watermilfoil formed dense, nearly pure stands in sheltered coves and in the tidewater segments of tributary streams.

The shallower parts of most of the brackish estuarine bays of the Upper Chesapeake Region supported extensive, widely distributed beds of submerged plants (Stewart 1962). Wigeongrass was the most abundant species (Phillip and Brown 1965; Orth 1975); redhead pondweed and sago pondweed also were principal components of these beds. Eelgrass was abundant in several areas. Other species that were common locally include: common waterweed, sealettuce, enteromorpha, and two or three kinds of red algae. Horned pondweed grew in some areas in scattered patches, and Eurasian watermilfoil was abundant in many coves and tributaries in the Potomac River estuary.

The tidal creeks, guts, and ponds in the marshes that fringe the moderately brackish bays of the Upper Chesapeake Region generally are highly turbid, and their silt-laden waters scour the bottoms and sides of the channels.

Apparently as a result of these conditions, submerged plants are absent from, or are relatively scarce in, these habitats (Stewart 1962). In permanent ponds on the marsh surface, however, wigeongrass generally was the predominant plant. Stoneworts were abundant in some ponds, and sago pondweed was present in a few ponds.

Eelgrass, wigeongrass, and sealettuce were the most widely distributed submerged plants in the highly brackish estuarine bays of the Upper Chesapeake Region (Stewart 1962). Sago pondweed was abundant in several places; horned pondweed and enteromorpha occurred in very widely scattered patches; and two or three kinds of red algae were common and widely distributed over the bay bottoms. Wigeongrass also was abundant in the ponds and creeks in the marshes that adjoin the highly brackish bays.

The shallow sections of the saline, coastal bays supported small, scattered beds of sealettuce, enteromorpha, and several kinds of red and brown algae (Stewart 1962). Prior to a widespread dieback during the 1920's and early 1930's, extensive stands of eelgrass were characteristic of these coastal bays (Cottam and Munro 1954). A gradual regrowth of eelgrass in many parts of Chesapeake Bay was documented from aerial photographs by Burkholder and Doheny (1968). During the 1970's, however, large areas of eelgrass have been destroyed by the rooting of cownose rays which feed on mollusks in the underlying sediments (Orth 1975).

Sealettuce generally grows at the mouths of tidal creeks in the saline wetlands adjacent to the coastal bays. Sparse stands of wigeongrass grow in permanent ponds that dot the wetlands, and the stands may be better developed in artificial ponds that have been formed behind gut plugs or small dams.

During August and September of the four years from 1971 through 1974, Kerwin, Munro, and Peterson (1976) sampled the submerged vegetation at 613 to 629 stations in Chesapeake Bay north of the mouth of the Potomac River. Their study began in the year prior to tropical storm Agnes (June 1972) and continued for two years after that storm.

Submerged vegetation was found at 29% of the stations that were sampled during 1971, but at only 21% of the stations during 1972 and at 10% during 1973. The decline of submerged vegetation apparently was checked after 1973, because plants were found at 15% of the stations during 1974.

Throughout the period, although its frequencies varied from year to year, wigeongrass was the most common species of submerged flowering plant. Eelgrass was the second most common species during 1971 and 1972, but it declined to fourth most common in 1973. Redhead pondweed was the third most common species in 1971. After tropical storm Agnes in 1972, sago pondweed became the third most common flowering plant. In 1973 and 1974, redhead pondweed was the second most common species. Sago pondweed remained as the third ranked species in 1973, but eelgrass became third most common during 1974.

Environmental measures indicated slight variations in the average depth of the water and in the average temperature of the water during the four-year period. The most marked difference, however, was in salinity. According to the authors, "Salinity decreased uniformly and significantly over the. . .[northern section of the] Bay by an average of 5.78 ppt from 1971 to 1972." The average salinity during 1972 was 15.44 ppt. The average decreased after tropical storm Agnes to 9.66 ppt during 1972. It increased to 10.37 ppt in 1973 and to 13.49 ppt during 1974. The transparency of the water was not measured during 1971. During 1972 and 1973, the average transparencies were nearly equal. The average transparency during 1974, however, was significantly greater. Salinity and turbidity, therefore, appear to be related to the growth, distribution, and abundance of submerged plants.

1.3 SUMMARY OF WETLANDS BY COUNTIES AND WATERSHEDS

The area covered by each type of wetland vegetation was estimated by grid counts on the approximately 2,000 wetland photomaps. A standard grid was used on which two series of lines, spaced 1.04 inches apart, were inscribed at right angles to form a series of squares. At the scale of the photomaps (1 inch equals 200 feet), each square represented an area of 1 acre.

To estimate the acreages of the types that were represented on a particular photomap, the grid was placed over the map. The point at the top, left side of each square on the grid was considered to represent that square, or to characterize the 1 acre outlined by the square. One technician examined the grid to determine the type of vegetation that was present at each grid point in wetland areas. A second technician recorded these determinations by vegetation type.

Grid points that fell in mixed types of vegetation (i.e., 41/51/47) were recorded as the predominant type of the mixture (e.g., 41 in this example). Rosemallow and smartweeds commonly were recorded as associated types in mixed stands, so the calculated acreages of these types understate the actual areas on which they occur.

The scheme that was utilized to designate watersheds and to number sub-basins is illustrated in Figure 39. The acreages of coastal wetlands in these watersheds are summarized in Table 13. These data indicate that 66.4% of the coastal wetlands of Maryland are concentrated in the watersheds of the Pocomoke River, Nanticoke River, and Choptank River on the Eastern Shore. The acreages of the individual wetland types are summarized for each watershed in Table 14, and these measurements are expressed as percentages in Table 15.

More than a third (36.4%) of the coastal wetlands of Maryland are included in Dorchester County, and more than a quarter (26.0%) are located in Somerset County (Table 16). The acreages of the 35 types of wetland vegetation are analyzed by county in Table 17, and the measurements are expressed as percentages in Table 18.

1.4. THE FLORA OF THE WETLANDS

The vascular plants of Maryland were cataloged by Norton and Brown (1946). Although these authors included all of the larger plants that occur in the coastal wetlands, their list does not specify habitats or localities from which the plants were collected, and it does not consider vegetation types.

A comprehensive flora of the intertidal zone of Chesapeake Bay was prepared by Krauss and others (1970). This list is arranged taxonomically, and it is annotated to characterize briefly the salinity regimes in which most of the species grow. There are no descriptions, however, of vegetation types or of their components.

An annotated list of the plants that were collected from twelve marsh areas in the Maryland section of the Chesapeake estuary was compiled by Thompson (1974). Although this checklist is not a complete flora of the intertidal zone, it includes 453 species of vascular plants which represent 79 families.

Figure 39. Major watersheds and corresponding sub-basin designation numbers in the tidewater counties of Maryland. Code numbers are defined in Table 13.

Table 13. Total area of coastal wetlands in the major watersheds of Maryland. The measurements are expressed in terms of acres and as percentages of the total area of coastal wetlands in the State.

SUB-BASIN DESIGNATION	WATERSHED	ACRES	PERCENTAGE
02-12-02	Lower Susquehanna River	841	0.3
02-13-01	Coastal Area	17,225	6.6
02-13-02	Pocomoke River	53,246	20.4
02-13-03	Nanticoke River	83,409	31.9
02-13-04	Choptank River	36,877	14.1
02-13-05	Chester River	16,204	6.2
02-13-06	Elk River	3,848	1.5
02-13-07	Bush River	5,992	2.3
02-13-08	Gunpowder River	2,599	1.0
02-13-09	Patapsco River	819	0.3
02-13-10	West Chesapeake Bay	3,419	1.3
02-13-11	Patuxent River	6,773	2.6
02-13-99	Chesapeake Bay	21,321	8.2
02-14-01	Lower Potomac River	8,438	3.2
02-14-02	Washington Metropolitan Area	298	0.1
	Total	261,309	100.0

Table 14. Acreages of the 35 types of coastal wetland vegetation in the 15 major watersheds of Maryland. The letter "a" indicates that stands of that type were present, but were not measured by the method of estimation.

	ACREAGE															
TYPE	LSus	CstA	Poco	Nant	Chop	Ches	Elk	Bush	Gunp	Ptap	WChB	Ptux	ChBa	LPot	Wash	TOTAL BY TYPE
Shrub Swamp Category																
11	0	0	0	0	8	0	0	1	0	0	10	25	0	7	0	51
12	4	0	1	0	0	0	120	11	11	1	0	339	0	7	30	524
13	1	29	75	897	150	34	482	52	13	1	22	97	0	167	5	2,025
Wooded Swamp Category																
21	0	2	4,152	0	0	0	0	0	0	0	0	0	0	0	0	4,154
22	4	35	2,884	7,024	1,066	19	144	103	4	0	2	14	0	12	80	11,391
23	0	4	159	866	133	0	0	73	0	0	1	6	0	11	0	1,253
Fresh Marsh Category																
30	9	4	454	360	241	19	312	95	99	89	7	889	0	252	94	2,924
31	0	0	143	769	597	6	21	17	5	0 [a]	0	132	0	26	58	1,774
32	6	0	77	1,254	945	238	497	459	144	21	0	128	0	155	1	3,925
33	2	0	0	169	7	5	61	145	25	0	1	15	0	0	1	431
34	13	0	166	1,394	1,035	473	1,248	2,442	1,064	256	14	714	2	186	11	9,018
35	0	0	105	44	52	10	113	657	212	12	0	25	0	26	0	1,256
36	0	0	3	196	26	0	112	154	39	0	0	237	0	0	9	776
37	0	0	0	1,041	145	23	25	906	393	89	0	73	0	104	9	2,808
38	0	0	348	386	186	246	0	239	63	4	0	122	0	310	0	1,904
39	1	0	0	32	3	20	104	139	71	94	0	270	13	0	0	747
Brackish High Marsh Category																
41	0	18	10,716	9,775	5,630	1,759	7	2	0	18	442	384	1,557	764	0	31,072
42	0	50	2,441	1,582	2,965	1,694	4	2	1	17	350	337	383	733	0	10,559
43	0	0	13,177	15,156	8,909	296	0	0	0	0	0	2	11,036	109	0	48,685
44	0	46	186	2,212	674	685	97	0	22	34	615	838	0	282	0	5,691
45	0	2	4	52	26	19	34	0	0	1	12	42	7	82	0	281
46	0	23	251	1,144	474	72	0	139	23	5	15	11	3	5	0	2,165
47	0	348	1,102	15,078	812	338	26	0	18	6	60	362	15	800	0	18,965
48	0	0	868	4,295	621	227	0	0	0	2	19	865	1	1,298	0	8,196
49	0	26	34	481	92	169	11	0	1	29	80	25	1	6	0	955
Brackish Low Marsh Category																
51	0	26	5,066	15,731	1,490	505	11	0	14	61	424	449	528	774	0	25,079
Saline High Marsh Category																
61	0	2,304	0	0	0	0	0	0	0	0	0	0	0	0	0	2,304
62	0	1,780	0	0	0	0	0	0	0	0	0	0	0	0	0	1,780
63	0	121	0	0	0	0	0	0	0	0	0	0	0	0	0	121
Saline Low Marsh Category																
71	0	95	0	0	0	0	0	0	0	0	0	0	0	0	0	95
72	0	9,449	0	0	0	0	0	0	0	0	0	0	0	0	0	9,449
Open Water Category																
80	0	638	1,689	2,080	344	213	100	13	17	16	55	177	178	36	0	5,556
Mudflat/Sandbar/Beach Category																
81	2	136	7	214	46	176	25	46	33	58	47	15	46	1	0 [a]	852
91	2	503	81	52	91	33	12	38	7	4	11	8	51	52	0	945
Submerged Aquatics Category																
101	797	1,586	9,057	1,098	10,109	8,925	282	259	320	1	1,232	51	7,500	1,092	0	42,309
Untyped Wetlands	0	0	0	27	0	0	0	0	0	0	0	121	0	1,141	0	1,289

Table 15. Percentage of the wetlands in each major watershed that is composed of a particular type. The letter "a" indicates that stands of that type were present, but were not measured by the method of estimation.

	PERCENTAGE														
TYPE	LSus	CstA	Poco	Nant	Chop	Ches	Elk	Bush	Gunp	Ptap	WChB	Ptux	ChBa	LPot	Wash
Shrub Swamp Category															
11	0	0	0	0	<0.1	0	0	<0.1	0	0	0.3	0.4	0	0.1	0
12	0.5	0	<0.1	0	0	0	3.1	0.2	0.4	0.1	0	5.0	0	0.1	10.1
13	0.1	0.2	0.1	1.1	0.4	0.2	12.5	0.9	0.5	0.1	0.6	1.4	0	2.0	1.7
Wooded Swamp Category															
21	0	<0.1	7.8	0	0	0	0	0	0	0	0	0	0	0	0
22	0.5	0.2	5.4	8.4	2.9	0.1	3.7	1.7	0.2	0	0.1	0.2	0	0.1	26.8
23	0	<0.1	0.3	1.0	0.4	0	0	1.2	0	0	<0.1	0.1	0	0.1	0
Fresh Marsh Category															
30	1.1	<0.1	0.9	0.4	0.7	0.1	8.1	1.6	3.8	10.9	0.2	13.1	0	3.0	31.5
31	0	0	0.3	0.9	1.6	<0.1	0.5	0.3	0.2	0 [a]	0	1.9	0	0.3	19.5
32	0.7	0	0.1	1.5	2.6	1.5	12.9	7.7	5.5	2.6	0	1.9	0	1.8	0.3
33	0.2	0	0	0.2	<0.1	<0.1	1.6	2.4	1.0	0	<0.1	0.2	0	0	0.3
34	1.5	0	0.3	1.7	2.8	2.9	32.4	40.8	40.9	31.3	0.4	10.5	<0.1	2.2	3.7
35	0	0	0.2	0.1	0.1	0.1	2.9	11.0	8.2	1.5	0	0.4	0	0.3	0
36	0	0	<0.1	0.2	0.1	0	2.9	2.6	1.5	0	0	3.5	0	0	3.0
37	0	0	0	1.2	0.4	0.1	0.6	15.1	15.1	10.9	0	1.1	0	1.2	3.0
38	0	0	0.7	0.5	0.5	1.5	0	4.0	2.4	0.5	0	1.8	0	3.7	0
39	0.1	0	0	<0.1	<0.1	0.1	2.7	2.3	2.7	11.5	0	4.0	0.1	0	0
Brackish High Marsh Category															
41	0	0.1	20.1	11.7	15.3	10.9	0.2	<0.1	0	2.2	12.9	5.7	7.3	9.1	0
42	0	0.3	4.6	1.9	8.0	10.5	0.1	<0.1	<0.1	2.1	10.2	5.0	1.8	8.7	0
43	0	0	24.7	18.2	24.2	1.8	0	0	0	0	0	<0.1	51.8	1.3	0
44	0	0.3	0.3	2.7	1.8	4.2	2.5	0	0.8	4.2	18.0	12.4	0	3.3	0
45	0	<0.1	<0.1	0.1	0.1	0.1	0.9	0	0	0.1	0.4	0.6	<0.1	1.0	0
46	0	0.1	0.5	1.4	1.3	0.4	0	2.3	0.9	0.6	0.4	0.2	<0.1	0.1	0
47	0	2.0	2.1	18.1	2.2	2.1	0.7	0	0.7	0.7	1.8	5.3	0.1	9.5	0
48	0	0	1.6	5.1	1.7	1.4	0	0	0	0.2	0.6	12.8	<0.1	15.4	0
49	0	0.2	0.1	0.6	0.2	1.0	0.3	0	<0.1	3.5	2.3	0.4	<0.1	0.1	0
Brackish Low Marsh Category															
51	0	0.2	9.5	18.9	4.0	3.1	0.3	0	0.5	7.4	12.4	6.6	2.5	9.2	0
Saline High Marsh Category															
61	0	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	10.3	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0
Saline Low Marsh Category															
71	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	54.9	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Water Category															
80	0	3.7	3.2	2.5	0.9	1.3	2.6	0.2	0.7	2.0	1.6	2.6	0.8	0.4	0
Mudflat/Sandbar/Beach Category															
81	0.2	0.8	<0.1	0.3	0.1	1.1	0.6	0.8	1.3	7.1	1.4	0.2	0.2	<0.1	0 [a]
91	0.2	2.9	0.2	0.1	0.2	0.2	0.3	0.6	0.3	0.5	0.3	0.1	0.2	0.6	0
Submerged Aquatic Category															
101	94.8	9.2	17.0	1.3	27.4	55.1	7.3	4.3	12.3	0.1	36.0	0.8	35.2	12.9	0
Untyped Wetlands	0	0	0	<0.1	0	0	0	0	0	0	0	1.8	0	13.5	0

Table 16. Total area of coastal wetlands in the tidewater counties of Maryland. The measurements are expressed in terms of acres and as percentages of the total area of coastal wetlands in the State.

COUNTY	ACRES	PERCENTAGE
Anne Arundel	3,643	1.4
Baltimore	2,400	0.9
Calvert	2,695	1.0
Caroline	3,392	1.3
Cecil	3,212	1.2
Charles	5,769	2.2
Dorchester	95,217	36.4
Harford	7,036	2.7
Kent	7,974	3.1
Prince George's	2,801	1.1
Queen Anne's	7,912	3.0
Somerset	67,990	26.0
St. Mary's	4,176	1.6
Talbot	9,183	3.5
Wicomico	13,753	5.3
Worcester	24,156	9.2
Total	261,309	100.0

Table 17. Acreages of the 35 types of coastal wetland vegetation in the 16 tidewater counties of Maryland. The letter "a" indicates that stands of that type were present, but were not measured by the method of estimation.

	ACREAGE																
TYPE	AnAr	Balt	Calv	Caro	Cec	Char	Dor	Harf	Kent	PrGe	QuAn	Somr	StMa	Talb	Wico	Worc	TOTAL BY TYPE
Shrub Swamp Category																	
11	35	0	0	3	0	7	0	1	0	0	0	0	0	5	0	0	51
12	84	10	6	0	124	1	0	13	0	263	0	1	22	0	0	0	524
13	32	6	18	2	157	165	906	59	354	40	4	67	37	27	110	41	2,025
Wooded Swamp Category																	
21	0	0	0	0	0	0	0	0	0	0	0	559	0	0	0	3,595	4,154
22	16	3	0	871	77	11	5,727	104	83	80	7	519	1	188	1,304	2,400	11,391
23	1	0	0	0	0	3	806	73	0	0	0	181	14	0	171	4	1,253
Fresh Marsh Category																	
30	228	147	25	196	305	248	173	127	26	740	7	63	12	40	180	407	2,924
31	43	3	6	466	10	26	430	19	17	141	0	0	0	118	352	143	1,774
32	31	129	79	572	413	155	283	496	229	20	86	61	0	381	952	38	3,925
33	14	25	0	2	61	0	12	146	5	3	0	11	0	6	146	0	431
34	151	835	195	393	904	186	934	2,909	636	421	152	132	0	667	400	103	9,018
35	6	81	11	7	60	18	11	800	54	8	9	26	8	44	33	80	1,256
36	113	35	28	6	112	0	132	158	0	105	0	0	0	5	79	3	776
37	0	431	4	35	25	104	1,038	957	23	78	0	0	0	110	3	0	2,808
38	0	59	14	12	0	310	85	247	223	108	23	190	0	172	284	177	1,904
39	23	140	66	1	98	0	7	176	17	183	9	1	0	2	24	0	747
Brackish High Marsh Category																	
41	315	47	303	1	0	349	12,728	2	706	22	935	13,236	605	552	1,253	18	31,072
42	313	20	190	13	0	276	3,361	2	524	2	897	3,057	640	1,076	133	55	10,559
43	0	0	2	0	0	7	23,131	0	7	0	281	22,543	102	122	2,490	0	48,685
44	369	30	664	196	0	237	2,330	0	192	171	493	197	320	380	66	46	5,691
45	12	8	7	1	0	43	26	0	34	0	15	4	74	27	28	2	281
46	9	20	10	120	0	0	1,301	150	52	0	18	253	12	80	112	28	2,165
47	21	39	220	203	0	669	14,891	0	296	126	65	1,656	186	46	199	348	18,965
48	21	0	447	232	0	970	2,167	0	13	274	212	1,093	472	314	1,981	0	8,196
49	82	4	36	0	0	3	488	0	61	8	105	38	9	78	17	26	955
Brackish Low Marsh Category																	
51	380	31	331	35	0	320	12,280	0[a]	398	8	104	6,901	653	341	3,271	26	25,079
Saline High Marsh Category																	
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,304	2,304
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,780	1,780
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	121

Table 17. Acreages of the 35 types of coastal wetland vegetation in the 16 tidewater counties of Maryland. The letter "a" indicates that stands of that type were present, but were not measured by the method of estimation (Concluded).

TYPE	AnAr	Balt	Calv	Caro	Cec	Char	Dor	Harf	Kent	PrGe	QuAn	Somr	StMa	Talb	Wico	Worc	TOTAL BY TYPE
	ACREAGE																
Saline Low Marsh Category																	
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	95
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9,449	9,449
Open Water Category																	
80	55	10	16	22	0	16	2,271	37	140	0	134	1,829	189	131	68	638	5,556
Mudflat/Sandbar/Beach Category																	
81	46	91	16	3	0[a]	0	210	48	85	0	107	18	1	20	71	136	852
91	11	17	1	0	5	0	98	40	8	0	21	119	59	37	26	503	945
Submerged Aquatic Category																	
101	1,232	179	0	0	861	383	9,391	472	3,791	0	4,228	15,208	760	4,214	0	1,590	42,309
Untyped Wetlands	0	0	0	0	0	1,262	0	0	0	0	0	27	0	0	0	0	1,289

Table 18. Percentage of the coastal wetlands in each county that is composed of a particular type. The letter "a" indicates that stands of that type were present, but were not measured by the method of estimation.

TYPE	AnAr	Balt	Calv	Caro	Cec	Char	Dor	Harf	Kent	PrGe	QuAn	Somr	StMa	Talb	Wico	Worc
	PERCENTAGE															
Shrub Swamp Category																
11	1.0	0	0	0.1	0	0.1	0	<0.1	0	0	0	0	0	0.1	0	0
12	2.3	0.4	0.2	0	3.9	<0.1	0	0.2	0	9.4	0	<0.1	0.5	0	0	0
13	0.9	0.3	0.7	0.1	4.9	2.9	1.0	1.1	4.4	1.4	0.1	0.1	0.9	0.3	0	0.2
Wooded Swamp Category																
21	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	14.9
22	0.4	0.1	0	25.7	2.4	0.2	6.0	1.5	1.0	2.9	0.1	0.8	<0.1	2.0	9.5	9.9
23	<0.1	0	0	0	0	0.1	0.8	1.0	0	0	0	0.3	0.3	0	1.2	<0.1
Fresh Marsh Category																
30	6.3	6.1	0.9	5.8	9.5	4.3	0.2	1.8	0.3	26.4	0.1	0.1	0.3	0.4	1.3	1.7
31	1.2	0.1	0.2	13.7	0.3	0.5	0.5	0.3	0.2	5.0	0	0	0	1.3	2.6	0.6
32	0.9	5.4	2.9	16.9	12.9	2.7	0.3	7.0	2.9	0.7	1.1	0.1	0	4.2	6.9	0.2
33	0.4	1.0	0	0.1	1.9	0	<0.1	2.1	0.1	0.1	0	<0.1	0	0.1	1.1	0
34	4.1	34.8	7.2	11.6	28.1	3.2	1.0	41.3	8.0	15.0	1.9	0.2	0	7.3	2.9	0.4
35	0.2	3.4	0.4	0.2	1.9	0.3	<0.1	11.4	0.7	0.3	0.1	<0.1	0.2	0.5	0.2	0.3
36	3.1	1.5	1.0	0.2	3.5	0	0.1	2.2	0	3.7	0	0	0	0.1	0.6	<0.1
37	0	18.0	0.1	1.0	0.8	1.8	1.1	13.6	0.3	2.8	0	0	0	1.2	<0.1	0
38	0	2.5	0.5	0.4	0	5.4	0.1	3.5	2.8	3.9	0.3	0.3	0	1.9	2.1	0.7
39	0.6	5.8	2.4	<0.1	1.0	0	<0.1	2.5	0.2	6.5	0.1	<0.1	0	<0.1	0.2	0
Brackish High Marsh Category																
41	8.6	2.0	11.2	<0.1	0	6.0	13.4	<0.1	8.9	0.8	11.8	19.5	14.5	6.0	9.1	0.1
42	8.6	0.8	7.1	0.4	0	4.8	3.5	<0.1	6.6	0.1	11.3	4.5	15.3	11.7	1.0	0.2
43	0	0	0.1	0	0	0.1	24.3	0	0.1	0	3.6	33.2	2.4	1.3	18.1	0
44	10.1	1.3	24.6	5.8	0	4.1	2.4	0	2.4	6.1	6.2	0.3	7.7	4.1	0.5	0.2
45	0.3	0.3	0.3	<0.1	0	0.7	<0.1	0	0.4	0	0.2	<0.1	1.8	0.3	0.2	<0.1
46	0.2	0.8	0.4	1.5	0	0	1.4	2.1	0.7	0	0.2	0.4	0.3	0.9	0.8	0.1
47	0.6	1.6	8.2	6.0	0	11.6	15.6	0	3.7	4.5	0.8	2.4	4.5	0.5	1.4	1.4
48	0.6	0	16.6	6.8	0	16.8	2.3	0	0.2	9.8	2.7	1.6	11.3	3.4	14.4	0
49	2.3	0.2	1.3	0	0	0.1	0.5	0	0.8	0.3	1.3	0.1	0.2	0.9	0.1	0.1
Brackish Low Marsh Category																
51	10.4	1.3	12.3	1.0	0	5.5	12.9	0[a]	5.0	0.3	1.3	10.2	15.6	3.7	23.8	0.1
Saline High Marsh Category																
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.5
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.4
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5

Table 18. Percentage of the coastal wetlands in each county that is composed of a particular type. The letter "a" indicates that stands of that type were present, but were not measured by the method of estimation (Concluded).

TYPE	PERCENTAGE															
	AnAr	Balt	Calv	Caro	Cec	Char	Dor	Harf	Kent	PrGe	QuAn	Somr	StMa	Talb	Wico	Worc
Saline Low Marsh Category																
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39.1
Open Water Category																
80	1.5	0.4	0.6	0.6	0	0.3	2.4	0.5	1.8	0 [a]	1.7	2.7	4.5	1.4	0.5	2.6
Mudflat/Sandbar/Beach Category																
81	1.3	3.8	0.6	0.1	0 [a]	0	0.2	0.7	1.1	0	1.4	<0.1	<0.1	0.2	0.5	0.6
91	0.3	0.7	<0.1	0	0.2	0	0.1	0.6	0.1	0	0.3	0.2	1.4	0.4	0.2	2.1
Submerged Aquatics Category																
101	33.8	7.5	0	0	26.9	6.6	9.9	6.7	47.5	0	53.4	22.4	18.2	45.9	0	6.6
Untyped Wetlands	0	0	0	0	0	21.9	0	0	0	0	0	<0.1	0	0	0	0

1.5. PREVIOUS CLASSIFICATIONS OF THE COASTAL WETLANDS OF MARYLAND

The earliest detailed study of the wetlands of Maryland, including those of the coastal zone, was conducted during 1908 by the Maryland Conservation Commission (1910). This survey was initiated to identify areas that "should be made available for agricultural purposes." Wetlands in the coastal area were categorized as freshwater swamps or saltwater marshes.

During the early 1950's, the Department of Natural Resources and the Department of Research and Education mapped the marshes of the Eastern Shore and the Atlantic coast of Maryland (Nicholson and Van Deusen 1953, 1954). The marshes were categorized according to six general types. Species of plants that form substantial portions of the vegetation apparently were the key identification features. The types used were:

Type I. Cattail-aquatic type
This type occurs in the upper reaches of fresh to very slightly brackish, tidal rivers and streams. The abundance of cattail varies, but it forms thick, extensive stands in some areas. Pickerelweed, wildrice, arrowarum, spikerushes, sedges, grasses, smartweeds, and Walter millet also contribute to the emergent vegetation.

Type II. Threesquare-cattail type
Marshes that are similar to the cattail-aquatic type, but contain Olney threesquare, meadow cordgrass, and smooth cordgrass, which are more characteristic of brackish areas, are classed as Type II wetlands. These marshes occur along the slightly brackish sections of the larger tidal rivers and streams. Big cordgrass forms stands along the banks of the streams in most of these areas. Other plants that may be relatively abundant in the vegetation are arrowarum, grasses, pickerelweed, sedges, spikerushes, smartweeds, and Walter millet.

Type III. Threesquare type
The threesquare type is restricted to the upper sections of the Blackwater River and its tributaries. Stands of Olney threesquare cover most of the area in which this type is recognized. Small stands of cattail may occur in the matrix of threesquare, and big cordgrass grows in narrow stands along the banks of the larger streams. Tidal fluctuations are irregular, but areas of this type seldom are flooded deeply. The water ranges from slightly brackish in the most inland sections to moderately brackish in the lower part of the Blackwater River drainage area. Spikegrass, meadow cordgrass, smooth cordgrass, needlerush, and stout threesquare are of minor importance in the vegetation.

Type IV. Threesquare-saltmeadow-needlerush type
Olney threesquare, needlerush, and meadow cordgrass occur in about equal proportions in the infrequently flooded areas characterized as Type IV marshes. The threesquare typically grows in shallow, low sites which are moister than the remainder of the marsh. Spikegrass, smooth cordgrass, big cordgrass, and stout threesquare also contribute to the vegetation.

Type V. Needlerush-saltmeadow type
The sites on which Type V marshes occur are relatively dry and are flooded only occasionally by the tides. Needlerush and meadow cordgrass are predominant in the vegetation, but marshelder and groundselbush are common on ridges of higher ground. Switchgrass also may cover large areas of the marshes adjacent to their upland boundaries. Stout threesquare and spikegrass may be common locally.

Type VI. Saltmarsh type

Areas along the seaside bays of the Atlantic Ocean in Worcester County are flooded regularly by saline waters. Smooth cordgrass, which is the most abundant plant on these areas, may grow to heights of 2 to 3 feet along the banks of creeks and ditches, but on other sites it seldom exeeds 1 foot in height. Meadow cordgrass grows near the upland boundaries of these marshes, and marshelder and groundselbush occupy low ridges and knolls of higher ground which dot the marshes.

As part of a nationwide survey of wetlands, the United States Fish and Wildlife Service conducted an inventory of the wetlands of Maryland during 1953 and 1954 (Office of River Basin Studies 1954). The Service employed a slight modification of a scheme devised by Martin and others (1953) that was designed to be useful in the evaluation of wetlands in regard to wildlife utilization. This scheme was republished in Circular 39 of the Fish and Wildlife Service (Shaw and Fredine 1956). Circular 39 is a summary report on the results of the nationwide survey, and includes photographs, estimates of acreage, and range maps for the various wetland types. This report has been distributed widely, and the Martin scheme outlined in it has been used by many field workers, principally wildlife biologists, during the past two decades.

The primary features that serve as the basis for classification in the Martin system are: The geographic location of the wetland (inland, or non-tidal; coastal, or tidal); salinity (fresh; saline); the presence or absence of vegetation on the surface (swamp or marsh; open water); the depth of water during the growing season (shallow; deep); the frequency of flooding by tides (irregular; regular); and the growth form of the predominant plants (shrub swamp; wooded swamp; marsh). The following types were utilized in the coastal areas of Maryland for the Federal survey:

Inland Fresh Areas

Type 6—Shrub Swamps

The soil normally is saturated during the growing season, and may be covered by water to a depth of 0.5 feet. Alders, willows, and buttonbush are prominent in the vegetation.

Type 7—Wooded Swamps

The soil normally is saturated to within a few inches from the surface throughout the growing season, and may be covered by water to a depth as great as 1 foot. Red maple, sweetgum, cypress, pin oak, and river birch are common trees.

Coastal Fresh Areas

Type 12—Shallow Fresh Marshes

The soil is saturated throughout the growing season, and may be covered by water as much as 0.5 foot deep at high water slack. Cattails, common reed, big cordgrass, arrowarum, threesquares, and panicgrass, in nearly pure stands or in various mixtures, form the bulk of the vegetation.

Type 13—Deep Fresh Marshes

At high water slack, the soils in these marshes are covered by water 0.5 to 3 feet deep. Wildrice, pickerelweed, spatterdock, and cattail are the principal components of the vegetation.

Type 14—Open Fresh Water

This type is formed by shallow, more or less enclosed tidal ponds and pondlike areas that are susceptible to artificial drainage or filling. Pondweeds, naiads, muskgrass, or other submerged plants may occupy the bottoms.

Coastal Saline Areas

Type 16—Salt Meadows

Salt meadows seldom are flooded by the tides, but the soil is saturated throughout the growing season. Meadow cordgrass and spikegrass are the principal components of the vegetation, but threesquares grow in the fresher sections.

Type 17—Irregularly Flooded Salt Marshes

Wind tides occasionally flood the soils in marshes of this type. Needlerush is predominant in the vegetation, and wigeongrass grows in many of the ponds that are scattered through the marshes.

Type 18—Regularly Flooded Salt Marshes

The soils in marshes of this type are covered by water 0.5 feet or more in depth at mean high water slack. Smooth cordgrass is the principal component of the vegetation.

Type 19—Sounds and Bays

For the survey of Maryland wetlands, this type was limited to mud-flats which are exposed at mean low water slack. These areas generally are devoid of larger plants.

The maps of the Eastern Shore and Atlantic coastal marshes that had been prepared by the State agencies were adapted for use in the Federal inventory. Most marshes in Types I, II, and III of the Nicholson-Van Deusen Scheme were included in the Federal Type 12. Deep marshes in Type I, which were identified by reference to the United States Geological Survey topographic maps, were placed in Federal Type 13. Approximately 67% of the Type IV marshes and 50% of the Type V marshes were assigned to Federal Type 16; and the remainders were classed as Type 17 wetlands. No explanation of the determinants used to make these allocations was given. All Type VI marshes were categorized as Federal Type 18 wetlands.

During the period from July 1955 to January 1956, the Maryland Game & Inland Fish Commission (1956) conducted an "inventory of potential wetland developmental areas." Whereas the United States Fish and Wildlife Service (Office of River Basin Studies 1954) had conducted a survey of wetland areas in the Coastal Plain, and had limited the survey to areas that contain 40 acres or more, the Commission designed its study to be statewide and to survey areas of 0.5 acre or more which are of importance to most species of game and fur-bearing animals. Approximately one week was allocated for work in each county. Inspections were made in the field by one surveyor and a local game warden or wildlife field superintendent. Each wetland area was outlined on a topograpic map (scale, 1:62,500), and was rated as of high, medium, or low value for various kinds of animals.

Continuous units of wetland were subdivided, insofar as possible, according to the classification established by the United States Fish and Wildlife Service (Martin and others 1953). Several of the federal types, however, were redefined slightly to adapt them more closely to conditions in Maryland. In regard to areas that may be coastal wetlands, these changes were:

Type 6—Shrub Swamp
The description of the composition of the vegetation of shrub swamps was expanded to include young or cutover forests by adding "small maples and sweetgums." Swamp rose was listed as another type of shrub; dogwood and swamp privet were deleted; and associated herbs, including tearthumb, beggarticks, beggarlice, jewelweed, joe-pye-weed, loosestrife, and native grasses and sedges, were mentioned.

Type 7—Wooded Swamp
The Federal description of composition was deleted, and red maple, river birch, sweetgum, pin oak, and cypress were listed as the principal trees. Sycamore, oaks, tuliptree, blacklocust, elms, beech, ash, walnuts, hickories, aspen, poplar, blackgum, and other oaks and maples were described as other important trees that compose wooded swamps. Sweetbay, pawpaw, holly, spicebush, winterberry, blackberry, greenbrier, honeysuckle, and grapes were noted to be present in the undergrowth as smaller trees, shrubs, and vines. Herbaceous plants, including lizardtail, nettle, beggarlice, burmarigolds, touch-me-not, and various grasses and sedges, were described as components of the forest floor growth.

Type 12—Shallow Fresh Marsh (Coastal)
A new list of the principal component species was substituted for the Federal description. These marshes were described as composed mostly of cattails, common reed, big cordgrass, arrowarum, pickerelweed, goldenclub, threesquares, panicgrasses, and rosemallows. Walter millet, swamp rose, rice cutgrass, waterparsnip, waterhemp, meadow cordgrass, smooth cordgrass, waxmyrtle, marshelder, and groundselbush were listed as associated plants.

Type 13—Deep Fresh Marsh (Coastal)
Waterlilies, arrowarum, goldenclub, smartweeds, and tearthumbs were added to the list of the principal species of plants in the vegetation of these marshes. Open water areas within the marshes were described as habitats for such submerged plants as coontail and wildcelery, as well as for pondweeds.

Type 14—Open Fresh Water (Coastal)
This type was redefined to include "shallow, more or less enclosed, tidal ponds or pondlike areas susceptible to drainage or fill." Wigeongrass was added to pondweeds, naiads, coontail, waterweeds, and muskgrasses in the list of submerged aquatic plants that may be common at depths as great as 6 feet, and wildcelery and milfoils were deleted. The areas also were described as being bordered by cattail, meadow cordgrass, common reed, smooth cordgrass, myrtles, marshelder, groundselbush, and threesquares.

Type 16—Salt Meadows (Coastal)
Meadow cordgrass and spikegrass were retained in the description of principal species, but blackrush was deleted. The description also was revised to indicate that the main vegetation is interrupted by patches of, or bordered by, smooth cordgrass, big cordgrass, threesquares, needlerush, myrtles, marshelders, groundselbush, and panicgrasses.

Type 17—Irregularly Flooded Salt Marshes
The Federal description was supplemented by a list of associated species. These are smooth cordgrass, meadow cordgrass, and marshelder.

Type 18—Regularly Flooded Salt Marshes
Meadow cordgrass, spikegrass, marshelder, bayberry, waxmyrtle, and glasswort were added to the Federal list as associates of smooth cordgrass.

Type 19—Sounds and Bays
The Federal definition of this type, "water of variable depth," was discarded, and the type was redefined as follows: "Mud flats exposed at mean low tide; may be very sparsely vegetated with pondweeds, wigeongrass, eelgrass, waterweeds, or coontail."

Coastal wetlands were identified in sixteen counties. The data for shrub swamps (Type 6) and wooded swamps (Type 7), as well as for the coastal wetland types, in these counties are totaled in Table 20. The 1956 survey tallied 237,032 acres of coastal marshes or 35,972 acres more than did the 1954 Federal survey. This difference consisted of an increase in fresh (19,254 acres) and saline (24,074 acres) marshes, and a decrease in brackish marsh (7,356 acres).

During 1964, pursuant to a joint resolution from the General Assembly, the Governor of Maryland appointed a Commission on Hunting Spaces. The Commission was charged with the responsibility to formulate recommendations for an expanded program of state action for the continued preservation of lands to serve the increasing demand for hunting areas open to the public. The Commission recognized the need for an inventory of the current habitats of the principal game and fur-bearing animals of the State, and requested the State Planning Department to conduct such an inventory.

Henry W. Dill, Jr., of the United States Department of the Interior, Bureau of Outdoor Recreation, initiated the inventory during 1964 (Maryland State Planning Department 1965). Aerial photographs taken during the period from 1962 to 1964 were utilized as the source of information. More than 2,500 plots, each containing 100 acres, were established randomly on the photographs, and these represented a 4% sample of the total land area of Maryland. Habitats were categorized into sixteen classes, and subclasses were recognized in the four forest classes. The data on these habitat classes were summarized by six subregions of the State. These subregions and the smaller division within each of them do not correspond with political units or with watersheds of major streams. It is not possible, therefore, to compare the results of the 1964/1965 investigation with those of the present survey in any detail.

Wetland habitats were divided into five classes: wooded swamp, shrub swamp, fresh-water marsh, salt-water marsh, and agricultural wet meadow. The name implies that salt-water marshes are tidal, but otherwise there was no distinction between tidewater wetlands and inland (non-tidal) wetlands.

In total, 168,000 acres of salt-water marshes were identified on the 1962/1964 photographs. The fact that the number is nearly equal to the total acreage of brackish and saline marshes that was determined by the present survey (165,397 acres) apparently is coincidental. Salt-water marshes were listed from two of the six subregions that were recognized by the Maryland State Planning Department (1965). These two subregions include only seven of the eleven counties that contain 1,000 acres or more of brackish and/or saline wetlands (Table 17). The extensive brackish tidal wetlands of Anne Arundel, Calvert, Charles, and St. Mary's Counties, as well as smaller areas elsewhere, apparently were grouped with "fresh-water marshes" in the study for the Commission on Hunting Spaces.

In response to House Resolution No. 2 (1967), the Department of Natural Resources, the Department of Economic and Community Development, and the Department of State Planning joined to form the Wetlands Technical Advisory Committee and to conduct an inventory of the wetlands of Maryland. The inventory was completed within two years. A draft report was prepared by the Maryland Department of State Planning (1969), and the final report was published during 1973 (Metzgar 1973).

The survey conducted during 1953/54 by the Federal Office of River Basin Studies considered only wetlands that covered 40 or more contiguous acres and the 1955/56 inventory of the Game and Inland Fish Commission included wetlands of 0.5 acres or more. The 1967/69 State survey, in contrast, considered wetlands of 5 acres or more.

The Wetlands Technical Advisory Committee adopted the Federal scheme of classification of wetlands (Martin and others 1953), as modified by the Game and Inland Fish Commission (1956). The Committee modified the scheme further-to include shrub swamps (Type 6) and wooded swamps (Type 7) in its Fresh Water Coastal Wetlands grouping, as well as in its Inland Wetlands grouping. No separate accounting was made, however, of those areas of Types 6 and 7 which are affected by tides (coastal) and those areas which are not affected (inland).

The more significant of the changes that the Committee made in the 1956 descriptions, and the slightly modified names of the types it developed were:

Type 14—Coastal Open Fresh Water
This type was expanded to include "shallow but variable depth portions of open water along fresh tidal rivers and sounds."

Type 18—Regularly Flooded Salt Marshes
Probably on the basis of the results of the 1956 inventory, marshes of this type were considered to be "located almost exclusively in estuaries in Worcester County where the tidal range is influenced by the Atlantic Ocean." Wigeongrass, eelgrass, pondweed, common waterweed, and coontail were said to occur in permanent open water in these marshes.

Type 19—Submerged Lands
In the original Federal system (Martin 1953), Type 19 was defined as "Water of variable depth." The Office of River Basin Studies (1954) and the Game and Inland Fish Commission (1956) included only intertidal mud flats in this category. The Committee redefined Type 19 to include the bottoms of "the open waters of Chesapeake Bay proper and. . .its sounds, bays, tidal rivers, mud flats from mean low tide seaward. Also included are the submerged lands under the waters of bays behind the barrier beach islands on the ocean side of Worcester County." No measurements were made, however, of the areas of submerged wetlands included in Type 19.

The Martin scheme, and the modification used in the State surveys, recognizes only two classes of coastal wetlands: fresh and saline. There is no category for brackish wetlands, and no specific definition is presented to distinguish between fresh and saline wetlands. The decision on the classification of a particular area must be intuitive, and is based on geographical location and the floristic composition of the vegetation. Arrowarum, cattail, goldenclub, and pickerelweed apparently are considered to be characteristic plants in marshes within the freshwater range. Blackrush, needlerush, and spikegrass are characteristic of saline wetlands. Smooth cordgrass and meadow cordgrass, which usually are considered to be indicative of saline to brackish wetlands, also may occur in association with Type 14 freshwater areas (Fish and Inland Game Commission 1956; Metzgar 1973). Where they are prominent in the vegetation, however, the cordgrasses would indicate areas to be categorized as saline in the Martin system.

The results of the survey by the Office of River Basin Studies (1954) and of the inventories conducted by the State agencies are not comparable. This is due only partly to the difference between the minimum sizes of the areas considered in the three investigations. Principally it is the reflection of inconsistencies between the applications of the typing scheme in the investigations. For example, nearly 3,000 acres were considered to be Deep Fresh Marshes (Type 13) by the Federal surveyors and the State Game Commission, but only 169 acres were classed as Type 13 by the State agencies in the 1967/69 inventory.

The previous classification schemes used in comprehensive surveys of the coastal area of Maryland have been intended to characterize wetland complexes, and not to detail the precise distribution of vegetation types. It is not possible, therefore, to compare the earlier schemes directly with the official State Wetland Mapping System utilized for vegetation type delineations during 1975/78. The diagram in Table 19, however, illustrates the general relationship between the three principal schemes.

The reports by the Game and Inland Fish Commission (1956) and the State agencies (Metzgar 1973) include a series of county maps to indicate the types and locations of the wetlands surveyed. In contrast, the results of the survey by the Office of River Basin Studies (1954) were summarized tabularly, but no maps were produced to show the locations and sizes of the specific wetlands. A generalized map was included but did not employ the classification scheme used during the survey. The map in the Federal report categorizes wetlands according to their relative values to wildlife. In the State survey (1973) only the general location of each wetland surveyed was shown, and each was numbered to correspond to an inventory sheet which provided general information on the wetland type and habitat characteristics.

Recently, a new scheme of wetland classification was introduced by the United States Fish and Wildlife Service (Cowardin and others 1979). This scheme has been applied preliminarily in Maryland as part of the National Wetlands Inventory, begun in 1974. The coastal wetlands of Maryland are encompassed by three systems of this new scheme, depending upon form and salinity. The "Estuarine System" includes all tidally influenced wetlands subject to an ocean-derived salinity 0.5 ppt or greater. The "Palustrine System" includes those tidally influenced swamps and persistent marshes subject to salinity less than 0.5 ppt. The "Riverine System" includes tidally influenced mudflats, submersed aquatic vegetation beds, and non-persistent marshes subject to salinity less than 0.5 ppt. These systems each are sub-divided into classes and subclasses based upon substrate type and vegetation life form. The final level of detail in this hierarchical scheme is "Dominance Type." All of the types recognized in Maryland's typing scheme are equivalent to Dominance Types in the Cowardin classification scheme.

Table 19. Correlation of types used during the 1975/1978 inventory of coastal wetlands with those used by Nicholson and Van Deusen in 1953, by the Office of River Basin Studies in 1953/1954, and the Wetlands Technical Advisory Committee during 1967/1969.

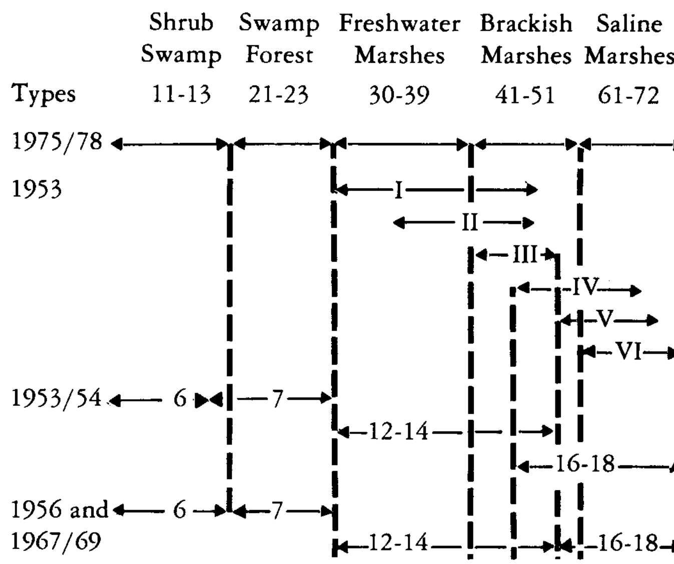

Table 20. A comparison of estimates of the area (in acres) of the coastal wetlands of Maryland by the United States Fish and Wildlife Service, Office of River Basin Studies (1954), the Maryland Game and Inland Fish Commission (1956), Stewart (1962), Metzgar (1973), and the present study (1978). The 1962 survey included an unstated number of acres in Delaware and Virginia.

	1954	1956	1962	1973	1978
6 Shrub swamp (Types 11-13)	4,150[a]	3,847[a]	—	6,364[a]	2,600
8 Wooded swamp (Types 21-23)	72,890[a]	83,240[a]	—	80,867[a]	16,798
Subtotal: Swamps	(77,040)[a]	(87,087)[a]		(87,231)[a]	(19,398)
12 Coastal fresh marsh, shallow	64,410	83,756	—	73,272	—
13 Coastal fresh marsh, deep	2,920	2,828	—	208	—
Estuarine river marsh	—	—	67,000[c]	—	—
Fresh estuarine bay marsh	—	—	30,000	—	—
Fresh marshes (Types 30-39)	—	—	—	—	25,563
Subtotal: Fresh marsh	(67,330)	(86,584)	(97,000)[c]	(73,480)	(25,563)
16 Coastal salt meadow	64,790	57,434	—	80,755	—
Brackish estuarine bay marsh	—	—	47,000	—	—
Brackish marshes (Types 41-51)	—	—	—	—	151,648
Subtotal: Brackish marsh	(64,790)	(57,434)	(47,000)	(80,755)	(151,648)
17 Salt marsh, irregularly flooded	53,050	72,411	—	67,711	—
18 Salt marsh, regularly flooded	15,890	20,603	—	14,614	—

Table 20. A comparison of estimates of the area (in acres) of the coastal wetlands of Maryland by the United States Fish and Wildlife Service, Office of River Basin Studies (1954), the Maryland Game and Inland Fish Commission (1956), Stewart (1962), Metzgar (1973), and the present study (1978). The 1962 survey included an unstated number of acres in Delaware and Virginia (Concluded).

	1954	1956	1962	1973	1978
Coastal embayed marshes	—	—	21,000	—	—
Salt estuarine bay marshes	—	—	113,000	—	—
Saline marshes (Types 61-72)	—	—	—	—	13,749
Subtotal: Saline marsh	(68,940)	(93,014)	(134,000)	(82,325)	(13,749)
Untyped coastal wetlands	—	—	—	—	1,289
Ponds (Type 80)	—	—	—	—	5,556
Subtotal: Coastal marsh	(201,060)	(237,032)	(278,000)	(236,560)	(197,805)
Mudflat (Type 81)	3,730	970	—	831	852
Sandbar/Beach (Type 91)	—	—	—	—	945
14 Coastal open fresh water	4,770	10,973	—	1,022	—
Submerged aquatic vegetation (Type 101)	—	—	—	—	42,309
Subtotal: Coastal wetlands	(228,958)[b]	(268,373)[b]	(297,398)[b]	(257,811)[b]	(261,309)
Open tidewater areas					
Fresh estuarine bays, shoal waters	—	—	61,000	—	—
Fresh estuarine bays, deeper waters	—	—	96,000	—	—
Subtotal: Fresh bays	—	—	(157,000)	—	—
Slightly brackish estuarine bays, shoal waters	—	—	24,000	—	—
Slightly brackish estuarine bays, deeper waters	—	—	158,000	—	—
Subtotal: Slightly brackish bays	—	—	(182,000)	—	—
Brackish estuarine bays, shoal waters	—	—	70,000	—	—
Brackish estuarine bays, deeper waters	—	—	292,000	—	—
Subtotal: Brackish bays	—	—	(362,000)	—	—
Salt estuarine bays, shoal waters	—	—	196,000	—	—
Salt estuarine bays, deeper waters	—	—	727,000	—	—
Subtotal: Salt bays	—	—	(923,000)	—	—
Coastal bays, shoal waters	—	—	83,000	—	—
Coastal bays, deeper waters	—	—	2,000	—	—
Subtotal: Coastal bays	—	—	(85,000)	—	—
Oceanic littoral zone, shoal waters	—	—	1,000	—	—
Oceanic littoral zone, deeper waters	—	—	25,000	—	—
Subtotal: Oceanic littoral zone	—	—	(26,000)	—	—
Subtotal: Shoal waters	—	—	(435,000)	—	—
Subtotal: Deeper waters	—	—	(1,300,000)	—	—
19 Permanently submerged lands (sounds and bays)	—	—	—	1,650,868	—
	—	—	(1,735,000)	(1,650,868)	—

[a]Tidal and nontidal.

[b]For tidal swamps, 19,398 acres were included in these totals.

[c]Fresh and brackish estuarine river marshes were not distinguished.

2. VALUES OF THE COASTAL WETLANDS

The coastal wetlands of Maryland are of value to man in many ways. Together with the tidewater creeks and rivers, the coastal bays, and the ocean, they form an extensive and aesthetically appealing system of open spaces. They are utilized as habitats by thousands of species of plants and animals. Many of these species, particularly the fish, shellfish, and furbearing animals, are of direct commercial value. Others provide recreation for fishermen, hunters, and naturalists. All of them provide an important education and scientific resource.

The marshes, shrub swamps, swamp forests, and submerged vegetation of the coastal wetlands are the principal sources of food for the animals that inhabit the waters of the Chesapeake Bay estuary, coastal bays, and the nearshore ocean. The details of the production, distribution, and consumption of this food supply still are not known, but the available information is adequate to demonstrate that a wealth of food is produced; that part of it is harvested directly by animals, but that much of the food is utilized in a finely pulverized form, as detritus; and that the production of fish, shellfish, waterfowl, furbearers, and other valuable forms of life would decline if the area of wetlands were reduced significantly.

2.1 FOOD WEB OF THE COASTAL WETLANDS

Food chains are series in which one organism is eaten by a second organism, the second organism is eaten by a third, and so on. For example, grass is eaten by cows, and cows are eaten by human beings — this is a simple food chain from grass to man.

In any community of living organisms, there are many food chains. One kind of organism may be fed upon by many species of predators, and most kinds of predators eat many different species of prey. Thus, the food chains interlock at various points (species) and, conceptually, form a network, or food web.

The green plants of the wetlands, the grasses, rushes, bulrushes, cattails, broadleaf herbs (forbs), shrubs, and trees, as well as the submerged vascular plants and the macroscopic and microscopic algae, are the original, or primary, food producers of the wetlands. With the energy derived from sunlight, these green plants combine carbon dioxide and water from the air and soil or water into energy-rich food compounds. This plant food is used, directly or indirectly, as a source of energy and nutrients by all of the animals and by the multitude of fungi, bacteria, and other non-green plants of the wetland ecosystem. In various forms, part of the energy and nutrients fixed by the plants is transported into the water of the estuary and to the nearshore ocean waters where it is utilized by fish, shellfish, and other organisms.

Herbivores are animals that graze or browse on plants and, thus, obtain their foods directly from the producers. The herbivores also are known as "primary consumers" because they are the first to utilize the energy stored by the plants. Predators that eat herbivores are the secondary consumers. Still other predators that eat the secondary consumers are known as tertiary consumers. The number of links differs from one food chain to another, but it is not common to have fourth or higher level consumers.

Organisms that feed on dead plant or animal material are termed scavengers if they are larger animals, saprovores if they are insects or other small, macroscopic animals, saprophytes if they are macroscopic plants, and decomposers if they are microorganisms (as bacteria and many kinds of fungi). Any of these organisms that feed on particulate organic material also may be referred to as detritivores. Omnivores are animals which have varied diets, which include plant material, animal prey, and in some cases, carrion or detritus.

In most wetlands, the plant-herbivore-predator food web apparently utilizes a relatively small proportion of the energy fixed by the green plants. The few measurements that have been made in Maryland (Cahoon 1975; Stevenson, Cahoon, and Seaton 1976) and elsewhere (Teal 1959; Smalley 1959, 1960; Kraeuter and Wolf 1974) suggest that 15% or less of the plant energy in saline wetlands is harvested directly by insects, snails, birds, mammals, and other animals. In the fresh wetlands of Maryland, the animals may harvest as much as 35 to 40% of the plant material that is produced.

Part of the plant material is decomposed in the wetlands or accumulates as organic material in the wetland soils. The dead plant material is fed upon by fiddler crabs, snails, amphipods, polychaete worms, and other macroscopic invertebrates, as well as by great numbers of fungi, bacteria, and other microorganisms, before it is broken down to its original inorganic components. Approximately 40% to 50% of the material produced by the wetland vegetation is consumed by this decomposer population.

Another portion of the dead plant material that is utilized by decomposers—about 55% at maximum, but typically less—is transported from the wetlands by tidal currents. This material becomes detritus, and it is utilized by a host of organisms that range from microscopic water animals known as zooplankton, to shellfish and fish. Detritus is described in greater detail in Section 2.3 of this report.

A radionuclide tracer was used by Marples (1966) to determine the food relationships of the predominant arthropods in a saline coastal wetland in Georgia. In each of two large plots, orthophosphate labeled with phosphorus-32 was injected into 200 stems scattered throughout dense stands of smooth cordgrass. On a third plot of the same size, the tracer was sprayed on the sediment around plant bases to label deposits of detritus. A smaller plot was established around an ant colony, and 18 stems of smooth cordgrass within it were labeled. Sweep nets were used to collect insects and spiders from the plots on several occasions for periods as long as 63 days after the initial treatment. Specimens of snails and crabs occasionally were collected by hand.

A true bug (*Trigonotylus* sp.), a sapsucking leafhopper (*Prokelisia marginata*), a grasshopper (*Orchelimum fidicinium*), and another true bug (*Ischnodemus badius*), roughly in that order, are the principal herbivores that feed on smooth cordgrass. Ants also appear to be herbivores, but they lost the tracer rapidly after a large initial uptake. This pattern may reflect the use by ants of a tissue of cordgrass that does not retain the label for more than a few days.

Marsh periwinkles, marsh fiddler crabs, and squareback crabs (*Sesarma cinereum*) are deposit feeders. They labeled rapidly in the plot in which the detritus was marked with the tracer. Predatory dolichopid flies and ephydrid flies obtain energy from both the grazing and detritus food chains. They became labeled in the plot in which plants were marked and in a plot in which the sediment was marked. They may ingest detritus incidentally as they feed on organisms in the sediment.

Spiders, parasitic wasps, and flies (*Oscinella insularis, Chaetopsis apicalis, C. aenea, Hoplodicta* sp.) did not become highly labeled, or they became noticeably labeled only three to four weeks after the initial treatments of the plots. These species did not feed actively on the live grass or on the detritus. The spiders are predators. The adult parasitic wasps and flies may not feed or they may eat nectar, or pollen which absorb little or none of the tracer.

2.2 PRIMARY BIOLOGICAL PRODUCTIVITY

Primary biological productivity is the rate at which various organisms, principally green plants, synthesize gaseous and dissolved inorganic chemicals into organic matter. The organic matter so produced is utilized by a wide variety of other organisms as a source of energy and nourishment.

The primary production of flowering plants, benthic algae, and phytoplankton in coastal wetlands is an important food source for organisms in the marshes, estuaries, and the sea. Herbivores feed directly on the plants. Detritus, which is composed of plant fragments in various stages of decay, is utilized by filter feeders and other kinds of animals and decomposer organisms.

The total amount of organic matter formed by green plants during a particular period of time is known as gross primary production. Some of the material is consumed by the life process of the producers. The remaining material, which is available for use by other organisms, is known as the net production.

Generally, 10% to 30% of the net primary production of a coastal wetland is consumed by herbivores while the plants are alive. The bulk of the plant material, including leaves, culms, and flower parts, dies and is decomposed by scavengers and saprophytes. Detritus, the fragmented, partially decomposed remains of plant tissues, is considered to be an important form of wetland production. This material supports dense colonies of fungi and bacteria which convert the plant products into body tissue and related substances.

Organic detritus is considered to be an important form for the storage and transport of food in the estuarine system. A large proportion of the organic matter produced during the growing season is stored in the wetlands as decomposing matter and is released subsequently as particulate detritus and dissolved organic compounds. The detritus and dissolved substances can be transported by tidal currents for considerable distances from the point of primary production and, thus, are available to organisms throughout the estuaries and nearshore ocean waters. Owing to the characteristic storage, delayed release, and transportability of detritus, it also serves as a nutritive buffer for the functioning of the estuarine system. Detritus is available throughout the year, whereas primary production in the wetlands is concentrated in the growing season.

Although much of the plant material (the net primary production) of a coastal wetland is consumed in the wetland, a significant proportion may be exported to the surrounding waters of the estuary and sea. Tidal currents are the principal mechanisms for the export of detrius. In Maryland and elsewhere, ice-rafting of detritus also may be of some importance. Certain organisms, such as the grass shrimp, may consume detritus in the wetland and, by their movement into the estuary, transport part of the energy and nutrients obtained from the detritus into the estuary.

Approximately 45% to 55% of the net primary production of a salt marsh is exported to the adjacent tidal waters (Teal 1962; Heald 1969; Cameron 1972; Day and others 1973; Odum and Skjei 1974; Eilers 1975). The actual proportion of material that is exported from any particular wetland is determined by its relationship to tidal planes and open channels. In high marshes that are remote from channels, less than 10% of the annual production may be exported. As much as 70% of the net annual production may be exported from a streamside marsh (Kirby and Gosselink 1976).

METHODS

Most investigators have compared the productivity of herbaceous coastal wetland vegetation by measuring the peak aerial standing crops (Whigham and others 1978). Because the standing crop usually is at a maximum during the late summer or autumn, an investigator may base his calculations on a single harvest during the period from middle August through early October. There is no objective method to determine the exact moment at which the peak crop exists, so there is an inherent variability and potential error in the single-harvest method. Generally, the method underestimates the actual production of the aerial plant parts and, of course, it provides no information about the amount of material produced by the roots and other underground organs. The total belowground productivity of needlerush in Mississippi, for example, was estimated to be 1360 grams per square meter per year, or 80% as great as the aboveground productivity (de la Cruz 1974; de la Cruz and Hackney 1977). In stands of the tall and short forms of smooth cordgrass along the Atlantic Coast, belowground productivity ranged from 12 to 39% and 25 to 39% as great as the aboveground production, respectively (Stroud 1976; Valiela and others 1976; de la Cruz and Hackney 1977). Belowground production in stands of wildrice, an annual plant, was equal to about 20% of the aboveground production (Whigham and Simpson 1977).

The single-harvest method, per se, does not account for plant tissues that develop and die during the growing season or for materials consumed by herbivores. A variation of the method is to examine the harvested plants and to determine the number of empty nodes that supported leaves earlier in the season. The data then are corrected to account for the weight of the missing tissues. This method variation is useful in studies of smooth cordgrass marshes, but has not been applied successfully to other vegetation types.

Multiple harvest techniques, in which collections are made at intervals of several days to several weeks throughout the growing period, have been used in several studies of coastal wetlands. Some authors have used the data only to identify and describe the peak standing crop in each vegetation type that they studied. Even within a single vegetation type, these studies indicate that the peak standing crop on one plot may occur 7 to 10 weeks before the peak on another plot.

The data from multiple harvests also may be used to estimate the total annual net production of a vegetation type. In this method, the weights of living and dead harvested materials are arranged chronologically. Any increase in the total weight of organic material (live plus dead) between successive harvests is considered to be net production. If there is an increase in the weight of live material coupled with a loss of weight of the dead material, the dead material is ignored and the increase of live weight is counted as net production for the period. When the weight of dead material increases, but the weight of live material decreases, the loss is added algebraically to the gain and the result is considered to be net production. When there are losses in the weights of both living and dead material, net production for the period is scored as zero. The sum of the incremental estimates of net production is considered to equal the annual net production.

Stroud and Cooper (1969) analyzed data from multiple harvests and found that dead material was underestimated. They attributed this to removal of material by tides between sampling dates and to errors in their classification of various components of the dead material. To calculate more nearly correct values, the field data were fitted to a fourth degree polynomial in the time variable by use of a computer program. Approximations of the weights of live and dead materials were generated for all twelve months and these were used to estimate annual net production. For most types, the computer-approximated annual net production exceeded that calculated directly from the original field data.

ORIGINAL ESTIMATES OF STANDING CROPS

During the period from 17 through 31 August 1976, JMA biologists harvested all herbaceous vegetation from 135 sample plots in the coastal wetlands of Maryland. Forty-five stands that represented 22 types of wetland vegetation were investigated. The estimated weights of the standing crops in these types are included in Table 22. Details of the field investigations, including diversity of the selected vegetation types, are contained in Appendix 2.

THE AVERAGE PRIMARY PRODUCTION OF WETLAND VEGETATION TYPES

A thorough review of the literature was conducted to obtain published and unpublished estimates of the primary production of types of wetland vegetation that occur in the State of Maryland. Data from Maryland, Virginia, North Carolina, Delaware, New Jersey, Pennsylvania, and localities around Long Island Sound were considered most relevant. A few estimates from Georgia are included. Because the production of some saline marshes in Georgia apparently is more than twice as great as that of saline wetland vegetation along the Middle Atlantic Coast, the Georgia data for these types are excluded from this summary.

No previous study of the primary production of shrubby or forested coastal wetlands was found. Similarly, no previous study of the production of a brackish rosemallow vegetation was found. The only available data for these types were generated by the original sampling conducted for this report. No samples were collected from black alder/willow shrub swamp (Type 12). No previous measurements for a freshwater bulrush marsh (Type 37) were located, and no samples were collected from this type by the JMA biologists.

Data are summarized in Table 21 for 39 types of coastal wetland vegetation. No data are available for Type 12 or Type 37. Twenty-nine of the types are among those officially recognized in the State of Maryland wetland mapping program. For six of these types, only information from collections made by JMA during 1976 is available. Previous estimates were found in the literature for 23 of the recognized types. Information for eight other types mentioned in the literature also is included. No stand of these types has been observed to be large enough to delineate on the official wetlands maps, but larger scale studies of individual wetland areas may indicate one or more of the types to be of local significance. These supplemental types were assigned alpha-numerical symbols in Tables 21 and 22 (3A, 3B, 3C, 3L, 3R, 3S, 7A, and 7M).

Table 21. Average mass of the aerial peak standing crops of thirty-nine vegetation types of the coastal wetlands of the Middle Atlantic States, derived from information listed in Table 22. Values are weights of oven-dry plant tissue. Estimates do no include woody tissues.

Type	Predominant Species	Tons per Acre	Grams per Square Meter
38	Big cordgrass (fresh)	10.3	2311
46	Switchgrass (brackish)	10.1	2270
49	Common reed (brackish)	9.6	2155
39	Common reed (fresh)	8.3	1850
35	Rosemallow (fresh)	7.6	1714
3L	Spiked loosestrife (fresh)	7.2	1616
30	Smartweed/rice cutgrass (fresh)	6.4	1425
44	Cattail (brackish)	6.1	1361
45	Rosemallow (brackish)	6.0	1354
43	Needlerush (brackish)	5.8	1290
36	Wildrice (fresh)	5.4	1218
3R	Giant ragweed (fresh)	5.4	1205
63	Needlerush (saline)	5.2	1160
71	Tall smooth cordgrass (saline)	5.2	1157
34	Cattail (fresh)	5.1	1136
48	Big cordgrass (brackish)	4.8	1085
3B	Burmarigold (fresh)	4.5	1017
51	Smooth cordgrass (brackish)	4.2	942
3A	Waterhemp (fresh)	4.2	940
41	Meadow cordgrass/spikegrass (brackish)	4.0	897
42	Marshelder/groundselbush (brackish)	4.0	895
33	Sweetflag (fresh)	3.8	857
32	Pickerelweed/arrowarum (fresh)	3.1	687
11	Swamp rose shrub	3.0	669
71	Medium smooth cordgrass (saline)	2.9	649
31	Spatterdock (fresh)	2.8	627
47	Threesquare (brackish)	2.7	606
3C	Reed canarygrass (fresh)	2.5	566
13	Red maple/ash shrub	2.5	560
23	Loblolly pine forest	2.3	506
22	Red maple/ash forest	2.2	485
61	Meadow cordgrass/spikegrass (saline)	2.1	467
72	Short smooth cordgrass (saline)	2.0	456
3S	Duckpotato (fresh)	1.9	432
101	Submerged vegetation	1.8	409
21	Baldcypress forest	1.5	344
7M	Short smooth cordgrass/meadow cordgrass	1.0	216
7A	Spreading orach	0.8	172
62	Marshelder/groundselbush (saline)	0.7	154
12	Smooth alder/black willow shrub	No estimate	
37	Bulrush (fresh)	No estimate	

Table 22. Summary of data on mean peak standing cops and net annual production of the vegetation of the coastal wetlands of Maryland and other Middle Atlantic States. Numbered sources are listed at the end of the table.

	Peak Standing Crop[a]						Annual Production (Tops)				
	Tons/acre			gm^{-2}							
	Tops	Roots	Dead	Tops	Roots	Dead	Tons/acre	gm^{-2}	$Kcal\,m^{-2}$	State	Source
Shrub Swamp Types											
11 Swamp rose	2.7[b]			615[b]						MD	JMA
	3.2[b]			723[b]						MD	JMA
12 Smooth alder/Black willow	NA			NA							
13 Red maple/Ash	1.6[b]			365[b]						MD	JMA
	1.6[b]			754[b]						MD	JMA
Swamp Forest Types											
21 Baldcypress	1.5[b]			333[b]						MD	JMA
	1.6[b]			355[b]						MD	JMA
22 Red maple/Ash	2.0[b]			445[b]						MD	JMA
	2.3[b]			525[b]						MD	JMA
23 Loblolly pine	1.9[b]			435[b]						MD	JMA
	2.6[b]			576[b]						MD	JMA
Freshwater Marsh Types											
30 Smartweed/Rice cutgrass	9.2			2052						MD	JMA
	10.0			2232						MD	JMA
	6.9			1547						VA	34
	3.4	2.3		769	507					NJ	8
	2.3			523						PA	18
31 Spatterdock	2.0			447						MD	JMA
	2.6			580						MD	JMA
	1.1			245						VA	34
	2.7			600			3.2	724		NJ	19
	4.0			886			4.5	1002		NJ	19

Table 22. Standing scrops and net annual production of coastal wetland vegetation (Continued).

	Peak Standing Crop[a]						Annual Production (Tops)				
	Tons/acre			gm-2							
	Tops	Roots	Dead	Tops	Roots	Dead	Tons/acre	gm^{-2}	Kcal m^{-2}	State	Source
	2.3			516						NJ	20
	2.7	5.11		605	1146					NJ	9
	1.7			380						NJ	35
	1.9			427						NJ	35
	2.1			460						NJ	35
	2.3			521						NJ	35
	2.4			548						NJ	35
	3.7			840						NJ	35
					4799		3.5	780		NJ	35
	5.2			1171						PA	18
	5.3			1178						PA	18
32 Pickerelweed/Arrowarum	2.7			613						MD	JMA
	3.0			682						MD	JMA
	4.4		0.6	988		132				MD	4
	2.5			553						NJ	8
	5.7	11.0		1286	2463					NJ	9
	4.1			919						NJ	20
	1.2			269						NJ	20
	2.1			468						NJ	35
	2.2			504						NJ	35
	2.6			576						NJ	35
	2.6			593						NJ	35
	3.6			802						NJ	35
							2.9	650		NJ	35
	3.0			677			5.0	1126		NJ	19
33 Sweetflag	4.7			1045						MD	JMA
	5.8			1303						MD	JMA
	2.7			605						NJ	20
	3.2			712						NJ	35
	3.2			722						NJ	35
	4.0			896						NJ	35
	4.2			946						NJ	35
	2.8			623			4.8	1071		NJ	19
34 Cattail	6.0		1.7	1346		391				MD	4
	4.6		1.2	1003		268				MD	4
	4.3			966			8.3	1868		MD	15
									4300	MD	15
	4.4			987						NJ	29
	3.8	8.0		850	1800					NJ	20
	4.0	6.1		894	1371					NJ	8
	5.0			1119						NJ	9
	5.3			1189						NJ	35
	7.1			1582						NJ	35
							5.9	1320		NJ	35
	5.4			1199			6.8	1534		NJ	19
	3.6	22.5		804	5053					NJ	39
	3.9			881						PA	18
	4.3			975						PA	18
	9.2			2073						PA	18
35 Rosemallow	6.8			1517						MD	JMA
	8.5			1910						MD	JMA
									2200	MD	29
36 Wildrice	7.0			1574						MD	JMA
	11.6			2607						MD	JMA
	6.0		0.5	1349		120				MD	4
	4.1		0.3	909		73				MD	4
	4.6		0.3	1023		77				MD	4
	6.4			1432						MD	4
	2.5			560						VA	34
	6.2			1390						NJ	20
	7.1	3.2		1600	721					NJ	9
	3.1			700			3.7	824		NJ	35

Table 22. Standing crops and net annual production of coastal wetland vegetation (Continued).

Fresh Marsh Types (Continued)	Peak Standing Crop[a] Tons/acre Tops	Roots	Dead	gm^{-2} Tops	Roots	Dead	Annual Production (Tops) Tons/acre	gm^{-2}	Kcal m^{-2}	State	Source
	3.6			796			7.2	1619		NJ	35
	3.8			841			9.6	2163		NJ	35
	5.0			1125			5.5	1234		NJ	35
							9.4	2108		NJ	35
	6.0			1346			6.8	1520		NJ(area)	19
	3.0			664						PA	18
	7.0			1569						PA	18
37 Bulrush	NA			NA							
38 Big cordgrass	15.2[c]			3418[c]						MD	JMA
	16.4[c]			3669[c]						MD	JMA
	4.2		1.1	951		241				MD	4
	5.4			1207			7.0	1572		MD	15
39 Common reed	15.3			3437						MD	JMA
	20.3			4560						MD	JMA
									3900	MD	29
	3.6		0.6	811		130				MD	4
	6.7		1.0	1498		230				MD	4
	8.0		3.0	1792		680				MD	4
	6.5			1451			7.5	1678		MD	15
	7.7			1727						NJ	20
	6.7			1493			9.2	2066		NJ	19
	4.8			1074						NJ	39
	2.9			654						PA	18
3A Waterhemp	5.0			1112			6.9	1547		NJ	19
	3.4	2.5		768	560					NJ	9
3B Burmarigold	3.4			756						NJ	35
	5.2			1160						NJ	35
	5.2			1162						NJ	35
							4.1	910		NJ	35
	4.9			1109			7.9	1771		NJ	19
	4.0			900						PA	18
3C Reed canarygrass	2.5			566						NJ	35
3L Spiked loosestrife	9.4			2104			9.4	2100		NJ	35
	4.4			995						PA	18
	7.8			1750						PA	18
3R Giant ragweed	5.2			1160			5.2	1160		NJ	35
	5.6			1252						PA	18
	5.4			1202						PA	18
3S Duckpotato	2.9			649			4.8	1071		NJ	19
	1.0			214						NJ	9
Brackish Marsh Types											
41 Meadow cordgrass/Spikegrass	3.3			744						MD	JMA
	3.3			746						MD	JMA
	8.4			1879						MD	JMA
	2.0			445						MD	3
	2.5			570						MD	10
	1.2			274						MD	10
	2.2			503						MD	10
	3.0		5.4	680		1209				MD	4
									2800	MD	29
	6.8[d]			1525[d]						MD	12
	6.8[d]			1525[d]						MD	12
	2.1			480			2.6	572		VA	22
	4.4			993						NY	2
	5.8			1296						NC	2
42 Marshelder/Groundselbush	3.4			766						MD	JMA
	6.2			1386						MD	JMA
	2.4			534						MD	3

Table 22. Standing crops and net annual production of coastal wetland vegetation (Continued).

	Peak Standing Crop[a]						Annual Production (Tops)				
	Tons/acre			gm⁻²							
Brackish Marsh Types (Continued)	Tops	Roots	Dead	Tops	Roots	Dead	Tons/acre	gm^{-2}	Kcal m^{-2}	State	Source
43 Needlerush	6.0			1349						MD	JMA
	8.3			1855						MD	JMA
	3.7			820						MD	10
	5.2			1167						MD	10
	5.6			1258						MD	10
44 Cattail	5.1			1148						MD	JMA
	7.8			1757						MD	JMA
	2.8			626						MD	3
	5.2		5.0	1170		1113				MD	4
	6.7		3.6	1496		814				MD	4
	10.4		0.7	2338		167				MD	4
	6.4			1435						MD	12
	4.1			919						VA	34
45 Rosemallow	5.4			1200						MD	JMA
	6.7			1507						MD	JMA
46 Switchgrass	16.8			3775						MD	JMA
	19.1			4282						MD	JMA
	2.9			652						MD	1
	1.6			369						MD	3
47 Threesquare	2.7			600						MD	JMA
	4.5			1003						MD	JMA
	1.3			292						MD	1
	2.0			440						MD	1
	2.1			472						MD	3
	2.3		0.9	514		212				MD	4
	3.8		1.4	844		314				MD	4
	5.1		1.6	1141		358				MD	4
	2.5			561						VA	34
	0.9			193						NJ	7
48 Big cordgrass	3.3			740						MD	1
	5.3			1195						MD	1
	3.0			672						MD	3
	7.4		5.5	1650		1232				MD	4
	9.6		0.6	2160		137				MD	4
	3.1		1.1	706		257				MD	4
	4.2			936						VA(min.)	34
	6.5			1452						VA(mean)	34
	8.1			1814						VA(max.)	34
	2.5			560			2.5	563		VA	22
	2.3		1.4	515		310	3.7	825	3482	GA	25
	3.4		0.5	762		110	3.9	872	3680	GA	25
	3.5		0.6	785		125	4.0	910	3840	GA	25
	5.5		3.8	1242		850	9.3	2092	8828	GA	25
49 Common reed	15.2			3398						MD	JMA
	17.0			3802						MD	JMA
	8.9		1.5	1992		326				MD	4
	5.0			1114						MD	3
	2.1			471						NJ	14
	9.6			2155						NJ	14
51 Smooth cordgrass	3.2			717						MD	JMA
	5.7			1288						MD	JMA
	2.6			587						MD	3
	3.6			807						MD	12
	5.5			1233						MD	12
	10.8			2410						VA	34
	5.3			1184						NJ	26
	4.3			971						NJ	14
	0.7			154						NJ	14
	3.2			725[4]						NJ	39
Saline Marsh Types											

Table 22. Standing crops and net annual production of coastal wetland vegetation (Continued).

	Peak Standing Crop[a]						Annual Production (Tops)				
	Tons/acre			gm-2							
Saline Marsh Types (Continued)	Tops	Roots	Dead	Tops	Roots	Dead	Tons/acre	gm^{-2}	Kcal m^{-2}	State	Source
61 Meadow cordgrass/Spikgrass	2.7			605						VA	34
	2.5			563			5.6	1262		DE	23
	0.04			8						NJ	7
	0.07			15						NJ	7
	0.08			19						NJ	7
	0.09			20						NJ	7
	0.09			20						NJ	7
	0.07			16						NJ(mean)	7
	1.1			254						NJ(mowed)	7
	0.3			61						NJ	7
	0.8			177						NJ(mowed)	7
	2.9			649						NJ	13
	3.6			817						NJ	27
	2.9			646						NY	32
	2.2			502						NY	32
	2.8			628						RI	31
	3.2			717						RI	31
	1.9			430						RI	24
62 Marshelder/Grounselbush	0.7			154						NJ	7
63 Needlerush	2.9			650						VA	34
	5.3			1184						NC	17
	5.3			1198						NC	17
	8.5			1917						NC	17
	8.8			1973						NC	17
	8.8			1977						NC	17
	3.1			704			2.5	560		NC	40
	2.7			605			4.0	895		NC	39
	3.3			743			3.4	754		NC	37
	2.9			654			5.4	1215	5346	NC	30
71 Smooth cordgrass Tall form	7.0			1570						VA	34
	2.1			480			4.3	956		DE	24
	2.4			532						NJ	7
	6.9			1555						NJ	13
	7.1			1592					6261	NJ	28
	3.7			825						NY	32
	3.5			785						RI	31
	3.7			840						RI	24
	6.7			1500			7.4	1650		NC	36
	5.2			1171		433	7.0	1563	6471	NC	30
	5.8			1300						NC	38
	7.7			1735						NC	38
Non-stunted	1.3			300						NJ(mean)	7
Undifferentiated	1.6			362			1.6	362		VA	22
	1.0			230						NJ(mean)	7
	2.4			545			2.9	650		NC	36
71 Smooth cordgrass Medium form	1.9			415		324	2.1	471	1856	NC	30
	3.6			800			4.5	1000		NC	36
	2.7			610						NC	38
	3.4			770						NC	38
72 Smooth cordgrass Short form	2.5		1.1	558		242				MD/VA	16
	2.3		1.8	518		396				MD/VA	16
	3.0			695						VA	34
	1.3			298						DE	23
	1.5			332			2.1	465		DE	23
	2.4			539						NJ	13
	2.6			592						NJ	28
	2.3			509						NY	32
	1.2			269						RI	31
	2.2			493						RI	31
	1.9			432						RI	24
	1.0			223		196	1.2	280	1106	NC	30
	1.6			350			1.6	350		NC	36

Table 22. Standing crops and net annual production of coastal wetland vegetation (Continued).

	Peak Standing Crop[a]						Annual Production (Tops)				
	Tons/acre			gm⁻²							
	Tops	Roots	Dead	Tops	Roots	Dead	Tons/acre	gm^{-2}	Kcal m^{-2}	State	Source
72 Smooth cordgrass	1.7			370						NC	38
Short form, continued	3.0			633						NC	38
7A Spreading orach	0.8			172						NJ	7
7M Smooth and meadow cordgrass	1.9		2.2	427		497				MD/VA	16
(Mixed community)	0.5			108						NJ	7
	0.4			90						NJ	7
	0.2			48						NJ	7
	0.1			21						NJ	7
	0.3			59						NJ	7
	3.4			762						RI	31
Other											
80 Water											
81 Mudflat											
91 Beach-sandbar											
101 Submerged vegetation	2.19		490.5							MD	38
	0.81		181.0							MD	38
	2.48		556.1[f]							NJ	40
Algae, edaphic											
Saline marsh											
Tall smooth cordgrass							0.7	158[e]		DE	6
Short smooth cordgrass							0.9	198[e]		DE	6
Spikegrass							0.5	122[e]		DE	6
Bare bank							0.3	76[e]		DE	6
Pan							0.8	182[e]		DE	6
Freshwater											
Spatterdock	0.02			5.3						NJ	35
Burmarigold	0.01			2.9						NJ	35
Wildrice	0.01			3.2						NJ	35
Cattail	0.02			3.6						NJ	35
Spiked loosestrife	0.01			3.1						NJ	35
Pickerelweed/Arrowarum	0.02			5.0						NJ	35
Bank	0.02			4.2							

[a]The term "roots" is intended to include all underground organs.
[b]Herbaceous plants and leaves of woody plants; no wood is included.
[c]These are adjusted estimates. The weights of all harvested materials in the two samples were 5416 gm^{-2} and 5875 gm^{-2}. The dried materials were examined and tissues identifiable unquestionably as current-year production were separated from the remainder. Figures cited are for this component of the collections. An undetermined proportion of the remaining material may also have been produced during the current year.
[d]Samples included exposed rhizome mat. Estimated annual standing crop was 5.0 to 6.0 tons per acre.
[e]Ash-free dry weight, gross production.
[f]Blotted dry, but not oven-dried.

LIST OF SOURCES

1 Anderson, Brown, and Rappleye 1968
2 de la Cruz 1973
3 Drake and Hayes 1973
4 Flemer and others 1978
5 Foster 1968 (Fide Williams and Murdoch 1972; total live standing crop estimated)
6 Gallagher and Daiber 1974
7 Good 1965
8 Good and Good 1975
9 Good and others 1975
10 Heinle 1972
11 Heinle and others 1974
12 Jack McCormick & Associates 1973a
13 Jack McCormick & Associates 1973b
14 Jack McCormick & Associates, Inc. 1974
15 Johnson 1970 (Annual production calculated from tables; Type 38 at Fenno incorrectly labeled *S. alterniflora*)
16 Keefe and Boynton 1973
17 Kuenzler and Marshall 1973
18 McCormick 1970
19 McCormick 1977b
20 McCormick and Ashbaugh 1972
21 Marshall 1970 (Standing crop cited is maximum minus minimum during year)
22 Mendelssohn and Marcellus 1976 (standing crop estimated from graph)
23 Morgan 1961 (data recalculated from table)
24 Nixon and Oviatt 1973
25 Odum and Fanning 1973
26 Potera and MacNamara Mss.
27 Slavin, Good, and Squiers 1975
28 Squiers and Good 1974
29 Stevenson and others 1976
30 Stroud and Cooper 1968 (standing crop cited is maximum minus minimum during year)
31 Stuckey 1970
32 Udell and others 1969
33 Waits 1967 (fide Williams and Murdoch 1972)
34 Wass and Wright 1969
35 Whigham and Simpson 1975
36 Williams and Murdoch 1969
37 Williams and Murdoch 1972 (Data interpreted from graphs)
38 Maldeis 1978
39 Walker and Good 1976
40 Moeller 1964

SUMMARY OF DETAILED DATA ON PRIMARY PRODUCTION

The wetland vegetation types are numbered and listed in Table 22 to correspond with the official list of coastal wetland types in the State of Maryland. The major associations are shrub swamp types (numbers 11 through 13), swamp forest types (21 through 23), freshwater marsh types (30 through 39), brackish marsh types (41 through 51), and saline marsh types (61 through 72).

Data on production are listed either as "Peak Standing Crop" or as "Annual Production (Aerial)." Most estimates of standing crops included values only for the living, aerial plant materials ("Tops"), but several studies presented information on the weight of standing dead material ("Dead"). A few investigators also estimated the amount of material present in live roots and rhizomes ("Roots"). All estimates of standing crops in Table 22 are expressed in both tons per acre and grams per square meter (gm^{-2}).

Annual production is an estimate of the total net production during the entire year. It is expressed in terms of mass per unit area (tons per acre and grams per square meter) and (or) in terms of the equivalent energy stored in chemical form (kilogram-calories per square meter).

COMMENTS ON THE TABULATED DATA

Measurements of the peak standing crop represent the approximate maximum amount of plant tissue present at any one instant during the year. They are considered to be estimates of the minimum amount of annual production.

This interpretation is predicated on the fact that the plant tissue present is herbaceous and that all of it was produced during the contemporary growing season. The method is not appropriate for use in woody vegetation types because part of the standing crop would have been produced during earlier years. Some herbaceous parts that were initiated during the summer or autumn in marshes in North Carolina and other southern states, however, may persist and continue to grow during the following season. In multiple harvest studies that are conducted in these areas, the minimum standing crop (usually measured during January through March) is subtracted from the weight of the peak standing crop to estimate the biomass produced during the current growing season. In Maryland and elsewhere, some leaves and stems (culms) that were formed during the previous year may be mixed with the dead, standing material in stands of big cordgrass, common reed, switchgrass, meadow cordgrass, cattail, and other types of vegetation. It usually is not possible to distinguish the older materials from those that were formed during the current growing season, and measurements of the standing crop, therefore, may overestimate the minimum production for the current year.

Data on the standing crops of roots and rhizomes that are included in Table 22 should be used with discretion. The underground mass of materials of annual plants, such as wildrice, is produced in one growing season and, thus, estimates of this mass correspond to the aerial measurements. The underground mass of materials of herbaceous perennials, such as cattail and spatterdock, however, accumulates over a period of years.Thus, estimates of the below-ground standing crop do not correspond to those for the more ephemeral aerial structures. No estimate of the annual underground production of a perennial plant in the coastal wetlands of the Middle Atlantic Region was found during this literature review.

EVALUATION OF PRODUCTION DATA

Estimates of the mass of the plant tissue produced annually by different herbaceous vegetation types that have been mapped in the coastal wetlands of Maryland range from less than 1 ton per acre (154 gm^{-2}) to 10.3 tons per acre (2311 gm^{-2}) on a dry weight basis. The unweighted average of the standing crops of these types of vegetation is approximately 4.4 tons per acre. This is less than the actual primary production, which probably is in the range from 5 to 6 tons per acre per year (Odum and Skjei 1974). Equal masses of raw plant material from different vegetation types, however, may not be equal in ecological value.

Part of the biomass of plants is composed of relatively inert material that remains as ash when the tissues are incinerated (Table 23). Based on the data assembled during this review, submerged plants, particularly the sealettuce which is an alga, have a higher ash content than the emergent plants. Plants of freshwater marshes appear to have a higher ash content than do those of saline marshes. More certainly, the available data indicate that the ash content of individuals of a particular species may vary significantly during the growing season (Bayly and O'Neill 1972). A more ecologically appropriate unit of comparison for the net production of different types of vegetation, therefore, is the ash-free dry weight of plant tissue.

The proportions of nitrogen, fats, and fiber in the tissues of various species of plants differ widely (Table 23). The nutritive value of the species to herbivores, thus, varies in relation to the proportions of the several food types present. This matter is complicated further, however, by the fact that the nutrient content of different parts of a single plant are not the same—the leaves, the stems, the roots, the flowers, and the fruits and seeds. Some herbivores graze indiscriminately on the entire plants, whereas others are highly selective, and many utilize only the seeds. In addition, the few estimates which are available suggest that relatively little, probably less than 15% in saline areas, but as much as 35 to 40% in fresh areas, of the net production of plant tissue in a tidal wetland is consumed by herbivores (Smalley 1959, 1960; Stevenson, Cahoon, and Seaton 1976). Although exact knowledge of nutrient content may prove to be of value in comparisons of production in the future, as our knowledge of nutrient conversion and cycling increases, at present the information is too scarce to permit its evaluation or use (Table 23).

Preliminary investigations of detritus suggest that the fragmentary plant material present in the detritus largely is in the form of crude fiber and that it serves principally as a substrate for the growth of microorganisms. The high nutrient value of the detritus, therefore, appears largely to be a product of the microbial populations rather than an artifact or a reprocessed form traceable to the original plant materials. The first colonizers of the plant tissue may draw all or most of their sustenance directly from the tissue, but subsequent colonizers apparently do not.

Most analyses of detritus have been conducted on materials derived from smooth cordgrass. There is no information available, therefore, upon which comparisons of the detrital value of tissues from different species of wetland plants can be based. If, indeed, there are significant differences in the detrital value of the various species, measurements of that value would be useful, in combination with measurements of net production, to compare vegetation types from an ecological point of view.

Several investigations have indicated that nutrients and energy also may be transported through the estuarine system in the form of dissolved organic materials. These dissolved substances may be absorbed and utilized by various kinds of organisms, and they may be the source of food utilized by detritus-enriching microorganisms. As our knowledge of the origin, circulation, and fate of these dissolved substances grows, some measure of the contribution made by the various kinds of marsh plants should enhance the value of comparisons of production.

Regardless of how the organic materials produced by the marsh plants are utilized in the system—directly by herbivores or decomposers, or indirectly in a dissolved form—there is no question that ultimately their energy value is extracted and their nutrients are cycled. It seems reasonable, therefore, to assume that the total energy contained in the plant tissues produced by different vegetation types, per unit of area, is a rough measure of relative ecological importance. Several investigators have measured the caloric content of different species of wetland plants (Table 24). The values obtained (expressed as calories per unit of weight) then are multiplied by the estimated biomass of plant tissue produced per unit area to approximate the energy equivalent of the net annual production. As more of these estimates become available, their utility for the evaluation of vegetation types can be assessed more thoroughly.

In summary, current comparisons of the productivity of different wetland vegetation types appear to be limited to evaluations of the mass of plant material produced. Most investigators report the estimated peak standing crop and base these estimates on a single harvest during late summer or early autumn.

The comparisons can be enhanced by utilizing multiple harvest techniques to estimate the net annual production of vegetation types. Furthermore, data expressed in terms of ash-free weight of plant materials will provide a more rational basis for ecological evaluations.

Within the present state of the art, the determination of the caloric content of the plant material would further increase the information available for comparisons. In combination with the estimates of the biomass of tissue produced, measurements of caloric content can be used to express the net annual production in terms of energy per unit area. (Caloric content per unit area is independent of the unit employed to express biomass—that is, whether or not biomass is expressed on an ash-free basis.)

Table 23. Chemical composition of plants known to occur in the coastal wetlands of Maryland or other Middle Atlantic States. Values are expressed as percentages of the total oven-dry weight of tissue. Numbered sources are listed at the end of the table.

Species	Ash	Carbon	Nitrogen	Phosphorus	Crude Protein	Crude Fiber	Fat	Source
Sweetflag			2.53					23
Smooth burmarigold			2.43					23
Carex canescens			1.42					11
Carex rostrata			1.72					11
Carex vesicaria			1.92					11
Twigrush			1.55					11
Spikegrass	5.5				9.6	34.9	1.7	22
		36.6	0.46	0.24				9
	6.7		0.85		5.3	32.4	1.7	20
Creeping spikerush			2.37					11
Spotted touch-me-not			3.45					23
Softrush			1.05					11
Needlerush		43.2	0.78	0.14				9
		41.9	0.95					24
Justicia americana			2.0					2
			3.6					2

Table 23. Chemical composition of wetland plants (Continued).

Species	Ash	Carbon	Ni- trogen	Phos- phorus	Crude Protein	Crude Fiber	Fat	Source
			2.83	0.18				3
			1.63	0.09				3
Spatterdock								
Tops, date 6/24	26.0							10
6/26	20.1							10
7/10	15.6							10
8/16	25.1							10
9/17	21.8							10
Rhizomes, date 6/24	44.2							10
6/26	44.1							10
7/10	38.7							10
8/16	29.7							10
Tops, mean	21.7							10
Rhizomes, mean	39.2							10
Arrowarum			3.59					23
Tops, date 6/14	12.9							10
6/18	12.8							10
7/10	32.3							10
8/16	27.8							10
8/27	32.8							10
9/21	37.7							10
Rhizomes, date 6/14	20.0							10
6/18	18.8							10
7/10	19.6							10
8/16	42.2							10
8/27	56.4							10
Tops, mean	26.1							10
Rhizomes, mean	31.4							10
Reed canarygrass			1.73					23
Common reed			1.76	0.12				8
			1.56	0.14				8
			1.80	0.17				19
			0.90	0.08				19
			0.65	0.05				19
			1.88	0.17				1
			1.59	0.07				1
			2.04	0.15				1
			1.30	0.03				1
			1.60	0.10				1
			2.11	0.12				1
			2.70	0.15				1
			3.57					1
Arrowleaf tearthumb			2.30					23
Duckpotato			2.04					2
			2.91					2
				0.30				4
Common threesquare		40.8	0.80	0.10				9
Smooth cordgrass								
Short form	20.6				14.4	9.2	1.6	22
Stand	13.3				8.8	30.4	2.4	20
Stand, live	16.2	38.7	0.70	0.15				15
Stand, dead	26.2	33.0	0.61	0.08				15

Table 23. Chemical composition of wetland plants (Continued).

Species	Ash	Carbon	Ni-trogen	Phos-phorus	Crude Protein	Crude Fiber	Fat	Source
With Distichlis, live	18.0	36.7	0.79	0.12				15
With Distichlis, dead	33.4	29.9	0.68	0.08				15
With tall form, live	22.2	35.7	0.80	0.15				15
With tall form, dead	48.2	21.6	1.36	0.12				15
Litter	37.2				5.0			18
Smooth cordgrass								
Medium form	7.9				14.9	17.2	2.9	22
Mature leaves	11.7			0.13	5.7	27.9	2.4	5
Weathered leaves	13.9			0.05	4.0	35.6	0.8	5
Tall form	10.6							17
	11.0				12.4	17.9	2.3	22
Mature leaves	9.8			0.17	8.5	29.4	2.8	5
Mature leaves	11.5			0.18	9.8	31.0	2.4	5
Mature leaves,								
stems	10.6			0.14	7.9	31.2	2.2	5
Young leaves	12.8			0.25	13.2	29.8	3.0	5
Live	12.6				7.5	39.7		18
Litter	34.7				6.1			18
Form unspecified								
Live		41.3	1.57					7
Live		38.3						25
Live			0.54					21
Live			1.40					13
Sprout	13.0							25
Mature	14.0							25
Dead	28.0							25
Dead		46.7	1.60					16
Big cordgrass			1.20	0.14				12
		32.1	0.45	0.10				9
	5.3							16
Meadow cordgrass	7.4				10.0	16.9	1.5	22
	9.0		0.96		6.0	30.0	2.2	20
Narrowleaf cattail								
Tops, date 6/18	7.0							10
7/16	5.8							10
8/22	7.9							10
9/17	5.8							10
Rhizomes, date 6/18	21.2							10
7/16	27.8							10
8/22	33.1							10
Tops, mean	6.6							10
Rhizomes, mean	27.7							10
			1.92					11
Common cattail			1.4	0.17				14
			0.9	0.13				14
			2.3	0.14				14
			2.0	0.18				14
			3.6	0.30				14
Sealettuce	58.2				20.8	2.3	0.5	22
Wildrice								
Tops, date 6/18	26.0							10
6/26	16.7							10

Table 23. Chemical composition of wetland plants (Concluded).

Species	Ash	Carbon	Ni-trogen	Phos-phorus	Crude Protein	Crude Fiber	Fat	Source
7/16	7.8							10
8/06	9.9							10
8/27	9.5							10
9/17	13.3							10
Roots, date 6/18	21.9							10
6/26	33.4							10
7/16	22.9							10
8/06	26.7							10
8/27	25.5							10
Tops, mean	13.9							10
Roots, mean	26.1							10
			0.9					23
Eelgrass	19.8				14.6	4.3	1.1	6
Leaves		44.5	1.91	0.04				6
Partly decayed		42.8	1.95					6
Rhizomes		34.1	1.01					6

LIST OF SOURCES

1 Allen and Persall 1963★
2 Boyd 1968★
3 Boyd 1969★
4 Boyd 1970★
5 Burkholder 1956
6 Burkholder and Doheny 1968
7 Burkholder and others 1959
8 Buttery and others 1965★
9 de la Cruz 1973
10 Good and others 1975
11 Gorham 1953★
12 Johnson 1970
13 Hall and others 1970
14 Harper and Daniel 1934★
15 Keefe and Boynton 1973
16 Odum and de la Cruz 1967
17 Odum and Fanning 1973
18 Squiers and Good 1974
19 Stake 1967★, 1968★
20 Stuckey 1970
21 Taschdjian 1954★
22 Udell and others 1969
23 Whigham and Simpson 1975
24 Williams and Murdoch 1972
25 Williams and Murdoch 1969

★References followed by an asterisk were not consulted; cited data are from a review by Keefe (1972).

Table 24. Caloric content of marsh plants. Values are expressed as gram-calories per gram of oven-dry tissue (dry weight) or per gram of ash-free tissue. Values from Udell and others (1969) were recalculated by using factors listed by Odum (1971). Numbered sources are listed at the end of the table.

Species	Dry Weight Total	Dry Weight Ash-Free	State	Source
Spikegrass	2556		NY	14
Live plants		4498	MS	4
		4654	MS	5
Needlerush	4397		NC	15
Live leaves		4740	MS	4
Live leaves		4791	FL	7
Dead leaves		4641	MS	4
Dead leaves		4279	FL	7
Partially decayed		4711	MS	4
Particulate detritus		4911	MS	4
		4692	MS	1
Diverse-leaved watermilfoil				
Tops, early summer	3961		TN	1
Spatterdock				
Tops, early summer	4315		TN	1
Tops, 24 June	3079	4162	NJ	6
Tops, 10 July	2391	3898	NJ	6
Tops, 16 August	3124	4173	NJ	6
Rhizomes, 24 June	2224	3988	NJ	6
Rhizomes, 16 August	3109	4425	NJ	6
Tops, mean	2865	4078	NJ	6
Rhizomes, mean	2667	4207	NJ	6

Species	Dry Weight Total	Dry Weight Ash-Free	State	Source
Arrowarum				
Tops, 14 June	3745	4301	NJ	6
Tops, 10 July	2953	4359	NJ	6
Tops, 21 September	2660	4270	NJ	6
Rhizomes, 14 June	3349	4184	NJ	6
Rhizomes, 10 July	3528	4391	NJ	6
Tops, mean	3119	4310	NJ	6
Rhizomes, mean	3439	4288	NJ	6
Common threesquare				
Live plants		4523	MS	4
		4459	MS	5
Smooth cordgrass				
Tall form	3900	4350	NJ	12
	3423		NY	14
	4135		NC	13
	4100	4590	GA	10
Mature leaves	3748	4157	GA	2
Mature leaves	3616	4085	GA	2
Mature leaves and stems	3726	4169	GA	2
Young leaves	3704	4249	GA	2
Weathered stems	3704	4299	GA	2

Table 24. Caloric content of marsh plants (Concluded).

Species	Dry Weight Total	Ash-Free	State	Source
Medium form	3284		NY	14
	3940		NC	13
	4028		GA	11
Leaves only	4113		GA	11
Mature leaves	3594	4071	GA	2
Dead stems	3777		GA	11
Short form	3900	4530	NJ	12
	2676		NY	14
	3948		NC	13
Unspecified form				
Live plants		3922	GA	3
Live plants		4094	LA	8
Dead plants		3788	GA	3
Dead plants		3884	LA	8
Partially decayed		3832	GA	3
Particulate detritus		3525	GA	3
Big cordgrass	4220	4460	GA	10
		4560	MS	4
		4597	MS	5
Meadow cordgrass	3194		NY	14
Narrowleaf cattail				
Tops, 18 June	4082	4390	NJ	6
Tops, 22 August	4097	4449	NJ	6
Tops, 17 September	4170	4424	NJ	6
Rhizomes, 18 June	3413	4329	NJ	6
Rhizomes, 22 August	2875	4296	NJ	6
Tops, mean	4116	4421	NJ	6
Rhizomes, mean	3114	4313	NJ	6
Common cattail				
Tops, early summer	4262		TN	1
Sealettuce	1814		NY	14
Various aquatic macrophytes				
Mean		4300		1
Wildrice				
Tops, 18 June	3292	4448	NJ	6
Tops, 26 June	3636	4364	NJ	6
Tops, 27 August	3922	4332	NJ	6
Tops, 17 September	3567	4114	NJ	6
Roots, 18 June	2656	3400	NJ	6
Roots, 26 June	3150	4732	NJ	6
Roots, 16 July	2614	3391	NJ	6
Roots, 27 August	3012	3938	NJ	6
Tops, mean	3604	4315	NJ	6
Roots, mean	2858	3865	NJ	6
Eelgrass	3239		NY	14

LIST OF SOURCES

1 Boyd 1968, 1970
2 Burkholder 1956
3 de la Cruz 1965
4 de la Cruz 1973
5 Gabriel and de la Cruz 1974
6 Good and others 1975
7 Heald 1969
8 Kirby 1971
9 Odum 1971
10 Odum and Fanning 1973
11 Smalley 1960
12 Squiers and Good 1974
13 Stroud and Cooper 1968
14 Udell and others 1969

2.3. DETRITUS

The net aboveground production of vascular plant materials in the coastal wetlands of the Middle Atlantic Coast averages about 4 to 5 tons per acre per year, exclusive of the materials that are eaten by herbivorous animals. The herbaceous aerial parts of most of the plants die during the autumn, and nearly all of the soluble food materials are leached from the dead remains when they next are flooded or when the next rain falls. Less is known about the amount and fate of net belowground production, which may be nearly equal to the aboveground production in some types of wetland vegetation. At least a part, however, must seep through the soil and into the water column in dissolved form (Gardner 1975; de la Cruz and Hackney 1977). Dissolved organic matter from the plants is absorbed from the water rapidly by microorganisms in the sediments and in the water column.

The leaching of dead plants releases such vitamins as biotin, cobalanin, niacin, and thiamin, as well as quantities of nutritious sugars. Organic acids, amino acids, and polypeptides, which also are released, may form complexes with such micronutrients as copper, iron, manganese, phosphate, and zinc, and thus may make these micronutrients available to the plankton organisms.

The bulk of the dead plant tissues falls to the surface of the wetland within a few weeks. Some of this material is carried, more or less intact, into the waters of the estuary or the nearshore ocean by tidal currents. The remainder begins to decompose in place. Belowground plant material is brought to the surface by such burrowing organisms as fiddler crabs and polychaete worms, and it is exposed by erosion and by human activities (de la Cruz and Hackney 1977). The amount of this material is small in comparison with the aerial tissues, but it becomes mixed with, and supplements, the aboveground material.

The primary production of submerged aquatic plants also is important to the estuarine system (Burkholder and Doheny 1968; McRoy 1970). Approximately 20% of the fresh leaves of eelgrass and 12% of the senescent leaves are formed by water soluble organic material (Mann 1972). These soluble constituents leach rapidly when the leaves die, and they add to the dissolved organic material available to aquatic organisms (Fenchel 1977). The dead leaves are surrounded by water, so all of the insoluble material enters the water column. Some of the insoluble tissue may be lost to the aquatic system when it is washed ashore and subsequently carried farther inland by winds or when accumulations are removed from beaches and deposited on inland disposal sites.

Fungi and bacteria are the principal agents in the decomposition of the plant tissues. Their actions, in combination with mechanical erosion by tidal waters and the activities of amphipods, grass shrimp, crabs, insects, and other wetland animals, fragment the plant materials (Fenchel 1970; Hargrave 1970; May 1974; Welsh 1975). Those pieces that are near the limit of visibility, and which become suspended in the water as the tides flood the wetland, are known as particulate detritus (de la Cruz 1973).

The minute plant fragments are composed of cellulose and lignin. These substances, which are the basic components of wood, are so resistant that they are of little value as food to macroinvertebrates and larger animals, and are relatively resistant to further decomposition by microorganisms. The fragments serve as rafts and as a growth substrate for bacteria, fungi, and protozoa. These microorganisms colonize the particles of plant material; feed on the cellulose and, to a lesser extent, on the lignin; and absorb dissolved organic materials from the surrounding water.

The value of particulate detritus, with its adhering bacteria, as food for filter feeders was recognized by Blegvard (1914), Bond (1933), Waksman (1934), ZoBell (1946), and many more recent investigators. Waksman (1933) also observed that "marine humus," or organic matter that is mixed with bottom muds and sand, is utilized as a source of food by such deposit feeders as shrimp and segmented worms.

The activities and growth of the colonizing microorganisms increase the concentrations and complexity of the proteins in the detrital materials, and maintain or enhance the caloric value of the detritus (Burkholder 1956; Odum and de la Cruz 1967; Keefe 1972; Ranwell 1972; de la Cruz 1973). The fatty acid content of the detritus also is increased by the activities of the microorganisms, and becomes several times as great as that in the plants before death (Schultz and Quinn 1973).

Although the original fragments of plant material are not utilized directly as food by most macroscopic animals, the detritus particles are rich in proteins, fatty acids, and other nutritious substances. In point of fact, the microbe-rich detritus is believed to be nutritionally a more useful food for marine animals than are the original green plant tissues (Starr 1956; de la Cruz 1965; Odum and de la Cruz 1967; Heald 1969; Odum 1970; de la Cruz and Gabriel 1974; Odum and Skjei 1974). Various studies now are underway to determine the degree to which different aquatic organisms may be sustained by detritus. It appears, however, that filter feeders, benthic scavengers, and other organisms are the principal "detritivores" or detritus feeders (Table 25).

Detritivores apparently ingest the detritus particles and strip them of their coatings of microorganisms. They derive their nutrition, thus, from the fungi, bacteria, and protozoa, as well as from the plant material (Baier 1935; ZoBell and Feltham 1938, 1942; Adams and Angelovic 1970; Fenchel 1970, 1972). Some of the plant particles, which may be broken into still smaller pieces by the digestive processes of the animals, are excreted. The excreted fragments then may be recolonized by microorganisms, and the detritus may be recycled several times before the plant substrate is disintegrated (Nelson 1947; Keefe 1972; Heinle and others 1974). Microorganisms may not be able to colonize extremely small particles (20 microns or less; Weibe and Pomeroy 1972), but such particles may reaggregrate and be colonized densely (Odum, Zieman, and Heald 1972).

Detritus is the base of the decomposer food web. The primary consumers, or detritivores, are eaten by other animals—the secondary consumers—and those, in turn, are fed upon by tertiary consumers.

The rate of flow of energy through the detritus food web of the estuary from season to season is less variable than the rate of flow through the herbivore food web, which is based on green plants (Keefe 1972). Although the amount of dead vegetation is at a maximum during late autumn and winter, it decomposes relatively slowly owing to low temperatures. During late spring and throughout the summer and early autumn, temperatures are relatively high, and the decomposition of the remaining dead vegetation progresses rapidly. As a result of these variations in the supply of material and in the rate of its decomposition, there is a continuous and relatively constant supply of food available to the detritus feeders.

Tidal wetlands are the principal source of organic material, as measured by carbon, in most of the estuaries of the Middle Atlantic Coast. In the upper section of Chesapeake Bay, however, Biggs and Flemer (1972) found that tree leaves and other materials derived from the uplands collectively are the largest single source of carbon. In regard to the entire Bay, however, the quantity of carbon from upland sources is estimated to be about equal to the quantity fixed by algae that live in the water, but approximately 80% of the total available carbon originates from tidal wetlands (Flemer and others 1970).

Stable marshes, in which the levees of creeks and rivers are lined with stands of big cordgrass, and scoured marshes, which appear to be of more recent origin and which have no levees, were recognized along the Patuxent River by Heinle and others (1975). They estimated that less than 1% of the annual production of the stable marshes is moved into the waters of the estuary. Heinle and others (1974), however, found that 6 to 9% of the production of Gotts Slough, a stable marsh, was exported. In contrast, it was estimated that virtually all of the material produced annually is moved, largely by ice-rafting, from the scoured marshes into the estuary during the period from January through March (Heinle and others 1975). The carbon budget of the estuary, and the supply of detritus, therefore, may be considerably greater during years with severe winters and widespread ice than during years in which the winters are mild and little or no ice is formed on the marshes.

2.4 WILDLIFE FOOD PLANTS OF THE COASTAL WETLANDS

Food, cover, water, space, and freedom from disturbance are the basic requirements of wildlife. The availability of these resources and their geographic relation to one another generally determine the relative value of a particular habitat.

In the level, rockless coastal wetlands of Maryland, plants are the sole source of cover. All food is derived directly or indirectly from plants. Many kinds of wetland wildlife are herbivores (plant eaters) or omnivores (general feeders). The predators feed on these animals or on other predators which have fed on the plant eaters. Detritus feeders, which obtain energy and materials from decaying plant remains, form another major circuit which utilizes and transfers food originally formed by plants.

Table 25. Some estuarine and saline marsh animals that utilize detritus as part of their normal diets (Teal 1962; Adams and Angelovic 1970; de la Cruz 1973). The names of species in which organic detritus composed 25% or more of the food of some stage in the life history (Darnell 1961) are preceded by a star (★). Letters following names indicate: F, filter feeder; D, deposit feeder; and S, scavenger, which feeds on large organic debris, as animal bodies (Dexter 1947).

Common name	Scientific name
Sponges	
Sponge	*Chalina oculata* (F)
Hydroids, Anemones	
Hydroid	*Abietinaria abietina* (F)
Hydroid	*Clava leptostyla* (F)
Hydroid	*Obelia* spp. (F)
Hydroid	*Sertularia pumila* (F)
Hydroid	*Tubularia spectabilis* (F)
Sea anemone	*Metridium senile* (F)
Bryozoans	
Bryozoan	*Bugula turrita* (F)
Bryozoan	*Lichenopora hispida* (F)
Mollusks: Snails and Slugs	
Snail	*Bittium varium*
Perwinkles	*Littorina* spp.
Marsh snails	*Melampus* spp.
Limpet	*Acmaea testudinalis* (F)
Limpet	*Crepidula fornicata* (F)
Mollusks: Bivalves	
Razor clam	*Ensis directus* (F)
Gem shell	*Gemma gemma* (F)
Bivalve	*Hiatella arctica* (F)
Baltic macoma	*Macoma balthica* (F)
Atlantic ribbed Mussel	*Modiolus demissus* (F)
Blue mussel	*Mytilus edulis* (F)
★Common rangia clam	*Rangia cuneata*
Sand-bar clam	*Siliqua costata* (F)
Bivalve	*Solemya velum* (F)
Segmented Worms	
Polychaete worm	*Clymenella torquata* (D)
Blood worm	*Glycera dibranchiata*
Polychaete worm	*Lumbrinereis tenuis* (D)
Polychaete worm	*Spirorbis spirillum* (S)
Insects	
Springtails	
Dolichopodid flies	
Ephyrid flies	
Crustaceans: Barnacles	
Acorn barnacle	*Balanus balanoides* (F)
Acorn barnacle	*Balanus eburneus* (F)
Crustaceans: Isopods	
Isopods	Unidentified species
Isopod	*Philoscia vittata* (S)
Crustaceans: Amphipods	
Amphipod	*Caprella penantis* (S)
Amphipods	*Gammarus* spp. (S)
Amphipod	*Talorchestia longicornis* (S)
Amphipod	*Orchestia platensis* (S)
Crustaceans: Shrimp	
Sand shrimp	*Crangon septemspinosa* (D)
★River shrimp	*Macrobranchium ohione*
Grass shrimp	*Paleomonetes pugio*
★White shrimp	*Penaeus setiferus*
Crustaceans: Crabs	
★Blue crab (juvenile, adult)	*Callinectes sapidus*
Rock crab	*Cancer irroratus* (S)
Green crab	*Carcinus maenus* (S)
Hermit crab	*Pagurus longicarpus* (S)
Marsh crab	*Sesarma reticulatum*
Fiddler crabs	*Uca* spp.
Tunicates	
Sea grapes	*Mogula manhattensis* (F)
Fish	
Ladyfish (juvenile)	*Elops saurus*
American eel	*Anguilla rostrata* (F)
Alewife	*Alosa pseudoharengus* (F)
★Gulf menhaden (young, juvenile)	*Brevoortia patronus*
Atlantic herring	*Clupea h. harengus* (F)
★Gizzard shad (adult)	*Dorosoma cepedianum*
Threadfin shad (juvenile)	*Dorosoma petenense*
★Bay anchovy (juvenile, adult)	*Anchoa mitchilli*
Rainbow smelt	*Osmerus mordax* (S)
★Blue catfish (juvenile, adult)	*Ictalurus furcatus*
★Channel catfish (juvenile)	*Ictalurus punctatus*
★Sea catfish (juvenile, adult)	*Arius felis*
Pollock	*Pollachius virens* (F)
★Atlantic needlefish (adult)	*Strongylura marina*
Sheepshead minnow	*Cyprinodon variegatus*
Mummichog, killifish	*Fundulus* spp. (F,S)[1]
Mosquitofish	*Gambusia affinis*
Sailfin molly	*Poecilia latipinna*
Tidewater silverside (adult)	*Menidia beryllina*
Northern pipefish	*Syngnathus fuscus* (F)
Yellow bass (adult)	*Morone mississippiensis*
Bluefish	*Pomatomus saltatrix* (F)
Pinfish (juvenile, adult)	*Lagodon rhomboides*
Freshwater drum (juvenile)	*Aplodinotus grunniens*
Silver perch (adult)	*Bairdiella chrysura*
Sand seatrout (juvenile, adult)	*Cynoscion arenarius*
Spotted seatrout (juvenile, adult)	*Cynoscion nebulosus*
★Spot (juvenile, adult)	*Leiostomus xanthurus*
★Atlantic croaker (all ages)	*Micropogon undulatus*
Red drum (adult)	*Sciaenops occellata*
Cunner	*Tautogolabrus adspersus* (F)
★Striped mullet (juvenile, adult)	*Mugil cephalus*
Atlantic mackerel	*Scomber scombrus* (F)
Grubby	*Myoxocephalus aenaeus* (S)
Longhorn sculpin	*Myoxocephalus octodecemspinosus* (F)
Shorthorn sculpin	*Myoxocephalus scorpius* (S)
★Hogchoker (adult)	*Trinectes maculatus*

[1]Schmelz 1964; Jeffries 1972; Lotrich 1975.

Water permeates the exposed wetlands and covers submerged wetlands. The major regional control of water, other than to produce the saturated condition of the wetlands, is exerted through its quality. The gradient of salinity from the ocean to the uppermost reaches of the tidal streams largely determines the nature and distribution of wetland vegetation types. Locally, the duration and depth of water are important habitat determinants.

Space is a psychological requirement of territorial animals. This is evident among predatory mammals and certain kinds of waterfowl, which appear to require visual isolation from other nesting pairs. Because vegetation can obscure visual contact, it can substitute for spatial separation for waterfowl. Vegetation also affords nest sites, nesting materials, refuge from floodwaters, hunting perches, song posts, and other requirements in addition to basic food and cover.

Most kinds of animals appear to relate more closely to the gross form of vegetation than to the species of plants of which the vegetation is composed. Although there are several major structural types of vegetation in the coastal wetlands—herbaceous marshes, shrub swamps, and forested swamps—the bulk of the wetlands are formed by the herbaceous marshes. More subtle features of vegetation structure, correlated tidal characteristics, associated distributions of smaller food animals, such as crabs and clams, and plant palatability appear to be principal determinants of marsh wildlife habitat suitability.

EMERGENT PLANTS USED AS FOOD

Information on the utilization by wildlife of various wetland plants for food is summarized in the four accompanying tables. Emergent plants which produce fruits or seeds that are eaten by birds and/or mammals are listed in Table 26. The foliage, stems, and/or rootstocks of emergent plants listed in Table 27 are of value to wildlife. Animals that feed on the products of trees and shrubs are tallied in Table 28, and those that feed on submerged plants are evaluated in Table 29.

Numerals in the tables are estimates of the relative importance of each kind of plant in the diets of animals that utilize it. These symbols are defined in Table 26. The higher numerals indicate that a greater proportion of the diet is composed of the species.

These values are based on analyses of the contents of gizzards, crops, stomachs, and/or droppings, and on qualitative field observations. The types and number of analyses vary from one species of animal to another, and the analyses were conducted in different seasons. In the laboratory analyses and in examinations of droppings, resistant materials are over-represented. Soft-bodied insects, fleshy fruits, and other easily digested materials are disintegrated quickly after they are ingested, and they are under-represented in the analyses. Thus, plant foods may be overrated in the total diets of some kinds of animals, and plants that lack resistant parts may be underrated. Nevertheless, the system that is utilized in this section yields the most usable indexes to the relative importance of different kinds of plants to wildlife. The values for any particular species of animal may not depict accurately the true mix of its diet. When the values are summed for each species of plant, however, the totals allow a rough approximation of overall relative importance to all types of wildlife. A large difference between the sums for any two kinds of plants suggests that one kind of plant is more valuable to wildlife in general than the other. Small differences probably are not significant. A plant that is indicated to be of low value to wildlife in general may be a prime food of one or a few species. If only the soft, easily digested parts of a plant are eaten, however, the rating derived from this system probably will be erroneously low. The tables, therefore, should be used with appropriate discretion.

Table 26. Emergent herbaceous wetland plants whose seeds or fruits are utilized as food by wetland wildlife (Martin and others, 1951).[a]

	Arrowarum	Arrowheads	Bulrushes	Burmarigold	Burreeds	Canarygrass	Cattails	Cordgrasses	Glassworts	Goldenrod	Orach	Panicgrass	Pickerelweed	Reed grass	Rice Cutgrass	Sedge	Smartweeds	Spatterdock	Touch-me-not	Umbrellasedge	Waterhemp	Walter millet	Wildrice
Waterfowl																							
Coot			5		2											2	2						5
Ducks																							
Baldpate			4		3							3c				2	2					3	3
Black			4		3			4					2			3	3				2		4
Bufflehead			2		2												2						3
Canvasback			5																				4
Gadwall			5									2c											
Goldeneye, American																2	2						
Mallard			4		2			2									5			3		4	5

Table 26. Emergent herbaceous wetland plants whose seeds or fruits are utilized as food by wetland wildlife (Continued).

	Arrowarum	Arrowheads	Bulrushes	Burmarigold	Burreeds	Canarygrass	Cattails	Cordgrasses	Glassworts	Goldenrod	Orach	Panicgrass	Pickerelweed	Reed grass	Rice Cutgrass	Sedge	Smartweeds	Spatterdock	Touch-me-not	Umbrellasedge	Waterhemp	Walter millet	Wildrice
Pintail			5						4							2	5			2		4	4
Redhead			4		2											2	3						5
Ringneck			3		2											2	4			2		2	4
Ruddy			4														2						
Scaup, greater			2		3				2														2
Scaup, lesser			3													2	2						4
Shoveller			5													2	2					3	
Teal, blue-winged			4		2							3c				3	3			3		2	3
Teal, green-winged			5					2				5c				4				4		4	4
Wood	4			3	4								2			3	4	3					5
Goose, snow																							3
Swan, whistling			2														4						
Marsh and Shore Birds																							
Dowitcher, eastern			2d														2						
Gallinule, purple												2										3	
Knot, American			2d																				
Rails																							
Clapper			2d					3								2	2						
King	2	3	2d		2												2						
Sora			4d		2			3				2		3	3	5	7					5	3
Virginia			3d					3								2	2	2					4
Yellow			2d													4	4						
Sandpipers																							
Pectoral			2d									2					2						
Semipalmated			3d				2									2							
Stilt			2d													2							
White-rumped																2							
Snipe, Wilson			3d		2											2	3					2	
Songbirds																							
Blackbirds																							
Red-winged												5					4					2	4
Rusty																							4
Bobolink												3					3			2			5
Bunting, snow			2									2											
Cardinal												3											
Cowbird												5											
Creeper, brown												2											
Crow, fish																							3
Goldfinch										3													
Grackle, boattailed																				3			

Table 26. Emergent herbaceous wetland plants whose seeds or fruits are utilized as food by wetland wildlife (Continued).

	Arrowarum	Arrowheads	Bulrushes	Burmarigold	Burreeds	Canarygrass	Cattails	Cordgrasses	Glassworts	Goldenrod	Orach	Panicgrass	Pickerelweed	Reed grass	Rice Cutgrass	Sedge	Smartweeds	Spatterdock	Touch-me-not	Umbrellasedge	Waterhemp	Walter millet	Wildrice
Songbirds, continued																							
Grosbeak, blue												4											
Hummingbird, ruby-throated																			4b				
Junco										2		3											
Lark, horned												2											
Longspur, Lapland												3											
Meadowlark, eastern												2					2						
Pipit, American												2											
Siskin, pine										2													
Sparrows																							
Bachman's												5											
Chipping												3											
English												2											
Field												4											
Grasshopper												2			2	3							
Henslow												2											
Ipswich											4	2											
Lincoln												5											
Savannah												4					3					3	
Seaside								5			4						3						
Sharp-tailed								6			2	2											4
Song			2									4				3	5						2
Swamp				2						2		4			3	5	5						
Tree										2		4			3								
Vesper												3											
White-crowned												4											
White-throated												3											
Upland Game Birds																							
Dove, mourning												3											
Grouse, ruffed																			2				
Pheasant, ringneck				2		2						2							2				
Quail, bobwhite												2					5		2				
Turkey, wild												2											
Woodcock												2											
Mammals																							
Cottontail, eastern										2c													
Meadow vole, eastern			2							2c													
Mouse, whitefoot																			2				
Muskrat													2										

Table 26. Emergent herbaceous wetland plants whose seeds or fruits are utilized as food by wetland wildlife (Concluded).

	Arrowarum	Arowheads	Bulrushes	Burmarigold	Burreeds	Canarygrass	Cattails	Cordgrasses	Glassworts	Goldenrod	Orach	Panicgrass	Pickerelweed	Reed grass	Rice Cutgrass	Sedge	Smartweeds	Spatterdock	Touch-me-not	Umbrellasedge	Waterhemp	Walter millet	Wildrice
Summary																							
Waterfowl																							
Number of user species	1	0	17	1	10	0	0	3	2	0	0	4	2	0	0	12	15	1	0	5	1	7	15
Total of Scores	4	0	66	3	25	0	0	8	6	0	0	13	4	0	0	29	45	3	0	14	2	22	58
Marsh and Shore Birds																							
Number of user species	1	1	11	0	3	0	1	3	0	0	0	4	0	1	1	8	8	1	0	0	0	3	2
Total of scores	2	3	27	0	6	0	2	9	0	0	0	9	0	3	3	21	24	2	0	0	0	10	7
Songbirds																							
Number of user species	0	0	2	1	0	0	0	2	0	5	3	28	0	0	2	3	8	0	1	2	0	2	6
Total of Scores	0	0	4	2	0	0	0	11	0	11	10	89	0	0	6	10	28	0	4	5	0	5	22
Upland Game Birds																							
Number of user species	0	0	0	1	0	1	0	0	0	0	0	5	0	0	0	0	1	0	3	0	0	0	0
Total of scores	0	0	0	2	0	2	0	0	0	0	0	11	0	0	0	0	5	0	6	0	0	0	0
Mammals																							
Number of user species	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	0	0	0
Total of Scores	0	0	2	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0	2	0	0	0	0

[a] Numerical scores indicate extent of use: (1) undetermined; (2) 0.5 to 2% of diet; (3) 2 to 5% of diet; (4) 5 to 10% of diet; (5) 10 to 25% of diet; (6) 25 to 50% of diet.
[b] Utilizes nectar
[c] Also utilizes foliage
[d] Also utilizes rootstocks

Table 27. Emergent herbaceous wetland plants whose vegetative parts are utilized as food by wildlife (Martin and others 1951). Except as indicated by footnotes, the rootstocks are utilized. Scores are defined in Table 26.

	Arrowheads	Bulrushes	Burreeds	Cattails	Cordgrasses	Glassworts	Goldenrod	Panicgrasses	Rice cutgrass	Rushes	Spatterdock	Spikegrass
Waterfowl												
American brant					2							
Ducks												
Baldpate									4[d]			
Black	3[d]											2[c]
Canvasback	2[d]											
Gadwall	4[d]											
Mallard	2[d]								3[d]			
Pintail	3[d]								2[d]			
Ringneck	3[d]								3[d]			

Table 27. Emergent herbaceous wetland plants whose vegetative parts are utilized as food by wildlife (Martin and others 1951). Except as indicated by footnotes, the rootstocks are utilized. Scores are defined in Table 26 (Concluded).

	Arrowheads	Bulrushes	Burreeds	Cattails	Cordgrasses	Glassworts	Goldenrod	Panicgrasses	Rice cutgrass	Rushes	Spatterdock	Spikegrass
Ruddy	2[d]											
Scaup, lesser	3[d]								2[d]			
Shoveller												2[c]
Teal, bluewing	2[d]								3[d]			
Teal, greenwing									3[d]			
Wood	3[d]								2[d]			
Geese												
Canada		5[b]			6	2[b]						2[c]
Snow					5							3[c]
Swan, whistling	4[d]											
Upland Game Birds												
Grouse, ruffed							2					
Mammals												
Beaver											4[a]	
Deer, whitetail							2					
Muskrat	4	5[a]	5	6[a]				4[b]	4[a]	3		
Summary												
Waterfowl												
Number of user species	11	1	0	0	3	1	0	0	8	0	0	4
Total value	31	5	0	0	13	2	0	0	22	0	0	9
Upland Game Birds												
Number of user species	0	0	0	0	0	0	1	0	0	0	0	0
Total value	0	0	0	0	0	0	2	0	0	0	0	0
Mammals												
Number of user species	1	1	1	1	0	0	1	1	1	1	1	0
Total value	4	5	5	6	0	0	2	4	4	3	4	0

[a]Utilizes aerial parts as well as rootstocks.
[b]Utilizes only aerial parts.
[c]Utilizes young plants, rootstocks, and seed heads.
[d]Also utilizes seeds.

Table 28. Wetland shrubs and trees which are utilized as food by wildlife (Martin and others 1951). Numerical scores are defined in Table 26. Plant parts eaten are indicated by footnotes.

	Alders	Arrowwoods	Ashes	Baldcypress	Blackberries	Blackgum	Blueberries	Buttonbush	Dogwoods	Magnolias	Maples	Myrtles	Oaks	Persimmon	Pines	Roses	Spicebush	Sweetgum	Tuliptree	Willows
Waterfowl																				
Ducks																				
Gadwall				2d				2d												
Mallard				2d				2d					3d					2d		
Ring-necked								2d												
Teal, blue-tailed								2d												
Teal, green-tailed								2d												
Wood			2d			3d		2d	2d			3d								
Gull, herring							3d													
Marsh and Shore Birds																				
Dowitcher												2d								
Rails																				
Clapper													2d							
King												2d								
Virginia								2d												
Yellow												2d								
Songbirds																				
Blackbirds																				
Red-winged					2d														2d	
Rusty					2d								2d							
Bluebird					2d	2d	4d		3d			3d								
Bunting, indigo					1d															
Cardinal		2d	2d		4d				4d										3d	
Catbird					5d		3d		3d			4d		3d			2d			
Chat, yellow-breasted					5d		3d													
Chickadees																				
Black-capped							2d					2d			4d					
Carolina											2b	2d			4d			2d	1d	
Creeper, brown															3d					
Crow																				
Common					2d	2d						2d	3d							
Fish					4d		2d					2d								
Crossbills																				
Red															7d					
White-winged															5d					
Finch, purple			3d			2d			3d		3b							3d	4d	
Flicker					2d	3d	2d		3d			2d	2d							
Flycatcher, crested		2d			2d		2d		2d								2d			
Goldfinch	3d										2b				2d			4d	4d	
Grackle																				
Boat-tailed												2d								

Table 28. Wetland shrubs and trees which are utilized as food by wildlife (Martin and others 1951). Numerical scores are defined in Table 26. Plant parts eaten are indicated by footnotes (Continued).

	Alders	Arrowwoods	Ashes	Baldcypress	Blackberries	Blackgum	Blueberries	Buttonbush	Dogwoods	Magnolias	Maples	Myrtles	Oaks	Persimmon	Pines	Roses	Spicebush	Sweetgum	Tuliptree	Willows
Purple					3d								4d							
Grosbeak																				
Evening			2d		2d				6d		6b									
Pine			3d		5d				3d		4b				6d					
Rose-breasted					3d						3b		2d							
Hummingbird, ruby-throated																			1e	
Jay, blue					3d		2d						6d							
Junco															2d			2d		
Kingbird					2d		2d		3d								2d			
Meadowlark, eastern												3d	2d		3d					
Mockingbird					3d	3d			2d			2d		1d						
Nuthatches																				
Brown-headed															6d					
Rose-breasted											3b				6d					
White-breasted													5d		3d					
Oriole																				
Baltimore					3d		2d													
Orchard					4d		3d													
Phoebe					2d		2d					2d								
Robin		2d			4d	4d	2d		4d					3d			2d			
Sapsucker, yellow-bellied			2e			2e			3d	2e	2e		2e	1d	2e			1e	2e	
Siskin, pine															4d					
Sparrows																				
Bachman's							3d								2d					
Fox					4d															
Henslow					3d															
Ipswich												2d								
Tree							2d		2d											
Starling		2d				3d			2d			3d	2d							
Swallow, tree												6d								
Tanagers																				
Scarlet					3d	2d	5d		2d			2d								
Summer					5d															
Thrasher, brown					5d	3d	3d		3d			3d	3d		3d					
Thrushes																				
Gray-cheeked		2d			2d	3d	3d		4d								2d			
Hermit		2d				2d	2d		3d			2d					2d			
Olive-backed		2d			2d	2d			3d											
Wood					3d	3d	2d		4d								4d			

Table 28. Wetland shrubs and trees which are utilized as food by wildlife (Martin and others 1951). Numerical scores are defined in Table 26. Plant parts eaten are indicated by footnotes (Continued).

	Alders	Arrowwoods	Ashes	Baldcypress	Blackberries	Blackgum	Blueberries	Buttonbush	Dogwoods	Magnolias	Maples	Myrtles	Oaks	Persimmon	Pines	Roses	Spicebush	Sweetgum	Tuliptree	Willows
Titmouse, tufted					3d	2d	3d					2d	4d		2d					
Towhee, rufous-sided					4d		3d			2d			4d		3d			2d		
Veery					3d		3d										3d			
Vireos																				
Philadelphia																2d				
Red-eyed					2d	2d			3d	2d							2d			
Warbling									3d											
White-eyed		3d			2d							3d								
Warblers																				
Myrtle		3d										3d		2d	2d					
Pine									3d						4d					
Waxwing, cedar		3d	2d		3d	2d			4d					3d						
Woodpeckers																				
Downy									3d				2d							
Hairy						2d			2d											
Pileated		2d				4d			2d											
Red-bellied						2d			2d			3d	5d		3d					
Red-headed					2d								5d							
Wren, Carolina												2d	2d		2d			2d		
Upland Game Birds																				
Bob-white quail			3d		3d	2b			3b			2d	3b		3m		2d	2d		
Mourning dove															3m					
Ruffed grouse	2b	2d			3d	2b	2m		2b		2a	2d	2b							3h
Ring-necked pheasant		2d			5d				2b				3b				2d			
Wild turkey		2d	2d		2d	2b	2m		4b		2a	2d	6b	2d	3m					
Woodcock	2b				2d															
Mammals																				
Beaver	3f		3g								3c				4m			5g	1g	4f
Chipmunk, eastern		3d			3c				3d		4d		4c					2d		
Cottontail		2d			4c										2m					
Deer, whitetail		2h	3h			3h	3m	3h		2h	6h	2d	3c	2d	2h	2h			1h	4c
Fox, gray							2m							2d						
Fox, red							2m						2d	2d						
Meadow vole, eastern											2d		2c							2c
Mouse, red-backed							1m													
Mouse, white-footed		1d	2d		1c		4m		2d	2d	3d		4c		3d	2d			3d	
Muskrat													2c							2c
Opossum						2d	2m							3d						
Raccoon						2d			2m		2c		6c	4d						
Skunk, eastern		2d			2c		3m		1m							2m				

Table 28. Wetland shrubs and trees which are utilized as food by wildlife (Martin and others 1951). Numerical scores are defined in Table 26. Plant parts eaten are indicated by footnotes (Concluded).

	Alders	Arrowwoods	Ashes	Baldcypress	Blackberries	Blackgum	Blueberries	Buttonbush	Dogwoods	Magnolias	Maples	Myrtles	Oaks	Persimmon	Pines	Roses	Spicebush	Sweetgum	Tuliptree	Willows
Squirrels																				
Flying											3c		4c							
Fox		2g			3c	2d	2m						5c							
Gray		2g			2c	3d			3m		4c		6c		3m			3d	2d	
Red					2c						4c		4c		3m	2m			3d	2c
Summary																				
Waterfowl																				
Number of user species	0	0	1	2	0	1	1	6	1	0	0	0	2	0	0	0	0	1	0	0
Total of scores	0	0	2	4	0	3	3	12	2	0	0	0	6	0	0	0	0	2	0	0
Marsh and Shore Birds																				
Number of user species	0	0	0	0	0	0	0	1	0	0	0	3	1	0	0	0	0	0	0	0
Total of scores	0	0	0	0	0	0	0	2	0	0	0	6	2	0	0	0	0	0	0	0
Songbirds																				
Number of user species	1	9	6	0	38	20	25	0	28	3	8	23	17	6	22	1	9	8	7	0
Total of scores	3	19	14	0	113	50	62	0	83	6	25	65	55	13	78	2	21	20	15	0
Upland Game Birds																				
Number of user species	2	3	2	0	5	3	2	0	4	0	2	3	4	1	3	0	2	1	0	1
Total of scores	4	6	5	0	15	6	4	0	11	0	4	6	14	2	9	0	4	2	0	3
Mammals																				
Number of user species	1	7	3	0	7	5	8	1	5	2	9	1	11	5	6	4	0	3	5	5
Total of scores	3	14	8	0	17	12	19	3	11	4	31	2	42	13	17	8	0	10	10	14

aBuds, twigs, seeds
bSeeds, buds and/or flowers
cSeeds, bark, twigs, buds and/or flowers
dSeeds or fruits
eSap or nectar
fWood, foliage
gWood, also seeds for some species
hTwigs, foliage and/or buds
mFruit, stems, foliage

Table 29. Submerged and floating aquatic plants utilized as food by wildlife (Martin and others 1951). The leaves, stems and seeds of most of these plants are eaten. Scores are defined in Table 26.

	Coontail	Duckweeds	Eelgrass	Horned pondweed	Naiads	Pondweeds	Waterlilies	Waterweed	Wigeongrass	Wildcelery
Waterfowl										
Brant, American			4						5	

Table 29. Submerged and floating aquatic plants utilized as food by wildlife (Martin and others 1951). The leaves, stems and seeds of most of these plants are eaten. Scores are defined in Table 26. (Continued).

	Coontail	Duckweeds	Eelgrass	Horned pondweed	Naiads	Pondweeds	Waterlilies	Waterweed	Wigeongrass	Wildcelery
Coot	3	3				6		3	5	3
Ducks										
Baldplate	2	2	2	3	4	5			5	3
Black		2	3		4	5			3	3
Bufflehead	2	2			4	3				3
Canvasback	2				2	5	5		2	6
Gadwall	4				4	3			5	
Goldeneye, American			2			4		2	2	3
Mallard	2	2	2	2	3	5			2	4
Pintail				2	3	5	2		4	2
Redhead	3	3		2	3	6	4		2	5
Ringneck	3				3	6	3		2	3
Ruddy	2				3	5			3	4
Scaup, greater	3		3		4	5	2		5	4
Scaup, lesser	2		2	4	4	5	3		2	5
Scoter, American			3						2	
Scoter, surf			3			2			2	
Scoter, whitewing			3			2				
Shoveller		3		2	2	4	3		3	
Teal, bluewing		5			4	4	3		3	
Teal, greenwing		4		2	3	3			2	2
Wood		3				5	4			3
Goose, Canada			2		2				5	
Swan, whistling						5				5
Marsh and Shore Birds										
Dowitcher, eastern						3*			2	
Gallinule, purple		4					2		2	
Knot, American			2*			2*			3	
Rail										
King					2	2*			2	
Sora		2				2*				
Virginia						2*				
Sandpiper										
Pectoral						2*			2	
Semipalmated									2	
Stilt						2*			2	
Whiterump									3	
Snipe, Wilson						2*				

Table 29. Submerged and floating aquatic plants utilized as food by wildlife (Martin and others 1951). The leaves, stems and seeds of most of these plants are eaten. Scores are defined in Table 26. (Concluded).

	Coontail	Duckweeds	Eelgrass	Horned pondweed	Naiads	Pondweeds	Waterlilies	Waterweed	Wigeongrass	Wildcelery
Mammals										
Beaver							4			
Muskrat						3	3			
Summary										
Waterfowl										
Number of user species	11	11	11	7	16	21	9	2	20	16
Total of scores	28	33	29	17	52	93	29	5	64	58
Marsh and Shore Birds										
Number of user species	0	2	1	0	1	8	1	0	8	0
Total of scores	0	6	2	0	2	17	2	0	18	0
Mammals										
Number of user species	0	0	0	0	0	1	2	0	0	0
Total of scores	0	0	0	0	0	3	7	0	0	0

*Values followed by an asterisk indicate that birds utilize only the seeds.

SUBMERGED PLANTS USED AS FOOD

Submerged vascular plants are of direct and significant value to waterfowl as food. They are of indirect value to waterfowl, as well, because the dense beds that are formed by submerged vascular plants serve as cover and as food for many kinds of fish and aquatic invertebrates upon which the waterfowl feed (Gosner 1968; Nixon and Oviatt 1972; Thayer and others 1975; Kikuchi and Peres 1977).

The relative values to wildlife of several species or groups of species of submerged vascular plants are listed in Table 29. The data on which the table is based are drawn from the entire northeastern United States and include analyses from inland areas as well as from coastal regions. Nevertheless, they parallel closely the several published evaluations for coastal Maryland.

In regard to waterfowl, the tabulated data support previous evaluations which have ranked wigeongrass as the most valuable of the submerged plants (McAtee 1939). As a group, the several species of pondweed are of high value to waterfowl, but wildcelery is the second most important species that is ranked individually. Eelgrass and coontail are of nearly equal value to waterfowl.

Wigeongrass, which has thin, almost hairlike leaves, covers large areas of the bottom in shallow waters of the brackish section of the Chesapeake Bay and many of its tributaries (Phillip and Brown 1965; Orth 1975). Its seeds and/or vegetative parts are utilized by such dabbling ducks as the mallard, black duck, pintail, gadwall, American wigeon, shoveller, blue-winged teal, and green-winged teal, and by redheads, canvasbacks, ring-necked ducks, lesser scaup, common goldeneyes, buffleheads, oldsquaws, ruddy ducks, whistling swans, Canada geese, and American coots (Tables 37, 38, 39, 41, and 42).

Owing to its abundance, wide distribution, and intensive utilization, the wigeongrass is considered to be the most important food plant for waterfowl in the coastal zone of Maryland (Stewart 1962; Metzgar 1973). The redhead pondweed generally is ranked as the second most important, although Anderson (1972) concluded that this species and Eurasian watermilfoil are not used intensively by waterfowl. Wildcelery, eelgrass, and coontail are important locally.

When eelgrass was abundant along the Atlantic Coast, it virtually was the only food used by wintering American brant (Cottam, Lynch, and Nelson 1944). Since the decline of eelgrass, which was complete by 1931, sealettuce has become the principal food of wintering brant in the saline coastal bays. Where it still occurs, or has recovered, eelgrass is utilized most intensively by brant in saline to slightly brackish waters, but wigeongrass now is the most important item in the diet of brant in these habitats (Stewart 1962; Ponkala 1973). Eelgrass stems and leaves also are eaten by the black duck, gadwall, American wigeon, greater scaup, lesser scaup, common goldeneye, bufflehead, oldsquaw, and redhead.

The mute swan was introduced into Chesapeake Bay when a pair of the birds escaped from a pen on the Miles River during a storm in March 1962 (Ringle 1977). The birds nested successfully, and apparently gave rise to a population that numbered about 300 within 15 years. The swans, unlike the large native waterfowl, are not migratory. They feed on eelgrass, and each may eat as much as 10 pounds of plants per day throughout most of the year. Although the birds still are localized, their feeding habits and their demonstrated capacity for successful and rapid reproduction pose a potential new threat to beds of submerged plants in Chesapeake Bay.

In brackish or fresh waters, sago pondweed is prominent in the diet of the whistling swan, Eurasian wigeon, American wigeon, lesser scaup, goldeneye, ruddy duck, and canvasback (Tables 37, 39). Wildcelery is important in the diet of the whistling swan, American wigeon, greater scaup, common goldeneye, bufflehead, ruddy duck, American coot, and canvasback (Table 37) in fresh and slightly brackish waters. The redhead pondweed is utilized by mallards, black ducks, gadwalls, American wigeons, lesser scaup, buffleheads, ruddy ducks, redheads, ring-necked ducks, canvasbacks, and American coots (Tables 37, 38, 39). Naiads are eaten by the gadwall, ruddy duck, redhead, common goldeneye, and Eurasian wigeon. The common waterweed is fed upon by redheads and American wigeons, and the Nuttall waterweed is an item in the diet of the wood duck. Gadwalls and ruddy ducks are known to eat the grassleaf pondweed. The ribbonleaf pondweed is eaten by wood ducks; Eurasian watermilfoil is eaten by the American coot; muskgrass is eaten by the American wigeon; and red algae are fed upon by the gadwall.

Submerged plants are of relatively little value to marsh and shore birds. Wigeongrass and pondweeds, however, each are utilized by at least eight species, and the seeds of eelgrass are used by the American knot. Muskrats also feed on pondweeds when they are available.

2.5. ANIMALS OF THE COASTAL WETLANDS

Except for birds, animals generally are not conspicuous in the landscape of the coastal wetlands. The lodges of muskrats may dot the landscape, but muskrats themselves are seen only occasionally. Most of the other marsh creatures are small; many dwell on or in the litter layer and soil; and most crawl or hop among the dense vegetation or swim beneath the surface of the water. To experience the animal life of the wetlands, one cannot merely view the scene from a distance. It is essential to enter the wetlands and to search among the plants, beneath the litter, and along the edge of the water.

INVERTEBRATES OF SALINE MARSHES

Fiddler crabs, marsh crabs, snails, and mussels are conspicuous and familiar large invertebrates of the saline marshes. These animals, as well as numerous, but smaller amphipods, shrimplike decapod crustaceans, insects, and spiders, are eaten by various birds and mammals, and the distribution and relative abundance of these invertebrates influence the occurrence and activities of the larger animals.

Meiofauna, which are very small invertebrates that range in size from springtails, which are insects, to barely visible nematodes, are the most abundant macroscopic animals of the marsh. Although their role in the food web of the marsh is not known in detail, the meiofauna are food items of snapping shrimp, fiddler crabs, polychaete worms, snails, spiders, fish, and other animals of the wetlands. The dead remains of meiofauna also are important in the food cycle, because they decay rapidly and contribute to detritus in the soil and water.

Crustaceans

The marsh fiddler crab is the characteristic member of its genus in saline areas. It feeds on algae, detritus, shrimp, small fish, and other organisms, and is preyed upon by a variety of birds and mammals, as well as by the diamondback terrapin (Shuster 1966; Kraeuter and Wolf 1974; Welsh 1975). In the State of Delaware, marsh fiddlers are most abundant in sections of estuaries in which the salinity ranges from 21 to 29 ppt (Miller and Maurer 1973). They also occur in large numbers in most of the saline wetlands of Maryland, and are the principal food of the clapper rail. Surveys in New Jersey indicated that the marsh fiddler is most abundant in dense stands of the tall growth form of smooth cordgrass (Type 71) along the banks of tidal waters (Table 30). In areas in which the salinity ranges from 10 to 20 ppt, the sand fiddler crab also is present, but no quantitative censuses of its populations have been found.

The food habits of another decapod crustacean, the marsh crab, are similar to those of the marsh fiddler crab. The marsh crab, however, also feeds directly on smooth cordgrass (Crichton 1960; Daiber and Crichton 1967). A single crab may consume as much as 0.06 gram (dry weight) of cordgrass per day. The activities of large numbers of crabs can reduce a stand of cordgrass to a stubble during the summer.

Blue crabs utilize the small marsh creeks as nursery areas. The crabs mature about 18 months after they hatch, and they molt approximately 27 times during this period (Dudley and Juday 1973). During the spawning season, which begins in May, adult females congregate at the mouths of estuaries, at inlets, and along ocean beaches where their eggs mature and hatch. The hatched larvae, or zoeae, swim, or are carried by currents, as far as 40 miles off shore. The zoeae molt six to eight times before they transform into the megalops stages of development. The megalops have been found as far as 80 miles off shore. By October the young crabs, now about 2.5 to 5.0 mm wide, begin to move into the estuaries. The crabs swim through the bays and into the small creeks in the tidal marshes, where they remain until the following spring. During April and May, the juvenile crabs move into the bays and remain there until they are mature. During their residence in the estuarine habitats, the crabs molt 18 to 20 times and grow to widths of 127 mm or more.

An isopod (*Philoscia vittata*) and, in combination, the sand flea and the beach flea, are most abundant in stands of meadow cordgrass in New Jersey (Table 31). The second most dense population of the isopod occurs in stands of marshelder where no sand fleas or beach fleas were observed. The second most dense population of the sand and beach fleas occupies stands of the short growth form of smooth cordgrass. The population of isopods in this type was about equal in density to that in stands of spikegrass. No individuals of these small crustaceans were collected from stands of switchgrass, Olney three-square, or common reed.

Table 30. Densities (individuals per square meter) of marsh fiddler crabs and saltmarsh snails in vegetation zones of saline and brackish marshes in New Jersey.

		Marsh Fiddler Crab		Saltmarsh Snail	
Type	Predominant plant	Northern[a]	Southern[b]	Northern[a]	Southern[b]
46	Switchgrass	0.0	NA	0.0	NA
47	Olney threesquare	0.0	NA	0.0	NA
49	Common reed	0.0	NA	139.0	NA
61	Meadow cordgrass	0.6	3	467.9	2
61	Spikegrass	1.7	NA	179.5	NA
62	Marshelder	21.2	NA	211.7	NA
71	Tall smooth cordgrass	192.2	46	183.4	21
72	Short smooth cordgrass	7.2	37	1,036.6	468

NA means that no data are available.
[a]Trout and Widjeskog 1976, Ocean County.
[b]Ferrigno and others 1969, Cumberland and Cape May Counties.

Snails

Most snails of the coastal wetlands feed on detritus and on algae and microorganisms that they rasp from the surfaces of plants, from the bottom, and from pilings and rocks (Kraeuter and Wolf 1974). The marsh periwinkle, for example, commonly is observed on the stems of cordgrass. Studies with radionuclide tracers indicated that the snails do not obtain food directly from the plants. When sediments were labeled, however, the snails picked up the tracer rapidly. This indicated that it is a detritivore.

The saltmarsh snail is eaten by killifish, by many kinds of shore birds, and by song sparrows, swamp sparrows, marsh wrens, red-winged blackbirds, and other marsh-dwelling birds (Hausman 1932). Although it is not the dominant item in the diet of any species, this snail also is an important food for wintering black ducks and other waterfowl (Ferrigno and others 1969). In Connecticut (Hausman 1932) and New Jersey (Table 30), the populations of the saltmarsh snail are most dense in the short growth form of smooth cordgrass (Type 72). Investigations in Maryland also indicated that the snails are most abundant in stands of the short form of smooth cordgrass (Personal communication, William Sipple and Harold Cassell 1977).

Table 31. Densities (individuals per square meter) of Atlantic ribbed mussels, an onoscoid isopod, and sand fleas in vegetation zones of saline and brackish marshes in New Jersey.

Type	Predominant plant	Mussel		Isopod[a]	Sand Flea Beach Flea[a]
		Northern[a]	Southern[b]		
46	Switchgrass	0	NA	0	0
47	Olney threesquare	0	NA	0	0
49	Common reed	0	NA	0	0
61	Meadow cordgrass	<1	<1	319	208
61	Spikegrass	0	NA	65	22
62	Marshelder	0	NA	127	0
71	Tall smooth cordgrass	85	5	4	35
72	Short smooth cordgrass	4	<1	68	54

NA means no data are available.
[a]Trout and Widjeskog 1976, Ocean County.
[b]Ferrigno and others 1969, Cumberland and Cape May Counties.

Bivalves

Ribbed mussels, which are filter-feeding detritivores, are most abundant along the banks of creeks, guts, bays, and ditches where they grow in clusters among the roots of smooth cordgrass (Shuster 1966). In New Jersey, the densities of ribbed mussels ranged from 85 per square meter in the tall smooth cordgrass (Type 71), to one per 14.3 square meters in meadow cordgrass marsh (Type 61), and none in stands of marshelder (Table 31). These bivalve mollusks feed on bacteria, diatoms, and fine particles of organic detritus that they filter from the water. Each mussel pumps more than a gallon of sea-water during each hour that it is covered by a flooding tide.

Spiders

The populations of spiders that dwell among the plants and on the ground in five types of vegetation in the saline coastal wetlands of North Carolina were studied by Barnes (1953). He sampled with sweep nets and pitfall traps, and utilized the results to rank the relative abundance of the more common spiders in each vegetation type.

In total, 40 species of spiders were listed in the collec-

Table 32. Spiders observed in five types of coastal wetland vegetation in North Carolina (Barnes 1953). Numbers indicate ranks of relative abundance in a vegetation type. Presence is indicated by an X.

	Smooth Cordgrass	Meadow Cordgrass	Meadow Cordgrass, Spikegrass, and Glasswort	Needlerush	Meadow Cordgrass, Broomsedge, and Switchgrass
Among Plants					
Eustata anastera	1	3	1	1	X
Hyctia pikei	2	2	X		1
Dictyna savanna	3	X	2	3	
Grammonota trivittata	4				
Argiope seminola	5	X	X	5	
Tibellus duttoni	X	1			X
Tetragnatha pallescens	X		3		
Paraphidippus marginatus	X		4	4	
Neoscona pratensis	X		5	2	
Hyctia bina	X	X			
Larinia directa	X	X			
Acanthepeira stellata	X		X		
Ceraticelus paschalis	X				
Ceratinopsis savanna	X				
Clubiona littoralis	X				
Eperigone bryanti	X				
Pelopatis undulata	X				
Poecilochroa capulata	X				
Poecilochroa unimaculata	X				
Singa keyserlingi	X				
Singa rubens	X				
Tetragnatha caudata	X				
Theridula sphaerula	X				
Hentzia ambigua		X			X
Pisaurina mira			X		
Mangora gibberosa				X	2
Among Plants (Cont.)					
Zygoballus bettini					X
Phidippus sp.				X	3
Agassa cerulea					X
Agiope aurantia					X
Allotheridion murarium					X
Aysha gracilis					X
Ceratinosis nigriceps					X
Coleosoma normale					X
Latrodectus mactans					X
Leucauge venusta					X
Misumenops celer					X
Neoscona minima					X
Oxypes salticus					X
Xysticus sp.					X
Number of species	23	8	8	8	19
On the Ground					
Lycosa modesta		1	1	1	
Arctosa furtiva		2			
Pardosa floridana		X	2	2	
Pirata suwaneus		X			1
Lycosa rabida		X			2
Gnaphosa sericata		3			X
Clubiona plumbi					3
Poecilochoroa famula					3
Drassyllus creolus					
Number of Species	0	6	2	2	5

tions from the coastal wetlands. A web-weaver, *Eustata anastera,* was the only species that was found in all five vegetation types (Table 32). It was the most abundant spider in three of the types. A jumping spider, *Hyctia pikei,* was predominant in mixed stands of meadow cordgrass, broomsedge, and switchgrass. This spider was the second most abundant species in stands of smooth cordgrass and meadow cordgrass, and it also was present in mixed stands of meadow cordgrass, spikegrass, and glasswort. In the meadow cordgrass marsh, a crab spider, *Tibellus duttoni,* was the most abundant species. The crab spider also was collected from smooth cordgrass vegetation and from mixed stands of meadow cordgrass, broomsedge, and switchgrass, but it was not among the most abundant species in those vegetation types.

Twenty-six kinds of spiders were observed in only one vegetation type. No species was limited to the meadow cordgrass type or the needlerush type, and only one spider was restricted to the meadow cordgrass, spikegrass, glasswort mixed type. About half of the kinds of spiders that were collected from the smooth cordgrass type (12 of 23 species listed) were not seen elsewhere. Approximately 70% (13 of 19 species listed) of the spiders that were observed in the mixed stands of meadow cordgrass, broomsedge, and switchgrass were not observed in the other wetland vegetation types, but eight of them also were collected in upland vegetation types.

Twenty-three species of spiders were listed from the aerial herbaceous stratum of smooth cordgrass stands, and 82% of the total number of individuals that were collected were web-building spiders. In contrast, only eight species of spiders were found in the aerial stratum of stands of meadow cordgrass, and 64% of the individuals were hunting spiders that do not construct webs. Web-builders and hunters were about equally abundant in the mixed stands of meadow cordgrass, broomsedge, and switchgrass, and a total of 19 species was listed from this vegetation type.

Smooth cordgrass, broomsedge, and switchgrass are 3 to 4 feet tall; their stalks diverge from a single base and may be branched; and they bear numerous leaves that angle out from the stalks. The structure of the vegetation that is formed by these plants, therefore, offers numerous sites that are suitable for the construction of webs of different sizes. Meadow cordgrass is shorter, usually not more than 1.5 feet tall, and stands of meadow cordgrass become flattened and matted by winds, rain, and tides early in the growing season. As a result, the structure of this vegetation is not suitable for the support of large webs.

Although the plants grow to heights of 4 to 5 feet, only eight kinds of spiders were observed in stands of needlerush. The low number of species may reflect the structure of this vegetation type, which is formed by cylindrical, unbranched stalks that grow more or less vertically and nearly parallel. Webs that are strung between the stalks are subject to damage when the stalks are moved by the wind, by tides, or by other forces. The three spiders that were most common in the needlerush vegetation type are web-builders. They may be the species that compete best for the limited number of suitable construction sites.

Ground-dwelling spiders were absent from the frequently flooded stands of smooth cordgrass, and only two species were reported from stands of needlerush and mixed stands of meadow cordgrass, spikegrass, and glasswort (Table 32). Six species were listed from meadow cordgrass marshes, and 14 kinds of ground-dwelling spiders were collected in the infrequently flooded stands of meadow cordgrass, broomsedge, and switchgrass. Wolf spiders (Family Lycosidae) were the predominant ground inhabitants. These hunters are cursorial, or running, forms that are most active at night.

Insects

Numerous observations and studies of the mosquitoes, midges, and other obnoxious insects of coastal wetlands have been published. There have been few studies, however, of the great variety and abundance of the other kinds of insects which are important components of the wetland ecosystem. The only comprehensive investigation of the adult insect populations of coastal wetlands along the Atlantic Coast was conducted in five types of vegetation in the saline marshes of North Carolina (Davis and Gray 1966). A similar, but less detailed, survey was conducted in eight types of vegetation in a coastal wetland in New Jersey (Ferrigno 1975; Trout and Widjeskog 1976). On the Pacific Coast, Cameron (1972) conducted a detailed survey of insects in two types of coastal wetland vegetation in California.

The results of the North Carolina and New Jersey surveys are most relevant to the conditions expected in Maryland owing to the geographic proximity of the states and the similarity of the vegetation types in their coastal wetlands. The San Francisco Bay wetlands are remote from Maryland, and no species of plant or insect that was found in the two California wetland communities is known to occur on the Middle Atlantic Coast. Nevertheless, the habitats on the east and west coasts are subject to similar, although not identical, tidal influences and seasonal variations. The predominant plants in the two types of western marshes that were studied, a cordgrass and a saltwort, also have important counterparts in the coastal wetlands along the East Coast.

Opportunities to make direct comparisons between the results of the investigations in North Carolina and New Jersey and in California are limited because the methods used in the field differed significantly. The limitation on comparisons is increased by the methods used to present and to analyze the results of the studies. Davis and Gray (1966) relied on the relative densities of specimens representative of different orders of insects; Trout and Widjeskog (1976) analyzed the data obtained by Ferrigno (1975) to estimate the actual densities of individuals of five groups of insects in each of eight vegetation types (Table 34); Cameron (1972) restricted his descriptions to considerations of the variations in the diversities of populations of herbivorous insects, saprophagous insects, and predaceous insects.

The North Carolina survey focused on adult insects that inhabit the aerial herbaceous stratum that is formed by the stalks, leaves, and flowering parts of the plants. Sampling was conducted at several, widely spaced stations, and each station was sampled about three times per month from June through August. Selected stations were sampled one time per month from September through May. Collections were made with sweep nets, and the contents of the nets immediately were placed in killing jars. In the laboratory, the insect specimens were sorted from the plant debris by hand. This sweeping technique samples large, but quantitatively undefined areas. It is suitable for general faunistic surveys, and it is particularly effective for the capture of rapidly moving insects that hop or fly. Because the exact area or volume of space that is sampled is unknown, the absolute density of insects and similar quantitative measures cannot be computed.

Collections in the New Jersey wetland area were made only during August. Ninety-four sample plots, each 1 square meter, were distributed in the eight vegetation types in numbers proportional to the areas occupied by the types. Only one plot was assigned to the switchgrass type, for example, whereas thirty-five plots were sampled in stands of the short growth form of smooth cordgrass.

In the California wetlands, Cameron (1972) utilized a clip-plot method to sample the insect populations in one stand of each of two vegetation types. A stand was an area of about 1.75 acres (0.71 ha). Each week throughout the year, he cut all of the plants within five small, randomly-selected plots, each of which was about 20 inches square (0.25 m^2). After the clipped material was removed, he scraped the litter from the surface of the soil. These materials were bagged and taken to the laboratory where the adult insects were extracted with a Berlese-Tullgren funnel. This device gently heats the plant material to force the insects to move to the bottom of the funnel where they fall into a jar. This clipping method is most effective for the collection of sedentary and ground-dwelling forms. Active flying or hopping insects may escape while the plot is being marked or while the plants are being clipped. Because a defined area is sampled, the results from clipped plots can be used to calculate densities and other quantitative parameters of populations. The standing crop of the vegetation at the time of sampling also can be determined and correlated with the measures of the insect populations.

One general finding of the North Carolina investigation was that most of the characteristic insects of the coastal wetlands are restricted to the coastal region, and most occur only in the wetlands. Some also utilize inland, freshwater marshes and other wetland habitats, and a few range widely throughout terrestrial habitats.

Another general finding of that investigation was that insects of the coastal wetlands are unable to survive prolonged periods of submergence. Numerous earlier reports had hypothesized that wetland insects frequently are inundated by the tides and that they have developed adaptations that permit them to remain under the water for periods as long as several hours. Observations in the field and in the laboratory, however, indicated that marsh insects escape inundation by crawling to parts of the plants that remain above the water, by flying or swimming to exposed surfaces, or by hopping on the surface film of the water until they locate a safe refuge. Several kinds of marsh insects were able to endure prolonged submergence, but their capacities to do so may be equaled by related insects from terrestrial habitats.

In California, as along the Middle Atlantic Coast, there is a pronounced annual cycle of biological activity in the coastal wetlands. During the autumn, the aerial parts of plants in stands of most types of herbaceous vegetation become yellowish and brownish, and primary production slows and ceases. Concurrently the activities of insects in the coastal wetlands begin to decline as the temperatures of the air and water drop and as the vegetation dies back to the ground. Most adult insects die, and their bodies enter the detritus food chain. Eggs that were laid during the summer or autumn represent the life stage in which most kinds of insects will endure the winter.

Two general categories of insects were recognized by Cameron (1972) on the basis of the periodicity of activities of the adults. Persistent species are those that are represented by adults throughout the year. The adults of seasonal species are present only during the growing season of the vegetation (herbivores) or at times of the maximum accumulation of dead plant material (litter-feeders). Little evidence of large migrations of insects into the wetlands from other habitats was found in the three studies. The seasonal species, therefore, are assumed to be represented in the wetlands by eggs, larvae, and/or pupae during most of the year.

Sampling in the San Francisco Bay wetlands indicated that most kinds of litter-feeding insects are persistent species. Most herbivores are seasonal species. The adults of most of the herbivorous insects appear in the spring after the growth of plants begins. A major eruption of seasonal species, which accounted for 30 to 40% of the number of species of herbivores seen during the year, occurred during the nine weeks in which the marsh plants were flowering.

Insects that inhabit the litter layer of the wetlands were not surveyed in North Carolina or New Jersey. In the herbaceous stratum, however, torpid adults of a few kinds of insects were found to survive during the winter in sheltered places. These include several kinds of planthoppers, grasshoppers, marsh flies, shore flies, a seed bug, and at least one kind of midge. On warm days, even in midwinter, these adults become active and may be seen moving about the marsh. Midges and planthoppers may be active on all but the coldest days during the late winter and early spring.

The plants of the saline wetlands in North Carolina initiate new growth during middle or late April. The eggs of insects may start to hatch during April, but the populations of insects develop most rapidly during May. Many kinds of insects reach their summer levels of abundance in June.[1]

The densities of grasshoppers and true bugs generally reach their peaks during middle or late summer and decline sharply by September. The populations of some Homopterans are largest in summer or early autumn, but those of other species of Homopterans and of several flies vary only slightly during the same period. Adult salt marsh mosquitoes attain their maximum numbers during September and October.

By late October or early November, the vegetation of the North Carolina marshes dies back, and temperatures decline. Adult insects become increasingly scarce, and the winter period of dormancy begins once again.

A similar pattern of seasonal changes in the populations of marsh insects was apparent in the San Francisco Bay region (Cameron 1972). In the spring, the adults of most species of herbivorous insects begin to appear about two to three weeks after the growth of their food plants is renewed. During the autumn, there is a similar lag of two to three weeks between the time of the minimum standing crop of live vegetation and the wholesale disappearance of adult herbivorous insects. The populations of predaceous insects are synchronized with those of their prey, and they increase and decrease as do those of the herbivores.

The fluctuations of the populations of litter-feeding insects in California were correlated with variations in amounts of litter. These insects were most abundant during the late autumn and winter. Occasional high tides redistributed the litter and the litter-feeding insects, and may have carried some into the Bay. Springtails (*Xenylla baconae*) were the most abundant litter-feeding insects in cordgrass stands. They represented about 80% of the total number of individuals collected during the year, and their average density was nearly 28,000 per square meter (112 million per acre). Large numbers of these minute insects apparently were carried into the sample area by high tides, because the density of their population increased by four to six times immediately after periods of inundation.

Summer is the period of maximum activity by insects. In the paragraphs that follow, the summer populations of the characteristic insects in five types of coastal wetland in North Carolina are described and compared. These descriptions are based on the averages of several collections, so they ignore the temporal variations that occur during the summer and early autumn.

Leafhoppers and other Homopterans were the most abundant insects in four of the five saline wetland vegetation types that were surveyed (Table 33). A delphacid planthopper, *Delphacodes detecta*, was widely distributed and relatively abundant in stands of all types, other than needlerush. Another member of the same family, *Prokelisia marginata,* was the most abundant Homopteran in stands of smooth cordgrass and in mixtures of smooth cordgrass, glasswort, and sealavender. Individuals of this species also were frequent in stands of spikegrass and meadow cordgrass, but they were considered to have strayed into these types from nearby stands of smooth cordgrass.

Flies (Diptera) were predominant in stands of meadow cordgrass, and Homopterans constituted the second most abundant group. In other vegetation types, flies ranked second in abundance in smooth cordgrass and in mixtures of smooth cordgrass, glasswort, and sealavender, and they ranked third in stands of spikegrass and needlerush. All of the flies that were captured in needlerush stands were believed to have been strays from other types of vegetation. A frit fly, *Conioscinella infesta,* was the commonest fly in all five of the vegetation types.

True bugs (Hemiptera) were the second most common group of insects in spikerush stands, and grasshoppers (Orthoptera) were the second most abundant group in stands of needlerush. In other types, true bugs contributed less than 10% of the total number of individuals collected, and grasshoppers were represented by no more than 3% of the specimens.

The density of insects varied substantially from stand to stand in the low marsh vegetation types. The average number of insects captured per unit effort of sampling in the most productive stand of smooth cordgrass, for example, was 42 times as great as the number captured in the least productive stand. The variability in needlerush stands was considerably less (7x). The maximum variability in high marsh types was about 2x in meadow cordgrass and it was less than 2x between stands of spikegrass.

The largest average number of insects per sample (2,529 individuals) was obtained from stands of smooth cordgrass. The average density of individuals in samples from spikegrass (1,345) was 53% as great; that from meadow cordgrass (196) was 8% as great; and the average from needlerush (63) was 2.5% as great. Only one stand of the smooth cordgrass, glasswort, and sealavender type was surveyed, and the average density of insects there (411 per sample) was 16% as great as the average in six stands of smooth cordgrass.

The spikegrass vegetation type supported the greatest number of species of insects. Four species of insects, however, contributed approximately 80% of the total number of individuals collected from stands of spikegrass. These were *Delphacodes detecta,* a planthopper; *Amphicephalus littoralis,* a leafhopper; *Trigonotylus americanus,* a leaf bug (Hemiptera); and *Conioscinella infesta,* a frit fly (Diptera). The last species also contributed 35% of the total number of insects collected from stands of meadow cordgrass. No other species in meadow cordgrass habitats, however, was represented by an unusually large proportion of the total number of individuals.

Leafhoppers also were the most abundant insects in the coastal wetlands of New Jersey (Table 34). Their numbers ranged from 6 to 152 individuals per square meter (24,000 to 615,000 per acre) in the eight types of vegetation that were sampled. No other group of insects was represented in stands of Olney threesquare, com-

Table 33. Composition of insect populations in five types of saline coastal wetlands in North Carolina (Davis and Gray 1966). Numbers indicate percentage of total number of insect individuals collected in each type that represented the relevant order. The symbol "X" indicates a characteristic member of the insect fauna; "s" indicates a member of lesser importance.

	Smooth Cordgrass	Smooth Cordgrass, Glasswort, and Sealavender	Needlerush	Spikegrass	Meadow Cordgrass
Homoptera	90%	78%	72%	57%	30%
Prokelisia marginata	X	X		s	s
Sanctanus aestuarium	X	X			
Draeculacephala portola	X	X			
Delphacodes detecta	X	X		X	X
Sanctanus sanctus		X			
Keyflana hastata			X		
Rhynchomitra microrhina			X		
Amphicephalus littoralis				X	
Spangbergiella vulnerata				X	
Tumidagena terminalis				X	X
Neomegamelanus dorsalis				X	X
Hapalaxius enotatus					X
Aphelonema simplex				s	X
Diptera	7%	13%	10%	19%	44%
Chaetopsis apicalis	X	X			
Chaetopsis fulvifrons	X	X	s	s	s
Conioscinella infesta	X	X	s	X	X
Dimecoenia austrina		X			
Pelastoneurus lamellatus		X		s	s
Oscinella ovalis				X	X
Ceropsilopa costalis				X	
Tomosvaryella coquilletti				X	
Hippelates particeps	s			s	X
Hemiptera	2%	4%	3%	19%	9%
Ischnodemus badius	X				
Trigonotylus uhleri	X				X
Trigonotylus americanus				X	
Rhytidolomia saucia				X	
Cymus breviceps	s	s	s	X	X
Orthoptera	<1%	3%	11%	1%	3%
Orchelimum fidicinium	X				
Conocephalus spp.	X		X	X	X
Orphulella olivacea		X		X	s
Paroxya clavuliger			X		
Nemobius sparsalsus				X	
Clinocephalus elegans				X	X
Mermiria intertexta				s	X
Coleoptera	<1%	1%	<1%	2%	4%
Isohydnocera tabida	X				
Mordellistena spp.	X				
Collops nigriceps	X	s			
Naemia serriata	s			X	s
Isohydnocera aegra					X
Glyphonyx sp.					X
Hymenoptera	<1%	<1%	3%	1%	9%
Crematogaster clara	s	s	s	s	s
Dorymyrmex pyramicus					X
Pseudomyrmex pallida			s	s	X
Iridomyrmex pruinosus				s	X
Other Orders	<1%	<1%	<1%	<1%	1%

mon reed, or tall-form smooth cordgrass. The densities of true bugs (order Hemiptera) ranged from less than 1 to 21 per square meter (<4,000 to 85,000 per acre), and they formed the second most common group of insects in stands of switchgrass, spikegrass, and marshelder. Orthopterans were the second most abundant group in stands of meadow cordgrass, where the densities of grasshoppers and crickets were equal (3 per square meter, or about 12,000 of each per acre).

The highest density of insects in the New Jersey wetland area was observed in the meadow cordgrass type (158 per square meter; Table 34). The densities of insects in stands of spikegrass (137 per square meter), short growth form smooth cordgrass (96), and switchgrass (74) ranged from 87% to 47% as great as the density in the meadow cordgrass type. In the other four types of vegetation, the densities ranged from 4% to 23% as great as that in meadow cordgrass.

The shelter and food that are available were considered by Davis and Gray (1966) generally to be more important than relative tidal inundation in establishing the numbers and kinds of insects that can be supported by a particular type of wetland. The dense, short carpet that is formed by spikegrass, for example, was considered to provide ample food and cover for many herbivorous insects. Smooth cordgrass is taller than spikegrass, so it provides a larger volume of space for insects. Because its stands are more open, the quality of cover that is afforded by smooth cordgrass is less than that of spikegrass. Needlerush, in contrast to the preceding types, is formed by slender, cylindrical stalks that are highly fibrous and bear no expanded leaves. Stands of needlerush, therefore, provide little cover from predators, slight protection from wind, and a scant supply of food for most herbivores. The high relative importance of grasshoppers in stands of this type may reflect the ability of grasshoppers to utilize the tough tissues of needlerush for food more effectively than other insects.

The floristic diversity of the vegetation also may be an important determinant of the diversity of the insect fauna of a vegetation type. Davis and Gray (1966) noted that herbivorous insects commonly feed only on a few, closely related species of plants. The greater the variety of plants in a vegetation type, therefore, the greater is the potential variety of insects that can be supported by that type. Owing to the method used to sample insects, Davis and Gray were not able to correlate each species of herbivorous insect with the species of plants on which it was feeding. Furthermore, fewer than 100 of the more common species of the nearly 400 kinds of insects that were collected by Davis and Gray were mentioned in their report. A future, more detailed faunistic analysis will be required to determine the extent of restricted plant-insect relationships in coastal wetlands and to evaluate the ecological importance of such relationships.

One kind of ant, *Crematogaster clara,* was collected from all of the wetland vegetation types in North Carolina. This species nests in hollow, dead stems of smooth cordgrass that remain erect (Teal 1962). Ground-nesting ants, however, were relatively abundant only in stands of meadow cordgrass, although they foraged into other types of vegetation. The virtual limitation of nests to the areas occupied by meadow cordgrass apparently was governed by the more frequent flooding of other habitats by tides.

Table 34. Densities (individuals per square meter) of insects and spiders in vegetation zones of saline and brackish marshes in New Jersey (Trout and Widjeskog 1976).

Type	Predominant plant	Leaf-hoppers	Grass-hoppers	Crickets	Ants	Bugs	Spiders
46	Switchgrass	53	0	0	0	21	90
47	Olney threesquare	33	0	0	0	0	132
49	Common reed	6	0	0	0	0	46
61	Meadow cordgrass	152	3	3	0	0	121
61	Spikegrass	134	0	0	0	3	99
62	Marshelder	18	0	0	6	13	297
71	Tall smooth cordgrass	29	0	0	0	0	22
72	Short smooth cordgrass	95	<1	0	0	<1	48

The majority of the species of insects and of the individual insects that were collected from wetland vegetation in North Carolina and California were herbivores, or forms that feed directly on the plants. No specific analysis was presented by Davis and Gray (1966), but Cameron (1972) found that approximately 50% of the species were herbivores, 35% were litter-feeders, and 15% were predators. Some of the herbivores, particularly the grasshoppers and ants, have chewing mouthparts and eat the tissues of the plants. The Homopterans and Hemipterans have piercing/sucking mouthparts which they use to obtain sap from the plants. Picture-wing flies (*Chaetopsis fulvifrons, C. apicalis*) and a frit fly (*Conioscinella infesta*) in the North Carolina wetlands are equipped with sponging mouthparts that allow them to obtain secretions from the surfaces of the plants. These flies also may eat detritus and bacteria that adhere to the surfaces of the plants. The larvae of most of the frit flies live in the stalks of grasses and feed on the internal tissues of the plants.

Spiders were considered to be the most abundant and important predatory arthropods in the marsh vegetation both in California and North Carolina. Many insects, however, obtain their food by eating other insects or sucking the fluids from the bodies of insects, snails, mammals, or other animals. In North Carolina, adult dragonflies, which were seen most frequently in stands of needlerush, prey on flying insects. Other predators that feed on tissues include soft-winged flower beetles (*Collops nigriceps*), checkered beetles (*Isohydnocera tabida, I. aegra*), and ladybird beetles (*Naemia serriata*). The larvae of chamaemyiid flies prey on aphids and mealybugs.

Several kinds of flies obtain food by sucking the body fluids from other kinds of animals. Robber flies (Family Asilidae, not listed by species) prey on insects as large as grasshoppers. Marsh flies (*Dictya oxybeles, Hoplodictya spinicornis*) were observed in stands of smooth cordgrass and mixed stands of smooth cordgrass, glasswort, and sealavender. The larvae of these flies prey on snails and may attack the marsh periwinkle in the coastal wetlands. Assassin bugs (*Doldina interjungens, Sinea diadema, Zelus cervicalis*) and damsel bugs (*Nabis capsiformis*) prey on insects, whereas midges (unidentified) and mosquitoes (*Aedes sollicitans*) prey on warm-blooded vertebrates.

Adult parasitic wasps, including chalcids, braconids, ichneumons, tiphiids, and scelionids, were observed in all five of the wetland vegetation types. It was assumed, therefore, that the larvae, which are internal parasites of adult insects, insect larvae, and eggs, also were present in the stands. The larvae of a big-headed fly (*Tomosvaryella coquilletti*) are parasites of various leafhoppers and planthoppers.

The adults of most of the long-legged flies (*Chrysotus discolor, C. picticornis, Paraclius vicinus, P. claviculatus, Pelastoneurus lamellatus, Thinophilus ochrifacies*) are predaceous on smaller insects. The larvae are detritivores. The larvae of shore flies (*Psilopa flavida, Ceropsilopa costalis, Notiphila bispinosa*) also are detritus feeders.

Meiofauna

The total number of meiofauna ranges from 1.2 million per square meter during November to 10.6 million during June in smooth cordgrass stands along the Delaware Bay in New Jersey (Brickman 1972). The biomass of these individually small organisms ranges from 2.19 to 17.59 grams per square meter (20 to 157 pounds per acre) during the year. Vertically, 69% of the animals are contained in the uppermost 5 cm of the soil. Nematodes account for 97% of the total number of organisms and 93% of the total biomass. Predatory and omnivorous individuals compose about 3% of the total nematode population; about 14% are of species that feed on the slime that coats the surfaces of plant rootstocks and soil particles; and the majority feed on detritus.

BIRDS OF SALINE MARSHES[1]

The abundance of crustaceans, mollusks, and other invertebrates in the smooth cordgrass zone of the tidal marsh attracts herons, egrets, boat-tailed grackles, laughing gulls, seaside sparrows, and other birds to feed. During their migratory visits, especially in autumn, forty or more species of shorebirds, including sandpipers, plovers, and the whimbrel and willet, forage over the saline marshes and tidal flats and in shallow pools.

Gulls are scavengers, but they also feed on marsh invertebrates, on eggs, and on other available items. Nesting colonies of herring gulls may be established on sandy areas within the saline marshes. A typical nesting habitat is formed where small mounds of dredged materials have been deposited in an extensive marsh system. In some cases, the full colony may surround a heronry established by glossy ibises or black-crowned night herons. Where trees or shrubs are present, the heronries may be utilized by snowy egrets, great egrets, little blue herons, cattle egrets, Louisiana herons, yellow-crowned night herons, great blue herons, green herons, or mixtures of two or more of these species (Kane and Farrar 1976). Cattle egrets generally are scavengers, but the other species feed on fish and invertebrates that they obtain from the bays and tidal streams.

Laughing gulls may establish their nesting colonies in the smooth cordgrass zone. Occasionally a laughing gull colony will encircle a colony of herring gulls that has been assembled on a sandy hillock. Common terns or Forster's terns may nest nearby, but they invariably are segregated from the gull colony. The terns traditionally deposit their eggs on bare sand. Recent surveys along the New Jersey coast, however, suggest that the intensive human use of beaches and the usurpation by gulls of other sandy areas may force the terns to nest in areas that are covered with meadow cordgrass or common reed (Kane and Farrar 1976).

The Atlantic brant and snow goose winter in saline marshes. The brants feed largely on submerged aquatic plants, particularly on sealettuce, eelgrass, and wigeongrass. The principal food of the snow goose, however, is the rootstock of smooth cordgrass. Where the birds feed heavily, they may cause eatouts, or areas devoid of plant cover. These areas are slightly depressed, and they frequently develop into barren pans or shallow marsh ponds.

The rootstocks and leaves of smooth cordgrass and spikegrass are important items in the diet of the Canada goose, and the seeds of the cordgrass may be utilized by the black duck. Glassworts, which usually are scattered through the cordgrass stands, are minor food sources. Geese eat the fleshy branches, and ducks feed on the seeds (Tables 26 and 39).

Several kinds of shore birds feed along the margins of shallow ponds in the short-growth, smooth cordgrass marshes, particularly during the spring and autumn periods of migration. These include the greater yellowlegs, lesser yellowlegs, dowitchers, pectoral sandpiper, least sandpiper, stilt sandpiper, and whimbrel. Ponds that are bordered by mudflats or sand are utilized by the willet, semipalmated sandpiper, western sandpiper, dunlin, knot, semipalmated plover, black-bellied plover, and other shore birds. Willets may nest in short-growth, smooth cordgrass near the ponds.

Clapper rails are associated strongly with the smooth cordgrass. The principal food of these predatory birds is the marsh fiddler crab, which is most abundant in the smooth cordgrass zone. Investigations in New Jersey (Table 35) and near Chincoteague, Virginia (Stewart

[1]Except as noted, most of the information on the birds of the coastal wetlands was obtained from Meanley (1975).

1951), revealed that approximately 80 to 90% of the nests of the clapper rail are constructed in smooth cordgrass, and particularly in stands of the tall growth form (Table 36). In Maryland, some rails also may utilize stands of needlerush (Meanley 1975).

Marshelder occurs in linear stands along levees that are adjacent to tidal creeks and ditches, as well as on open shorelines. These narrow bands of shrubby vegetation are utilized as nesting habitat by the black duck, bluewinged teal, longbilled marsh wren, seaside sparrow, and marsh hawk.

Utilization of the meadow cordgrass-spikegrass marsh type is discussed in the section on Birds of Brackish Marshes. This marsh type also is characteristic of the higher, less-frequently flooded sections of the saline wetlands.

Table 35. Densities of populations of several kinds of animals in vegetation types in brackish and saline wetlands in New Jersey (Ferrigno, MacNamara, and Jobbins 1969).

	Type			
	71	72	61	49
	Smooth Cordgrass		Meadow	Common
	Tall	Short	Cordgrass	Reed
Waterfowl[1]	3.15	2.35	0.67	0.02
Clapper rails[2]	0.14	0.41	0.03	0
Muskrats[1]	3.7	0.2	0.08	0.01
Fiddler crabs[3]	46.3	36.9	3.2	0
Saltmarsh snails[4]	20.5	468.2	2.36	0
Ribbed mussels[4]	4.68	0.21	0.07	0
Mosquitoes[5]	0	2.9	9.1	6.2

[1]Individuals per acre.
[2]Successful nest hatches per acre.
[3]Occupied burrows per square meter.
[4]Number per square meter.
[5]*Aedes* individuals per net dip.

Table 36. Association of nests of the clapper rail with vegetation types in saline wetlands. Values are percentages of the total number of nests.

	New Jersey		Long Island
	Kozicky and Schmidt 1949	Ferrigno 1966	MacNamara and Udell 1966
Smooth cordgrass, tall	73	91	16
Smooth cordgrass, short	4		—
Smooth cordgrass/ meadow cordgrass	7	4	—
Meadow cordgrass/ spikegrass	0	6	32
Marshelder	14	<1	16
Common reed	0	0	9
Miscellaneous[a]	2	<1	5

[a]Blackrush, bayberry

INVERTEBRATES OF BRACKISH MARSHES

Wildlife biologists generally have not recognized brackish marshes as a separate category of coastal wetlands. Instead, they have grouped most brackish wetlands with the saline marshes; and only the least brackish have been included with freshwater wetlands. As a result, the literature contains few references to brackish wetlands as such.

The meiofauna population in managed stands of meadow cordgrass (Type 41) in New Jersey ranges in density from 0.036 million per square meter during October to 1.2 million during June (Brickman 1972). The biomass also is less than that of smooth cordgrass stands (Type 51), and ranges from approximately 0.07 to 2.02 grams per hectare (0.6 to 18 pounds per acre) during the year. Vertically, 92% of the population is contained in the upper 5 cm of soil. Nematodes are predominant. They contribute 64% of the total number of individuals and 59% of the total biomass. Copepods are more prominent than in the smooth cordgrass stands. In meadow cordgrass they accounted for 28% of all individuals and for 32% of the total biomass of the meiofauna.

Red-jointed fiddler crabs (*Uca minax*) are present in saline marshes, but they reach a peak of abundance in mixed stands of meadow cordgrass and spikegrass (Kerwin 1971). Near Solomons Island, Maryland, Gray (1972) found that most red-jointed fiddlers were in stands of big cordgrass and paspalum. Tests in the State of Delaware indicated that the salinity of the water ranges from 0 to 12 ppt in areas in which the red-jointed fiddler crab is most abundant, and that the marsh fiddler and the red-jointed fiddler may be equally abundant in areas in which the salinities range from 8 to 12 ppt (Miller and Maurer 1973). No habitat data have been found for the sand fiddler crab, but it apparently is most abundant in brackish areas where salinities are intermediate (12 to 20 ppt) between those which seem to favor the other two species.

The ribbed mussel is the only bivalve mollusk that is common in brackish marshes (Stewart 1962). It occurs principally along the margins of tidal creeks and ponds.

The saltmarsh snail and another small snail (*Littoridinops* sp.) are the two most abundant and widely distributed gastropod mollusks in the brackish wetlands. In contrast to the distribution reported in saline marshes, Kerwin (1972) found that saltmarsh snails were more abundant in meadow cordgrass-spikegrass stands than in smooth cordgrass stands in the brackish wetland that he investigated (Table 30). Periwinkles, however, are rather common in the vegetation along tidal creeks (Stewart 1962).

In addition to fiddler crabs, a variety of other crustaceans inhabits the brackish wetlands. These include ostracods, copepods, isopods, amphipods, mud crabs, and the blue crab (Stewart 1962). The characteristic insects in these wetlands include mole crickets, dragonfly nymphs, water boatmen, giant water bugs, adult and larval mosquitoes, midge larvae, predaceous diving beetles, water scavenger beetles, and weevils.

BIRDS OF BRACKISH MARSHES

During the autumn and spring periods of migration, waterfowl are abundant on the brackish marshes along the bays in the upper Chesapeake region of Maryland (Stewart 1962). The most abundant waterfowl are:

Primary Species	
Black duck	Blue-winged teal
Green-winged teal	American wigeon
Secondary Species	
Canada goose	Pintail
Mallard	Northern shoveller
Gadwall	Hooded merganser
Casual or Irregular Visitors	
Whistling swan	Common goldeneye
Snow goose	Bufflehead
Blue goose	Ruddy duck
Redhead	Common merganser
Canvasback	American coot
Lesser scaup	

Black ducks and green-winged teal occur generally throughout the brackish marshes, but they tend to congregate near creeks and ponds in which mudflats are exposed during periods of low water. Gadwalls and American wigeons typically utilize permanent ponds that support extensive stands of wigeongrass or muskgrass. Ponds with surface areas of 5 acres or more seem to be most attractive to Canada geese, and hooded mergansers generally occupy only the larger tidal creeks. Other kinds of waterfowl that are characteristic of the brackish marshes do not exhibit definite habitat affinities, but most of them seem to be most numerous on and around permanent ponds. Foods that are utilized by waterfowl in the moderately brackish and highly brackish bays of the upper Chesapeake region are summarized in Tables 37 and 38.

Dunlins, greater yellowlegs, and lesser yellowlegs scour the open mudflats and shallow pools of the meadow cordgrass and Olney threesquare marshes to obtain invertebrates. Meadow cordgrass stands are the prime nesting habitat of the black rail, and also are utilized for nest sites by willets, redwinged blackbirds, seaside sparrows, and sharp-tailed sparrows (Stewart and Robbins 1958; Meanley 1975).

The brackish marshes also serve as breeding areas for comparatively large numbers of waterfowl (Stewart 1962). Black ducks utilize sites in all of the typical vegetation types, including big cordgrass and switchgrass, and also nest in marginal upland habitats. Blue-winged teal nest principally in stands of meadow cordgrass (Type 41). Gadwalls establish widely spaced nests, and usually are not abundant.

The contents of the gullets and gizzards of 348 specimens of waterfowl that were collected from brackish estuarine bay marshes in Maryland were analyzed by Stewart (1962). The results of this investigation indicate that large volumes of the leaves, stems, rootstocks, and seeds of wigeongrass are eaten by nearly all kinds of waterfowl in these marshes, and that the wigeongrass is the most important food for waterfowl that utilize this habitat (Table 39). The seeds of Olney threesquare also are important in the diets of many kinds of waterfowl. Other plant foods that are utilized rather intensively include the seeds of marshelder, the seeds of stout bulrush, and the vegetative parts of the alga, muskgrass. Canada geese eat large quantities of the rootstocks and culms of common threesquare and Olney threesquare. Seeds of twigrush apparently are carried by currents from fresh marsh areas and are deposited along tidal creeks and ponds in the brackish wetlands. These seeds were well represented in the analyses.

Animal items that were present in the ingested mass of food in one or more kinds of ducks included the saltmarsh snail, another small snail (*Littoridinops* sp.) and copepods. Small fish had been ingested by black ducks that were collected during the winter, but these ducks feed most intensively on the larvae and pupae of mosquitoes during the warmer seasons.

Table 37. Foods of waterfowl during late autumn, winter, and early spring in moderately brackish estuarine bays of the upper Chesapeake region, Maryland (Stewart 1962). Names followed by a superscript "t" indicate birds from areas of turbid water. Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume.

	Whistling swan	Brant	Mallard	Black duck	Pintail	American wigeon	Redhead	Canvasback	Canvasback^t	Greater scaup	Lesser scaup	Lesser scaup^t	Common goldeneye	Bufflehead	Oldsquaw	Ruddy duck	Ruddy duck^t
Number of Birds Examined:	42	8	13	40	5	57	81	41	9	9	13	14	7	18	6	9	9
Plants, Vegetative Parts																	
Submerged Aquatics	(71)	(100)	(38)	(75)	(60)	(98)	(90)	(56)	(22)	(33)	(23)	-	(29)	(22)	(50)	-	-
Wildcelery	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zosteraceae, unidentified	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-
Eelgrass	-	100	8	42	-	53	30	22	11	22	8	-	14	11	33	-	-
Pondweed, unidentified	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Redhead pondweed	5	-	23	50	20	70	53	46	-	-	8	-	-	-	-	-	-
Sago pondweed	21	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
Wigeongrass	69	100	8	28	20	47	14	10	11	-	8	-	14	22	17	-	-
Southern naiad	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Table 37. Foods of waterfowl during late autumn, winter, and early spring in moderately brackish estuarine bays, upper Chesapeake region (Continued).

	Whistling swan	Brant	Mallard	Black duck	Pintail	American wigeon	Redhead	Canvasback	Canvasback	Greater scaup	Lesser scaup	Lesser scaup	Common goldeneye	Bufflehead	Oldsquaw	Ruddy duck	Ruddy duck
Common waterweed	-	-	-	-	20	11	14	-	-	-	-	-	-	-	-	-	-
Sealettuce	-	-	-	-	-	4	5	-	-	-	-	-	-	-	-	-	-
Filamentous green algae	2	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-
Enteromorpha	2	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-
Emergent Plants	(2)	-	-	-	-	(2)	-	-	-	-	-	-	-	-	-	-	-
Unidentified	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smooth cordgrass	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Plants, seeds	(2)	-	(69)	(60)	(80)	(5)	(28)	(37)	-	(22)	(38)	(7)	-	(22)	-	(33)	(11)
Submerged Aquatics		-															
Grassleaf pondweed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-
Redhead pondweed	-	-	31	28	20	4	25	32	-	-	15	-	-	17	-	22	-
Sago pondweed	-	-	-	-	-	-	-	2	-	-	8	-	-	-	-	-	-
Southern naiad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-
Wigeongrass	-	-	46	42	20	-	6	17	-	22	31	-	-	17	-	11	-
Emergent Plants, Herbaceous		-															
Undetermined	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Great burreed	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
German millet	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Olney threesquare	-	-	8	2	20	-	1	-	-	-	-	7	-	-	-	-	11
Stout bulrush	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Smartweed, unidentified	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dotted smartweed	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pale smartweed	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Pinkweed	-	-	8	-	20	-	-	-	-	-	-	-	-	-	-	-	-
Emergent Plants, Shrubs and Trees																	
Swamp rose	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Holly	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marshelder	-	-	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Blackgum	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crop Plants (Bait)	(10)	-	(46)	(25)	(20)	(2)	(23)	(24)	(33)	(22)	(54)	(14)	(29)	(22)	(17)	-	-
Corn	10	-	38	25	20	2	23	24	33	22	54	14	29	22	17	-	-
Wheat	-	-	8	-	-	-	-	2	-	-	8	-	-	-	17	-	-
Animal Foods	(55)	-	(8)	(45)	(40)	(2)	(10)	(80)	(100)	(100)	(77)	(100)	(100)	(89)	(100)	(67)	(100)
Mollusks		-															
Undetermined	-	-	-	2	-	-	-	2	22	-	-	-	-	-	-	-	-
Gastropods		-															
Bittium varium	-	-	-	-	20	-	-	7	-	22	-	7	-	-	-	-	-
Ilyanassa obsoleta	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-
Saltmarsh snail	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
New England dog whelk	-	-	-	-	-	-	-	2	-	-	-	7	-	-	-	-	-
Odostomia impressa	-	-	-	-	-	-	-	2	-	11	-	21	-	11	-	-	-
Retrusa canaliculata	-	-	-	-	-	-	-	-	-	-	8	64	14	-	-	-	44
Sayella chesapeakea	-	-	-	-	-	-	-	-	11	15	-	7	-	-	-	-	11
Triphora perversa	-	-	-	-	-	-	-	2	-	-	-	14	-	-	-	-	-
Bivalves		-															
Undetermined	2	-	-	-	-	-	-	-	-	-	-	-	14	-	33	-	-
Bent mussel	-	-	-	8	-	-	-	2	-	22	23	29	-	6	17	-	-
Gem shell	-	-	-	5	-	-	-	7	-	-	23	-	-	17	17	-	11
Morton's cockle	-	-	-	-	-	-	-	2	-	11	-	36	-	-	-	-	-
Baltic macoma	31	-	8	32	-	2	2	56	78	11	15	36	14	22	-	11	56
Macoma phenax	2	-	-	-	-	-	-	2	-	-	-	7	-	11	-	56	-
Atlantic ribbed mussel	-	-	-	2	-	-	-	-	-	-	8	7	43	-	-	-	-
Coot clam	-	-	-	-	-	-	-	17	11	44	38	50	-	11	-	11	44
Common soft-shelled clam	26	-	-	-	-	-	1	7	-	-	15	7	-	6	-	33	-
Mytilidae	-	-	-	2	-	-	-	-	-	-	-	-	-	11	-	-	-
Stout razor clam	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Segmented Worms		-															
Undetermined polychaetes	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Clam worm	-	-	-	-	-	-	-	-	-	-	-	-	-	6	17	-	-
Arthropods																	
Crustaceans																	
Unidentified crustaceans	-	-	-	-	-	-	-	-	-	-	-	-	-	6	17	11	-

Table 37. Foods of waterfowl during late autumn, winter, and early spring in moderately brackish estuarine bays, upper Chesapeake region, (Concluded).

	Whistling swan	Brant	Mallard	Black duck	Pintail	American wigeon	Redhead	Canvasback	Canvasback	Greater scaup	Lesser scaup	Lesser scaup	Common goldeneye	Bufflehead	Oldsquaw	Ruddy duck	Ruddy duck
Unidentified barnacles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-
Acorn barnacles	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-
Unidentified isopods	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-
Chiridotea coeca	-	-	-	-	-	-	-	-	-	-	-	36	-	-	-	-	22
Cyathura spp.	-	-	-	-	20	-	-	-	11	-	-	-	-	6	-	11	-
Erichsonella spp.	-	-	-	2	-	-	-	7	-	-	-	-	-	11	17	-	-
Unidentified amphipods	-	-	-	-	-	-	1	-	-	-	-	-	-	-	17	-	-
Unidentified gammarids	-	-	-	2	-	-	-	-	-	15	-	14	14	11	-	22	11
Ampithoids	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified decapods	-	-	-	-	-	-	-	2	-	8	-	7	-	-	50	-	-
Unidentified mud crabs	-	-	-	2	-	-	5	24	11	-	-	-	43	22	-	11	-
Bluecrab	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-
Neopanope taxana sayi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-
Ladycrab	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Sesarma spp.	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-
Myriapods																	
Unidentified species	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-
Chordates																	
Unidentified tunicates	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-
Mogula spp.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrapes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified fish	-	-	-	2	-	-	-	-	-	-	-	-	43	11	33	-	-

Table 38. Foods of waterfowl during the autumn and winter in highly brackish estuarine bays of the upper Chesapeake region, Maryland (Stewart 1962). Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume.

	Brant	Redhead	Canvasback	Greater scaup	Lesser scaup	Common goldeneye	Bufflehead
Number of Birds Examined:	5	6	6	15	7	10	4
Plants, Vegetative Parts							
Submerged Aquatics	(100)	(50)	(17)	(47)	(43)	-	-
Eelgrass	-	33	17	47	43	-	-
Redhead pondweed	-	17	-	-	-	-	-
Wigeongrass	-	17	-	7	-	-	-
Sealettuce	100	-	-	-	-	-	-
Plants, Seeds	-	-	-	-	(14)	-	-
Submerged Aquatics							
Wigeongrass	-	-	-	-	14	-	-
Emergents							
Olney threesquare	-	-	-	-	14	-	-
Crop plants (bait)	-	(83)	(67)	(27)	(57)	(70)	-
Corn	-	83	67	27	57	70	-
Sorghum	-	33	-	-	-	-	-
Wheat	-	-	17	-	-	-	-
Animal Foods	-	(33)	(83)	(93)	(100)	(90)	(100)
Mollusks							
Undetermined	-	-	50	27	-	-	-
Gastropods							
Anachis avara	-	-	-	27	-	-	-
Bittium sp.	-	-	-	-	57	-	-
Bittium varium	-	-	17	53	-	-	-
Cerithiopsis subulata	-	-	-	7	-	-	-
Clathurella jewetti	-	-	-	13	-	-	-
Ilyanassa obsoleta	-	-	-	13	14	10	-
Lora sp.	-	-	-	-	-	-	25
Mitrella lunata	-	-	-	53	14	-	-
New England dog whelk	-	-	-	33	-	-	25
Odostomia impressa	-	-	-	7	14	-	25
Pleurotoma sp.	-	-	-	7	-	-	-

Table 38. Foods of waterfowl during the autumn and winter in highly brackish estuarine bays of the upper Chesapeake region, Maryland (Stewart 1962). Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume (Concluded).

Number of Birds Examined:	Brant 5	Redhead 6	Canvasback 6	Greater scaup 15	Lesser scaup 7	Common goldeneye 10	Bufflehead 4
Pyramidella sp.	-	-	-	7	-	-	-
Retrusa canaliculata	-	-	17	13	14	-	25
Rissoidae, unidentified	-	-	-	-	14	-	-
Sayella chesapeakea	-	-	17	-	-	-	-
Triphora perversa	-	-	-	-	14	-	-
Turbonilla sp.	-	-	-	7	-	-	-
Bivalves							
Undetermined	-	-	-	-	14	20	-
Bent mussel	-	-	-	-	-	30	-
Platform mussel	-	-	17	-	-	-	-
Gem shell	-	17	-	7	14	-	25
Morton's cockle	-	-	-	13	-	-	-
Baltic macoma	-	-	33	20	-	10	50
Coot clam	-	-	17	-	14	20	50
Spisula sp.	-	-	17	-	-	-	-
Veneridae, unidentified	-	-	-	-	-	10	-
Polychaetes, undetermined	-	-	17	-	-	-	-
Crustaceans							
Undetermined isopods	-	-	-	-	-	10	-
Erichosonella filiformis	-	17	-	-	-	-	-
Undetermined gammarids	-	-	-	-	14	20	50
Undetermined mud crabs	-	-	-	-	-	40	25
Blue crab	-	-	17	-	-	-	-

Table 39. Foods of waterfowl that were collected from coastal marshes in the upper Chesapeake region of Maryland from autumn through late spring (Stewart 1962). Most of the specimens were obtained from brackish marshes, but a few were taken in fresh marshes and nineteen black ducks were from saline marshes. Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume.

	Whistling swan	Canada goose	Mallard	Black duck	Gadwall	Pintail	American wigeon	Green-winged teal	Blue-winged teal	Northern shoveller	Hooded merganser
Number of Birds Examined:	4	10	28	133	24	13	86	34	43	12	2
Plants, Vegetative Parts											
Submerged Aquatics	(75)	(30)	(32)	(31)	(88)	(38)	(93)	-	(12)	(17)	-
Undetermined species	-	-	-	1	-	-	-	-	-	-	-
Eelgrass	-	-	-	-	17	-	1	-	-	-	-
Pondweed, unidentified	-	-	4	2	-	-	-	-	2	-	-
Grassleaf pondweed	-	-	-	-	4	-	-	-	-	-	-
Redhead pondweed	-	-	-	1	8	-	3	-	-	-	-
Sago pondweed	-	-	4	-	-	8	2	-	-	-	-
Wigeongrass	50	30	21	23	67	31	78	-	5	8	-
Common waterweed	-	-	-	-	4	-	-	-	-	-	-
Pinnate watermilfoil	-	-	-	-	4	-	-	-	-	-	-
Muskgrass	25	-	11	2	12	-	27	-	5	17	-
Sealettuce	-	-	-	2	-	-	-	-	-	-	-
Filamentous green algae	-	-	-	-	4	-	1	-	-	-	-
Enteromorpha	-	-	-	2	-	-	-	-	-	-	-
Emergent Plants, Herbaceous	(75)	(70)	(7)	(5)	(8)	-	(6)	-	-	(8)	-
Undetermined species	25	-	7	-	-	-	-	-	-	-	-
Grass, rootstalks, unidentified	-	-	-	1	-	-	-	-	-	-	-
Spikegrass	25	20	-	3	8	-	3	-	-	-	-
Cordgrass, unidentified	-	-	-	-	-	-	-	-	-	8	-
Smooth cordgrass	-	10	-	2	-	-	2	-	-	-	-
Threesquare, unidentified	25	60	-	-	-	-	-	-	-	-	-

Table 39. Foods of waterfowl that were collected from coastal marshes, upper Chesapeake region, Maryland, autumn through late spring (Continued).

	Whistling swan	Canada goose	Mallard	Black duck	Gadwall	Pintail	American wigeon	Green-winged teal	Blue-winged teal	Northern shoveller	Hooded merganser
Number of Birds Examined:	4	10	28	133	24	13	86	34	43	12	2
Plants, Seeds	-	(30)	(68)	(70)	(25)	(85)	(7)	(100)	(95)	(75)	-
Submerged Aquatics											
Redhead pondweed	-	-	-	-	4	-	-	-	2	-	-
Sago pondweed	-	-	4	1	-	8	-	-	2	-	-
Wigeongrass	-	-	25	23	8	46	3	59	51	25	-
Emergent Plants, Herbaceous											
Common burreed	-	-	4	-	-	8	-	-	-	-	-
Spikegrass	-	-	14	7	-	8	3	9	7	17	-
Cordgrass, unidentified	-	-	-	-	-	23	-	-	5	-	-
Big cordgrass	-	-	-	2	-	-	-	-	-	-	-
Smooth cordgrass	-	-	14	6	8	-	-	6	-	-	-
Rice cutgrass	-	-	-	1	-	-	-	3	-	-	-
Crabgrass	-	-	-	-	-	15	-	-	-	-	-
Knucklegrass	-	-	-	-	-	8	-	-	-	-	-
Walter millet	-	-	-	1	-	8	-	-	-	-	-
Foxtail grass	-	-	-	-	-	8	-	-	-	-	-
Fragrant umbrellasedge	-	-	-	-	-	-	-	3	-	-	-
Common spikerush	-	-	-	-	-	-	1	-	-	-	-
Dwarf spikerush	-	-	-	-	-	-	-	9	-	-	-
Chestnutsedge	-	-	-	-	-	-	-	3	-	-	-
Bulrush, unidentified	-	-	-	1	-	-	-	-	-	-	-
Common threesquare	-	20	-	1	-	8	-	6	-	-	-
Olney threesquare	-	-	29	32	8	23	2	85	77	33	-
Softstem bulrush	-	-	7	2	-	-	-	3	2	-	-
Stout bulrush	-	-	7	10	-	-	-	12	16	-	-
Twigrush	-	10	25	14	-	23	1	15	14	8	-
Needlerush	-	-	-	1	-	-	-	3	-	-	-
Smartweed, unidentified	-	-	-	1	-	-	-	-	-	-	-
Dotted smartweed	-	-	4	6	-	-	-	3	-	-	-
Pinkweed	-	-	4	-	-	-	-	-	-	-	-
Spreading orach	-	-	-	1	-	-	-	-	-	-	-
Mermaidweed	-	-	-	-	-	-	-	3	-	-	-
Carolina sealavender	-	-	-	1	-	-	-	-	-	-	-
Dodder, unidentified	-	-	-	1	-	-	-	-	-	8	-
Bluecurls	-	-	-	1	-	-	-	-	-	-	-
Emergent Plants, Shrubs and Trees											
Bayberry	-	-	-	1	-	-	-	-	-	-	-
Waxmyrtle	-	-	-	1	-	8	-	-	-	-	-
Blackberry	-	-	-	1	-	-	-	-	-	-	-
Possumhaw	-	-	-	1	-	-	-	-		-	-
Buttonbush	-	-	-	1	-	8	-	-	-	-	-
Groundselbush	-	-	-	1	-	-	-	-	-	-	-
Marshelder	-	-	7	7	-	-	-	6	12	-	-
Blackgum	-	10	-	1	-	8	-	-	-	-	-
Crop Plants (Bait)	-	(10)	(25)	(7)	-	(15)	-	(6)	(2)	-	-
Corn	-	10	25	7	-	15	-	6	2	-	-
Wheat	-	10	-	1	-	-	-	-	-	-	-
Animal Foods	-	-	(25)	(56)	(4)	(31)	(2)	(59)	(44)	(67)	(100)
Cnidarians											
Hydromedusae											
Undetermined species	-	-	-	-	-	-	1	-	-	-	-
Mollusks											
Gastropods											
Undetermined species	-	-	-	-	-	-	-	-	2	-	-
Bittium varium	-	-	-	2	-	-	1	3	-	8	-
Littoridinops spp.	-	-	-	6	-	-	-	12	23	33	-
Littorina irrorata	-	-	-	1	-	-	-	-	-	-	-
Saltmarsh snail	-	-	-	27	-	8	-	9	2	-	-
Bivalves											
Atlantic ribbed mussel	-	-	11	5	-	8	-	-	2	-	-

Table 39. Foods of waterfowl that were collected from coastal marshes, upper Chesapeake region, Maryland, autumn through late spring (Concluded).

	Whistling swan	Canada goose	Mallard	Black duck	Gadwall	Pintail	American wigeon	Green-winged teal	Blue-winged teal	Northern shoveller	Hooded merganser
Coot clam	-	-	-	1	-	-	-	-	-	-	-
Mytilidae, unidentified	-	-	-	1	-	-	-	-	-	-	-
Segmented Worms											
Clam worms	-	-	-	1	-	-	-	-	-	-	-
Arthropods											
Crustaceans											
Unidentified ostracods	-	-	-	-	-	-	-	9	7	-	-
Unidentified cladeocerans	-	-	-	-	-	-	-	-	-	8	-
Unidentified copepods	-	-	-	-	-	-	-	-	-	25	-
Leptochelia savignyi	-	-	-	-	-	-	-	12	-	-	-
Chiridotea coeca	-	-	4	2	-	-	-	6	-	-	-
Unidentified amphipods	-	-	4	6	-	-	-	21	-	8	-
Unidentified decapods	-	-	4	5	-	-	-	-	-	-	-
Unidentified mud crabs	-	-	-	-	-	-	-	-	-	-	100
Insects											
Unidentified insects	-	-	-	-	-	-	-	3	-	-	-
Dragonfly nymphs	-	-	-	5	-	8	-	-	2	-	-
Mole crickets	-	-	-	2	-	-	-	-	-	-	-
True bug nymphs	-	-	-	1	-	-	-	-	-	-	-
Giant water bugs	-	-	-	3	-	-	-	-	-	-	-
Water boatmen	-	-	-	1	-	-	-	-	-	-	-
Beetles, unidentified	-	-	-	6	-	-	-	-	7	-	-
Weevils	-	-	-	-	-	-	-	-	5	-	-
Fly larvae	-	-	-	-	-	-	-	3	-	-	-
Mosquito larvae	-	-	-	4	-	-	-	-	-	-	-
Midge larvae	-	-	-	1	-	-	-	9	-	-	-
Ants	-	-	-	1	-	-	-	-	2	-	-
Chordates											
Tunicates											
Molgula spp.	-	-	4	-	-	-	-	-	-	-	-
Sea grapes	-	-	-	-	-	8	-	-	-	-	-
Vertebrates											
Fish eggs	-	-	-	1	-	-	-	-	5	-	-
Fish, mostly killifish	-	-	4	17	4	-	-	-	-	17	100

Two shrubs, the marshelder and groundselbush, colonize low banks along marsh channels, and marshelder also may cover rather extensive sections of the marsh adjacent to the uplands. Even where the shrubs are scattered widely through the marsh, however, they are important components of the habitat for birds. Red-winged blackbirds, long-billed marsh wrens, and least bitterns, for example, may be attracted to marshes in which weak-stemmed herbaceous plants are predominant if shrubs are dotted through the areas. In these places, the birds construct nests in the shrubs, and forage in the surrounding herbaceous marshes (Stewart 1949). Stands of the shrubs form prime nesting habitat for the red-winged blackbird and boat-tailed grackle (Higman 1972). Of 650 active nests of the red-winged blackbird, Meanley and Webb (1963) found 50% among the branches of marshelder and 28% in the crowns of the groundselbush. Swamp sparrows also may nest in the shrubs in certain coastal localities.

Stands of switchgrass (Type 46) occupy the highest sections of some brackish wetlands, and in places they may have an overstory of loblolly pine. These stands are nesting habitat for short-billed marsh wrens and king rails. The grass produces relatively large seeds which are utilized as an autumnal food by several kinds of birds. Although the grass becomes yellowish brown during autumn, it maintains its form and provides cover throughout the winter and spring. This marsh type is used moderately for nesting cover by the red-winged blackbird.

The predominant plants in some types of coastal wetland vegetation have coarse stems that are strong enough, and tall enough, to support nests above the level of normal high tides. In other types of vegetation, the stems of the most abundant plants are short or weak, and will not support elevated nests. Most of the brackish marsh types are composed of robust plants which do provide adequate substrates for elevated nests (Stewart 1949).

The long-billed marsh wren is the most common nesting bird in needlerush marshes (Type 43). Nests of seaside sparrows frequently are placed in needlerush, and these stands are used as nest sites by a few clapper rails. Nests of the long-billed marsh wren, together with those of the red-winged blackbird and least bittern, also are common to abundant in stands of cattail (Type 44). King rails and Virginia rails nest in cattail marshes, but the birds are secretive and their nests are inconspicuous, so they seldom are seen. Red-winged blackbirds nest rather abundantly in stands of stout bulrush (Type 37) and common reed (Type 39). Long-billed marsh wrens and least bitterns also utilize the common reed habitat, whereas short-billed marsh wrens, seaside sparrows, Virginia rails, and king rails construct nests in stands of stout bulrush.

Big cordgrass, which commonly is 7 to 8 feet tall, forms narrow stands along the tidal rivers and marsh channels (Type 48). This grass is not a significant source of food for wildlife, but it provides dense cover that persists through the winter. The red-winged blackbird and long-billed marsh wren are common in these stands, and clapper rails and king rails also utilize the habitat (Stewart 1949). Marsh wrens and, in a few areas, swamp sparrows nest in big cordgrass stands.

Meadow cordgrass/spikegrass marsh (Type 41), switchgrass (Type 46), Olney threesquare marsh (Type 47), and smooth cordgrass marsh (Type 51) are composed of plants that are not strong enough to support nests at elevations that are above the normal range of the tide. The low stands of meadow cordgrass are the principal habitat of the sharp-tailed sparrow, and the density of the breeding population may be as great as one pair per acre. Many eastern meadowlarks, and small numbers of secretive black rails, also utilize this habitat for their nest sites. Meadowlarks generally also are common nesters in stands of switchgrass. Stands of switchgrass, however, are of special importance as the optimum habitat in the upper Chesapeake region for the short-billed marsh wren and the American bittern. Rails, which construct bouyant nests, are the most characteristic breeding birds in stands of Olney threesquare and smooth cordgrass. The Virginia rail is common in threesquare marsh, and the clapper rail is the prevalent bird in areas covered by the cordgrass (Stewart 1949).

Populations of muskrats are dense in most stands of Olney threesquare (Type 47), cattail (Type 44), and big cordgrass (Type 48), and the mammals construct complex systems of runways through these thick marsh growths. Especially in threesquare marshes, king rails use the muskrat runs as avenues of movement and as sites from which to collect aquatic invertebrates. The birds also feed on red-jointed fiddler crabs and periwinkles that are common in most brackish wetlands. The king rail nests in threesquare marshes, but the nests almost invariably are placed in the branches of rosemallow plants which are scattered through the stands.

BIRDS OF FRESH MARSHES

The freshwater marshes are composed of more than sixty species of flowering plants, and are floristically the most diverse of all of the tidal wetlands. The aerial portions of cattail and common reed die in autumn, but the plants remain erect and provide cover throughout most of the winter. In contrast, the leaves and stems of most other herbaceous plants of the freshwater wetlands decompose rapidly, and most of the wetland area is devoid of cover from November through March.

Seed production is at a peak in the freshwater tidal marshes from mid-August through mid-September, and these wetlands become extensive granaries for wildlife. Redwings, bobolinks, rails, and teals and other ducks flock to the marshes to feed (Stewart 1949). Smartweeds, wildrice, and Walter millet are the prime sources of seed. Analyses of the stomachs of 241 soras from freshwater wetlands long the Patuxent River, for example, indicated that seeds of the halberdleaf tearthumb (37% by volume), Walter millet (19%), dotted smartweed (15%), and arrowleaf tearthumb (8%) formed 79% of the stomach contents (Meanley 1965).

Analyses of the contents of the stomachs of 130 red-winged blackbirds from the fresh marshes along the tidewater section of the Patuxent River during late summer revealed that the seeds of dotted smartweed formed 38% of the total volume and occurred in 88% of the stomachs (Meanley 1961). Seeds of wildrice, which was the most abundant and conspicuous plant in the marshes, occurred in 61% of the stomachs and formed 24% of the volume of foods present. Walter millet seeds occurred in 46% of the birds and constituted 11% of the food, but the seeds of each of seven other wild plants formed 1% or less of the volume of food and were noted in 4% or fewer of the stomachs. These plants were halberdleaf tearthumb, ragweed, panicgrass, arrowleaf tearthumb, rice cutgrass, crabgrass, and waterhemp.

Large numbers of red-winged blackbirds begin to flock to the fresh marshes during late July at the time of the onset of molt (Meanley 1961, 1964). The birds frequently perch on wildrice plants, and hundreds of the birds may be seen hovering in the air to grasp the flowering panicles of rice plants to loosen flowers or immature seeds. By mid-August to early September, as many as 50,000 red-wings may roost in the wildrice stands on the Patuxent River to feed on the ripe seeds. By late September the remaining rice seeds have fallen to the ground and become embedded in the mud. At this time, molting is complete, and the red-wings begin to migrate to the southeastern states.

The results of analyses of the contents of the gullets and gizzards of waterfowl that were collected from freshwater bays and from estuarine river marshes in the upper Chesapeake region are summarized in Tables 41 and 42. Seeds of the dotted smartweed are the principal plant food of marsh birds, but seeds of common burreed, wildrice, Walter millet, common threesquare, softstem bulrush, river bulrush, and halberdleaf tearthumb also are well represented in the analyses (Stewart 1962). Wood ducks feed most intensively on the seeds of arrowarum, but these seeds do not seem to be particularly attractive to other waterfowl or to marsh birds.

Seeds of the cattails are not significant as wildlife food, but the tubers are a winter food of geese. More importantly, the dense stands formed by cattails are utilized as nesting habitat by long-billed marsh wrens, common gallinules, least bitterns, and red-winged blackbirds.

Many of the maturing fruits of wildrice are eaten or are dislodged by winds and rains during late July and August. Those that remain ripen by late August and shower to the ground almost immediately. After the rice seeds have dropped, red-winged blackbirds and rails concentrate on the seeds of dotted smartweed, arrowleaf tearthumb, and halberdleaf tearthumb. Large congregations of dabbling ducks—black ducks, mallards, pintails, shovellers, blue-winged teal, and green-winged teal, in particular—also secure seeds directly from the marsh plants, but more commonly they scoop up the soupy muck from marsh channels and strain it through their bills to glean fallen seeds. Bobwhite quail also feed on the seeds, and these small gamebirds utilize the marsh edges throughout the year (Office of River Basin Studies 1954).

The Canada goose and the black duck are the most common migrant waterfowl during the autumn and spring in the fresh marshes along the estuarine bays of the upper Chesapeake region of Maryland (Stewart 1962). The geese utilize large, shallow ponds, particularly those ponds that support stands of Olney threessquare or other threesquares or bulrushes. Black ducks, as well as green-winged teal and blue-winged teal, are most numerous in tidal ponds and creeks in which mudflats are exposed during periods of low water. Ring-necked ducks and, to a lesser extent, other diving ducks utilize deeper tidal ponds. Whistling swans, gadwalls, American wigeons, and American coots, in contrast, are seen most often in ponds that are clear enough to support stands of submerged aquatic plants.

The results of investigations of the contents of the gullets and gizzards of waterfowl collected from fresh estuarine bay marshes during the migration periods are included in Table 41. The analyses indicated that the principal plant foods utilized by waterfowl were the seeds of twigrush; the seeds and rootstalks of Olney threesquare; the rootstalks of common threesquare; and the leaves and rootstalks of redhead pondweed and wigeongrass. Killifish, gammarids (amphipod crustaceans), and midge larvae were the most important animal foods, and were utilized principally by black ducks.

During a yearlong survey of the wildlife on a 2,000 acre rural tract adjacent to a tributary of the Delaware River in southern New Jersey, 207 kinds of birds were observed to visit or nest (McCormick 1976). Of these, 67 species were associated most closely with fresh tidal marshes that occupied about 500 acres. More than 40% of the individuals of fourteen species were observed in the wetlands (Table 40).

Fresh estuarine river marshes in the upper Chesapeake region of Maryland are especially noted as habitat for large numbers of sora during the autumn (Stewart 1962). Bobolinks, red-winged blackbirds, common snipe, and many other kinds of marsh birds also occur in myriads. In contrast, birds are comparatively scarce in typical brackish estuarine river marshes in the region. The results of investigations of the contents of the gullets and gizzards of waterfowl collected from tidewater river wetlands and floodplains are presented in Table 42.

During the spring and autumn periods of migration, the following species of waterfowl are characteristic of the estuarine river marshes of the upper Chesapeake region (Stewart 1962):

Principal Species	
Mallard	Green-winged teal
Black duck	Blue-winged teal
Pintail	Wood duck
Secondary Species	
Canada goose	Hooded merganser
American wigeon	Common merganser
Ring-necked duck	American coot
Casual or Irregular Visitors	
Whistling swan	Redhead
Gadwall	Common goldeneye
Northern shoveller	Ruddy duck

Table 40. Birds associated most closely with the Oldmans Creek NJ freshwater tidal marsh. Values are expressed as percentages of the total number of individuals observed in all types of habitats (Total Records) on a rural tract of 2,000 acres (McCormick 1976).

During all seasons	Tidal Marsh	Total Records
Ringbilled gull	49%	648
Greater yellowlegs	73	217
Great blackbacked gull	76	105
Autumn, winter and spring		
Pintail	99	5,674
Whistling swan	68	945
Green-winged teal	51	209
Common snipe	95	60
Dunlin	55	11
Spring and summer		
Longbilled marsh wren[1]	78	94
King rail	100	3
Spring, summer and autumn		
Pectoral sandpiper	95	37
Virginia rail	73	11
Least sandpiper	55	11
Spring and autumn		
Lesser yellowlegs	76	37

[1]Nests in the tidal marshes.

Table 41. Foods of waterfowl in fresh estuarine bays of the upper Chesapeake region, Maryland (Stewart 1962). Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume.

	Whistling swan	Canada goose	Redhead	Ring-necked duck	Canvasback	Greater scaup	Lesser scaup	Common goldeneye	Ruddy duck	Hooded merganser
Number of Birds Examined:	4	5	11	17	30	19	22	6	11	3
Plants, Vegetative Parts										
Submerged Aquatics	(100)	(20)	(64)	(82)	(90)	(84)	(36)	(67)	(55)	-
Pondweed, unidentified	-	-	45	53	-	11	9	33	9	-
Grassleaf pondweed	-	-	9	6	-	-	9	-	-	-
Redhead pondweed	25	20	-	-	-	-	14	-	-	-
Sago pondweed	-	-	18	6	17	-	-	17	9	-
Wigeongrass	-	-	-	-	-	-	14	-	-	-
Naiad	-	-	9	24	3	-	9	-	-	-
Wildcelery	100	20	-	6	70	74	9	17	55	-
Muskgrass	-	-	-	-	-	5	-	-	-	-
Emergent Plants (Rootstalks)	-	-	-	-	(3)	-	(5)	-	-	-
Arrowhead	-	-	-	-	3	-	5	-	-	-
Plants, Seeds	-	-	(55)	-	(47)	(42)	-	(33)	(18)	-
Submerged Aquatics										
Pondweed, unidentified	-	-	-	-	7	32	-	17	-	-
Grassleaf pondweed	-	-	-	-	-	-	-	-	9	-
Redhead pondweed	-	-	-	-	20	-	-	-	-	-
Sago pondweed	-	-	9	-	20	5	-	17	-	-
Wigeongrass	-	-	9	-	-	5	-	-	9	-
Naiad	-	-	18	-	-	-	-	17	-	-
Common waterweed	-	-	9	-	-	-	-	-	-	-
Emergent Plants, Herbaceous										
Wildrice	-	-	9	-	-	-	-	-	-	-
Bulrush	-	-	9	-	-	-	-	-	-	-
Corncockle	-	-	-	-	-	-	-	-	9	-
Crop Plants (Bait)	-	(100)	-	-	-	-	(18)	-	(27)	-
Corn	-	100	-	-	-	-	18	-	-	-
Wheat	-	-	-	-	-	-	5	-	27	-
Animal Foods	-	-	(18)	(47)	(3)	(74)	(77)	(67)	(18)	(100)
Mollusks										
Undetermined	-	-	-	-	-	-	-	17	-	-
Gastropods										
Undetermined	-	-	-	-	-	37	36	33	-	-
Amnicola spp.	-	-	-	-	-	11	23	-	-	-
Bittium spp.	-	-	-	-	-	-	5	-	-	-
Gillia altilis	-	-	-	-	-	-	14	-	-	-
Oxytrema virginica	-	-	-	35	-	26	36	17	-	-
Planorbis spp.	-	-	18	-	-	-	14	-	9	-
Rissoidea, unidentified	-	-	-	-	-	-	5	-	-	-
Valvata tricarinata	-	-	-	-	-	-	5	-	-	-
Bivalves										
Undetermined	-	-	-	-	-	-	14	-	-	-
Gem shell	-	-	-	-	-	5	-	-	-	-
Sphaerium spp.	-	-	-	-	-	-	5	-	-	-
Unionidae, unidentified	-	-	-	-	-	-	14	17	-	-
Arthropods										
Crustaceans										
Unidentified cladocerans	-	-	-	-	-	-	5	-	-	-
Unidentified amphipods	-	-	-	-	-	5	-	-	-	-
Unidentified decapods	-	-	-	-	-	-	-	17	-	-
Insects										
Mayfly larvae	-	-	-	-	3	-	-	-	-	-
Dragonfly larvae	-	-	-	-	-	-	-	17	-	-
Caddisfly larvae	-	-	-	6	-	-	-	17	-	33

Table 41. Foods of waterfowl in fresh estuarine bays of the upper Chesapeake region, Maryland (Stewart 1962). Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume (Concluded).

	Whistling swan	Canada goose	Redhead	Ring-necked duck	Canvasback	Greater scaup	Lesser scaup	Common goldeneye	Ruddy duck	Hooded merganser
Number of Birds Examined:	4	5	11	17	30	19	22	6	11	3
Midge larvae	-	-	-	-	-	-	-	-	9	-
Chordates										
Fish										
Unidentified	-	-	-	-	-	-	-	17	-	100

Table 42. Foods of waterfowl during early autumn to spring in tidewater river wetlands and floodplain forests in the upper Chesapeake region of Maryland (Stewart 1962). Figures represent the percentage of the total number of birds sampled in which the particular food item composed 5% or more of the contents of the gullet and gizzard, by volume.

	Estuarine River Marshes						Forested Riverbottom Habitats			
	Mallard	Black duck	Pintail	Green-winged teal	Blue-winged teal	Wood duck	Mallard	Black duck	Wood duck	Hooded merganser
Number of Birds Examined:	12	15	4	8	10	20	17	17	57	3
Plants, Vegetative Parts										
Submerged Aquatics	-	(7)	-	-	-	-	(18)	-	(25)	-
Ribbonleaf pondweed	-	-	-	-	-	-	-	-	14	-
Common waterweed	-	7	-	-	-	-	-	-	-	-
Nuttall waterweed	-	-	-	-	-	-	-	-	7	-
Coontail	-	7	-	-	-	-	-	-	-	-
Nitella (alga)	-	-	-	-	-	-	18	-	4	-
Spirogyra (alga)	-	-	-	-	-	-	-	-	2	-
Emergent Plants, Herbs	(25)	(7)	-	-	(10)	(5)	-	(12)	-	-
Unidentified rootstalks	8	-	-	-	-	5	-	-	-	-
Unidentified leaf fragments	-	-	-	-	-	-	-	6	-	-
Common burreed rootstalks	-	-	-	-	-	-	-	6	-	-
Grass leaves	-	7	-	-	10	-	-	-	-	-
Bulrush rootstalks	17	-	-	-	-	-	-	-	-	-
Plants, Small Seeds	(100)	(93)	(100)	(100)	(100)	(100)	(59)	(65)	(47)	-
Submerged Aquatics										
Pondweed, unidentified	-	-	-	-	-	5	-	-	-	-
Grassleaf pondweed	8	-	-	-	-	-	-	-	-	-
Ribbonleaf pondweed	-	-	-	12	-	-	-	-	-	-
Emergent Plants, Herbs										
Common burreed	17	13	-	-	30	10	-	6	7	-
Great burreed	17	13	-	-	20	30	-	-	-	-
Arrowhead	-	-	-	12	-	-	-	-	-	-
Big cordgrass	8	-	-	-	-	-	-	-	-	-
Rice cutgrass	-	-	-	12	-	-	-	6	-	-
Wildrice	-	13	25	-	10	10	-	-	-	-
Panicgrass	-	7	-	-	-	-	-	-	-	-
Walter millet	8	-	25	12	60	-	-	-	-	-
Common spikegrass	-	-	-	-	10	-	-	-	-	-
Bulrush, unidentified	-	7	-	-	-	-	-	-	-	-
Common threesquare	42	7	50	-	20	-	-	-	-	-
Olney threesquare	8	7	-	-	-	-	-	-	-	-
River bulrush	-	-	-	38	-	-	-	-	-	-
Softstem bulrush	42	-	25	50	40	-	-	-	-	-
Stout bulrush	8	-	-	-	-	-	-	-	-	-
Fringed sedge	-	-	-	-	10	-	-	-	-	-
Long sedge	-	-	-	-	-	-	-	-	2	-
Bladder sedge	-	-	-	-	-	-	-	-	2	-
Hop sedge	-	-	-	-	-	5	-	-	-	-
Sallow sedge	8	-	-	-	-	5	-	-	-	-

Table 42. Foods of waterfowl during early autumn to spring in tidewater river wetlands and floodplain forests, upper Chesapeake region (Continued).

	Estuarine River Marshes						Forested Riverbottom Habitats			
	Mallard	Black duck	Pintail	Green-winged teal	Blue-winged teal	Wood duck	Mallard	Black duck	Wood duck	Hooded merganser
Number of Birds Examined:	12	15	4	8	10	20	17	17	57	3
Arrowarum	25	13	25	-	-	60	-	-	-	-
Pickerelweed	-	20	-	-	20	-	-	-	-	-
Waterdock	8	-	-	-	-	-	-	-	-	-
Smartweed, unidentified	-	7	-	-	-	5	-	-	-	-
Common smartweed	-	-	-	-	-	-	-	6	-	-
Dotted smartweed	58	60	100	88	80	-	-	12	-	-
Southern smartweed	-	-	-	-	-	5	-	-	-	-
Arrowleaf tearthumb	-	13	-	25	20	-	-	-	-	-
Halberdleaf tearthumb	33	27	50	38	30	15	-	-	14	-
Waterhemp	-	-	25	12	30	-	-	-	-	-
Dodder, unidentified	-	-	-	-	50	-	-	-	-	-
Emergent Plants, Shrubs and Woody Vines										
Waxmyrtle	17	-	-	-	-	-	-	-	-	-
Blackberry	-	7	-	-	-	-	-	-	-	-
Swamp rose	-	-	-	-	-	10	-	-	-	-
Poison ivy	-	-	-	-	-	-	6	18	2	-
Winterberry	-	7	-	-	-	5	-	-	2	-
Grape	17	-	-	-	-	-	6	12	4	-
Rosemallow	-	7	-	-	-	5	-	-	-	-
Silky dogwood	-	-	-	-	-	10	-	-	-	-
Buttonbush	-	7	-	-	-	-	-	-	-	-
Emergent Plants, Trees										
Bluebeech	-	-	-	-	-	-	47	41	14	-
Sweetbay	-	-	-	-	-	-	6	-	-	-
Sweetgum	-	-	-	-	-	-	12	6	7	-
Black cherry	-	-	-	-	-	-	-	6	-	-
Blackgum	8	-	25	-	-	-	-	12	7	-
Plants, Mast	-	-	-	-	-	-	(100)	(53)	(84)	-
Beech	-	-	-	-	-	-	76	35	46	-
Oak, unidentified	-	-	-	-	-	-	6	24	-	-
Pin oak	-	-	-	-	-	-	-	-	14	-
White oak	-	-	-	-	-	-	24	-	30	-
Willow oak	-	-	-	-	-	-	-	-	2	-
Crop Plants	-	-	-	-	-	(5)	-	-	-	-
Corn	-	-	-	-	-	5	-	-	-	-
Animal Foods	-	(20)	(25)	(12)	-	-	(24)	(53)	(2)	(100)
Mollusks										
Gastropods										
Undetermined species	-	7	-	-	-	-	-	-	-	-
Ambloxis decisum	-	-	-	-	-	-	-	41	-	-
Gyraulus spp.	-	-	-	-	-	-	-	6	-	-
Physa spp.	-	-	-	-	-	-	12	6	-	-
Rissoidae, undetermined	-	7	-	-	-	-	-	-	-	-
Bivalves										
Pisidium atlanticum	-	-	25	-	-	-	-	-	-	-
Sphaerium spp.	-	-	-	-	-	-	-	12	-	-
Arthropods										
Crustaceans										
Corophium spp.	-	-	-	12	-	-	-	-	-	-
Unidentified gammarids	-	7	-	-	-	-	-	-	-	-
Cambarus spp.	-	-	-	-	-	-	-	-	-	33
Spiders										
Unidentified	-	-	-	-	-	-	-	-	2	-
Insects										
Dragonfly nymphs	-	7	-	-	-	-	6	-	-	-

Table 42. Foods of waterfowl during early autumn to spring in tidewater river wetlands and floodplain forests in the upper Chesapeake region (Concluded).

	Estuarine River Marshes						Forested Riverbottom Habitats			
	Mallard	Black duck	Pintail	Green-winged teal	Blue-winged teal	Wood duck	Mallard	Black duck	Wood duck	Hooded merganser
Number of Birds Examined:	12	15	4	8	10	20	17	17	57	3
Chordates										
Fish										
Centrarchidae	-	-	-	-	-	-	-	-	-	67
Ictaluridae	-	-	-	-	-	-	-	-	-	33
Cyprinidae	-	-	-	-	-	-	-	-	-	33
Johnny darter	-	-	-	-	-	-	-	-	-	67
American eel	-	-	-	-	-	-	-	-	-	33

The fresh and slightly brackish marshes commonly freeze over for long periods during most years. Furthermore, the vegetation of the fresh marshes, particularly such types as the wildrice, spatterdock, pickerelweed/arrowarum, sweetflag, and smartweed/rice cutgrass, produce abundant seed, but they provide little or no cover during the cold seasons. Waterfowl, therefore, generally are scarce in fresh marshes during the late autumn, winter, and early spring.

BIRDS OF SHRUB SWAMPS AND SWAMP FORESTS

Dense thickets of lowland shrubs and the multi-layered lowland forests provide excellent cover, a great variety of nest sites, an abundance of animal and plant foods, and a constant supply of water. These habitats provide cover and a diversity of foods, and they are important production sites for wood ducks, mallards, herons, egrets, ibises, and other waders, as well as for many kinds of songbirds (Table 42). Shrub swamps are of high value to woodcocks and of moderate value to bobwhite quail for food and cover. Rusty blackbirds, most of which are migrants in Maryland, usually are associated with alder shrub swamps along marsh edges (Meanley 1975). Swamp forests are of high value to the quail and of moderate value to the woodcock (Office of River Basin Studies 1954).

Approximately 66%, or 136 of 207 species, of the different kinds of birds observed in all habitats during a yearlong survey of a 2,000 acre rural tract in southern New Jersey were seen at least once in shrub swamps or wooded swamps and 99 species were recorded from shrub swamps. Forty percent or more of the habitat records for 65 species were obtained from the two swamp types (Table 43).

Although they were observed more frequently in other types of habitat, the red-winged blackbird (3,400 records from swamps), starling (2,400 records), mourning dove (2,000 records), and American robin (740 records), were the most common permanent residents in the shrub and wooded swamps. Of the species that were seen more frequently in the swamps than in other habitats, the song sparrow (1,670 records), cardinal (1,000 records), and common grackle (600 records), were the most common. All of these species and at least thirty-one other kinds of birds were observed, or are believed, to nest in shrub swamps and/or wooded swamps (Table 43).

The vegetation of the wooded bottomlands along the Patuxent River was described by Hotchkiss and Stewart (1947), and the utilization of this habitat complex by waterfowl was discussed by Stewart (1962). Hooded mergansers, which are predators on such aquatic animals as fish and crayfish, are restricted to the River. They composed about 5% of the population of transient waterfowl. Wood ducks (40% of the population), mallards (30%), black ducks (20%), and pintails, green-winged teal, blue-winged teal, American wigeons, ring-necked ducks, common goldeneyes, buffleheads, and common mergansers (5%, in combination), also utilized the surface of the river.

The numbers of these transient waterfowl vary from one year to another. The abundance of migratory mallards, black ducks, and wood ducks apparently is correlated with the size of the local mast crop, particularly with the crops of beechnuts, pin oak acorns, and white oak acorns in the floodplain forests. During years of low mast production, there may be no more than 20 birds per square mile of forest, whereas during years of high production, there may be 50 to 100 birds per square mile.

The results of analyses of the contents of the gullets and gizzards of 94 specimens of transient waterfowl from the wooded bottomlands along the Patuxent River are summarized in Table 42. These results indicate that mallards, wood ducks, and black ducks feed preferentially on beechnuts and acorns. The seeds of bluebeech, poison ivy, grape, blackgum, sweetgum, halberdleaf tearthumb, and dotted smartweed also are important in the diets of these waterfowl, and probably are utilized more intensively during years of low mast production. The leaves and stems of submerged aquatic plants, particularly ribbonleaf pondweed and Nuttall waterweed, also are eaten, and small mollusks are a supplementary food for black ducks and, to a lesser degree, for mallards.

Table 43. Birds observed most frequently in shrub swamp and swamp forest habitats during a yearlong investigation of a 2,000 acre rural tract in Gloucester County, New Jersey (McCormick mss.). At least 40% of the sightings of species listed were from the two swamp habitats. Only species for which at least five sightings (Total Records) were made on the entire tract are included. Asterisks (*) indicate species which are known or believed to nest in the swamp habitats. A plus mark (+) indicates that at least 40% of the records for the species were from upland forest habitats.

During All Seasons	Shrub Swamp (%)	Wooded Swamp (%)	Total Records (Number)
*Song sparrow	16	36	3,218
*Cardinal	11	48	1,721
*Common grackle	8	36	1,378
*Carolina wren	7	55	645
*Blue jay	6	41+	611
*American goldfinch	12	30	591
*Common flicker	8	42	539
*Swamp sparrow	40	21	497
*Carolina chickadee	12	42+	420
*Downy woodpecker	9	49	408
*Eastern kingbird	14	40	232
*Rufous-sided towhee	4	51+	196
*Common crow	9	31	171
*Tufted titmouse	10	41+	78
*Hairy woodpecker	7	39+	61
Belted kingfisher	26	30	54
*American woodcock	3	39	38
Red-bellied woodpecker	7	45+	29
*Fish crow	0	58+	12
*Great horned owl	0	50	12
Black-crowned night heron	0	57	7
Autumn, winter, and spring			
White-throated sparrow	7	51	2,053
Rusty blackbird	25	54	347
Tree sparrow	18	29	263
Red-tailed hawk	6	54	50
Purple finch	6	57	47
Fox sparrow	21	32+	19
House finch	89	11	9
Red-shouldered hawk	20	60	5
Spring, summer, and autumn			
*Yellow warbler	21	53	618
*Gray catbird	19	49	541
*Yellowthroat	21	38	493

	Shrub Swamp (%)	Wooded Swamp (%)	Total Records (Number)
*Indigo bunting	4	45	173
*Green heron	29	24	124
*House wren	3	57	75
*Willow flycatcher	52	25	67
*Red-eyed vireo	0	48+	64
*Northern oriole	2	41	44
*Yellow-billed cuckoo	2	70	44
American redstart	0	46+	37
*Wood thrush	0	70	27
Cape May warbler	0	48+	23
Blackpoll warbler	0	55+	20
*Great crested flycatcher	0	40+	15
Northern waterthrush	7	57	14
*Black-billed cuckoo	8	46	13
*White-eyed vireo	20	60	10
*Least bittern	44	11	9
Swainson's thrush	11	78	9
Eastern wood pewee	14	29+	7
American bittern	80	20	5
Canada warbler	0	40+	5
Spring and/or autumn			
Yellow-rumped warbler	4	45	168
Ruby-crowned kinglet	8	49+	78
Eastern phoebe	35	15	20
Black and white warbler	0	67	12
Northern parula	0	67	12
Black-throated blue warbler	0	43+	7
Magnolia warbler	0	43+	7
Ovenbird	0	43+	7
Scarlet tanager	0	50+	6
Red-breasted nuthatch	0	40	5
Tennessee warbler	0	60+	5
Summer only			
Summer tanager	8	46	13
*Yellow-breasted chat	67	11	9

MAMMALS OF THE COASTAL WETLANDS

The abundant food resources of the wetlands are attractive to many kinds of mammals. Most of the wetlands are remote from intensive human activities and provide extensive protected areas in which animals can hunt and feed. Permanent ponds and channels which are interspersed through the wetlands also are suitable habitat for several semi-aquatic mammals.

Mammals that are more characteristic of upland habitats frequently venture into the wetlands to feed (McAtee 1939; Shuster 1966). Cottontails, striped skunks, red foxes, gray foxes, raccoons, longtail weasels, and opossums are among these visitors. Owing to disturbances by trappers in the Blackwater marshes of Dorchester County, red foxes generally do not utilize the marsh area during the winter and spring, but they do inhabit dens on islands in the wetlands. Meadow voles are the most important item in the diet of red foxes that hunt on the marshes, and they were found in 49% of the fox scats that were examined by Heit (1944). Muskrat remains were found in 39%; seeds of persimmon and blackberry were found in 11%; and insects were found in 9%.

Whitetail and Sika deer commonly graze in marsh areas near the landward margin of the wetlands. Shrub swamps are considered to be moderately valuable for food and cover throughout the year for raccoons, deer, and cottontails. The edges of saline, brackish, and freshwater marshes are of moderate value to cottontails and of high value to raccoons. Raccoons also venture farther out into the more deeply flooded sections of the freshwater marshes, and these are rated to be of moderate value to the animals. Similarly, the meadow cordgrass-spikegrass and threesquare zones in saline and brackish wetlands are of high value to raccoons, but the more frequently flooded stands of needlerush and smooth cordgrass are of low value (Office of River Basin Studies 1954).

Mink and river otters utilize tidal streams and feed in the marshes, but they seldom are abundant in the marshes. In contrast, two other aquatic mammals, the muskrat and the nutria, are characteristic inhabitants of the marshes. Beavers recently have been reintroduced in the region, but they currently are neither abundant nor widespread in the coastal wetlands.

Smooth cordgrass, meadow cordgrass, spikegrass, and needlerush apparently are not particularly attractive to muskrats as food plants, and the saline wetlands generally do not support large populations of these mammals (Smith 1938; Dozier 1947; Harris 1952; Office of River Basin Studies 1954). In brackish marshes, the average weight of muskrats was least (2.16 to 2.20 pounds) in areas covered by meadow cordgrass, smooth cordgrass, and tall cordgrass, and greatest (2.25 to 2.26 pounds) in stands of Olney threesquare and cattail (Dozier, Markley, and Llewellyn 1948). Stands of Olney threesquare, common threesquare, and cattail form prime habitat for muskrats, and these plants may constitute 80% of the diet of the animals (Smith 1938; Stearns and Goodwin 1941). The rootstocks of threesquare and cattail are eaten by the animals, and the culms of the plants are used in house construction.

During the period from 1971 to 1973, twenty-three muskrats were collected from shallow, brackish tidal marshes at the Deal Island Wildlife Management Area in Somerset County, on the eastern shore of Maryland (Willner, Chapman, and Goldsberry 1975). Specimens were collected during all seasons, and the results of analyses of the contents of their stomachs were summarized for bimonthly periods of the calendar year (i.e. January-February, March-April, and so on). Three to five animals were available for each bimonthly period.

Roots constituted nearly 80% of the plant material that was eaten by the muskrats. Stems of plants were a significant proportion of the diet (30 to 50%) only during the period from July through October, but leaves did not contribute measurably to the diet at any time during the year. More than half of the plant material that was consumed (58.5%) was from the narrowleaf cattail; 17.4% was from the Olney threesquare; and 8.0% was from Walter millet. The threesquare was present in the stomachs of all muskrats that were collected from January through April, and cattail was present in all, or nearly all (80%, July-August), of the stomachs from animals that were obtained from May through December. Unidentified algae composed about 5% of the annual diet, but they appeared in the stomachs only during the period from March through June.

Olney threesquare formed 78% of the annual plant diet of nutria in the coastal marshes of Dorchester County, Maryland (Maryland Wildlife Administration 1975). Panicgrass and common reed each represented about 6% of the annual diet. Creeping spikegrass contributed only 1.6% of the diet of nutria throughout the year, but it formed 53% of the plant food eaten during August. Groundselbush, algae, narrowleaf cattail, corn, spikegrass, and big cordgrass each contributed approximately 1% of the annual diet of the nutria.

Beaver feed principally on woody plants. Red maple, willow, alder, bluebeech, pond pine, loblolly pine, and willow oak are the preferred foods in the swamp forests and shrub swamps in the coastal wetlands (Maryland Department of Natural Resources and the U.S. Department of Agriculture 1972). In the inland wetlands and uplands adjacent to the coastal wetlands, beaver also feed heavily on beech, birch, cherry, hawthorn, oaks, pines, serviceberry, and witchhazel.

Where muskrat and/or nutia populations are dense, the feeding of the animals may produce "eatouts," or areas devoid of vegetation (Lynch, O'Neill, and Lay 1947). In the Blackwater National Wildlife Refuge, extensive eatouts develop in areas in which the number of muskrat houses is equal to, or greater than, 2.5 per acre. During the late 1930's and early 1940's, the average densities of houses on the Refuge ranged from 0.24 to 5.23 per acre (Dozier 1947; Dozier, Markley, and Llewellyn 1948). The denuded areas commonly become ponds, and emergent vegetation may not re-cover them for a decade or more. During the period of re-vegetation, however, these openings provide habitats which support a variety of submerged aquatic plants and other species that are absent from, or infrequent in, other sections of the marsh. The larger ponds, particularly those which support submerged vegetation, are especially attractive to waterfowl (Stewart 1962).

Dense stands of big cordgrass line the banks of many channels in brackish wetlands, but the plant generally is not predominant over large expanses of the marshes. Muskrats and nutria utilize the culms of the big cordgrass to construct their houses and platforms, respectively, and also may feed heavily on the plants (Stearns and others 1940; personal communication, William Sipple 1977).

As sources of food and/or cover throughout the year (Office of River Basin Studies 1954), freshwater tidal marshes are of high value to muskrats. Cattails, sweetflag, arrowarum, and other marsh plants are utilized as food and in house construction. Around concentrations of houses, the muskrats may feed so intensively that they create barren eatouts. The initial excavations by the muskrats often are magnified by oxidation or erosion of the exposed muck soil. The depressions that are formed commonly become shallow ponds in which arrowheads, arrowarums, and spatterdock become established (Meanley 1975).

Small mammal populations of the saline marshes are most dense in the shrubby habitats that are formed by marshelder and groundselbush (McAtee 1939; Paradiso and Handley 1965; Shure 1971). Herbivorous meadow voles, which are the most abundant small mammals in these wetlands, usually occur in increasing numbers from the zone of smooth cordgrass to areas covered by meadow cordgrass, and reach their peak density in stands in which meadow cordgrass forms a low cover beneath the groundselbush (Type 62). During the period from mid-April through early November 1975, however, Bosenberg (1976) found meadow mice to be equally abundant in stands of meadow cordgrass, spikegrass, and marshelder. They were slightly less abundant in stands of short-form smooth cordgrass, and were scarce in stands of tall smooth cordgrass. Meadow jumping mice, white-footed mice, and house mice, which also are herbivores, and carnivorous least shrews generally are restricted to the shrubby thickets along the upland margin of the wetlands. Rice rats, which feed on insects and crabs, are associated with tall stands of smooth cordgrass along tidal channels. These small mammals construct nests among the tops of big cordgrass or needlerush.

Little research has been conducted on small mammal populations of the brackish and freshwater tidal wetlands. Several observations are available, however, on the use by small mammals of muskrat lodges as nest sites and retreats. In brackish wetlands in New Jersey, for example, Rhoads (1903) found nests of rice rats, meadow voles, and least shrews in the parts of muskrat houses that extended above the level of mean high water. In stands of Olney threesquare in brackish wetlands in Maryland, Harris (1952, 1953) noted that rice rats, meadow voles, and house mice, as well as raccoons, utilized occupied and unoccupied muskrat lodges. Star-nose moles, white-footed mice, and Norway rats, and such larger mammals as eastern cottontails, woodchucks, foxes, minks, striped skunks, and house cats have been reported to use muskrat lodges in inland (non-tidal) wetlands in various other states (Kiviat 1978). Except for the spatial associations, there apparently is no special interaction between the various inhabitants of the lodges.

Observations in freshwater wetlands in southern New Jersey revealed intensive utilization by muskrats, but they suggested that small mammal utilization of the marsh vegetation was minimal (McCormick 1976). Norway rats were observed in marsh vegetation, and mink were reported by local trappers. Meadow voles were obtained along the edge of the marsh, but frequent tidal flooding apparently precluded permanent residence by the voles or other species. Rice rats are reported to range into freshwater marshes in Maryland (Paradiso 1969), but their nesting and feeding habits in these areas have not been described. Muskrats, Norway rats, opossums, and cottontails were noted in shrub swamps during the New Jersey survey. The greatest diversity of mammals in the wetland habitats, however, was observed in the wooded swamps. These were inhabited by white-footed mice, shorttail shrews, Norway rats, southern flying squirrels, gray squirrels, cottontails, and whitetail deer (McCormick mss.).

AMPHIBIANS AND REPTILES OF THE COASTAL WETLANDS

Amphibians and reptiles largely are carnivorous. Most of the kinds that are known to occur in the wetlands also are aquatic. Their local distributions, therefore, are related closely to the water and to the availability of prey, and the animals move from one vegetation type to another. The knowledge of the amphibians and reptiles of the Chesapeake Bay region was reviewed by Hardy (1972a, 1972b), but records for only two species of reptiles were cited for occurrences in the intertidal zone.

Leopard frogs, green frogs, pickerel frogs, bullfrogs, and spring peepers are common in freshwater wetlands and in slightly brackish marshes. During a yearlong survey of the vertebrates on a 2,000 acre rural tract in southern New Jersey, 9% of the bullfrogs observed were in a freshwater tidal marsh, 6% were in a diked area of freshwater wetland, and 3% were in shrub swamp habitats. Spring peepers (13% of the adults), green frogs (19%), and leopard frogs (11%) were found in the tidal marsh (McCormick 1976). Salamanders also may be relatively abundant in freshwater areas (Metzgar 1973). Fowler's toads generally remain in upland areas, and they breed in freshwater pools, but they do range into the higher portions of freshwater, brackish, and saline wetlands. During the yearlong survey in New Jersey, 7% of the Fowler's toads that were observed were in shrub swamp habitats. The remainder were found in upland habitats (McCormick 1976).

Several kinds of snakes range into the wetlands from adjacent upland areas or from the waterways. The redbellied water snake is an inhabitant of swamp forests and shrub swamps, and it also ranges into brackish wetlands. Ribbon snakes venture into freshwater and brackish wetlands. Common watersnakes, black ratsnakes, blackracers, eastern kingsnakes, eastern gartersnakes, and rough greensnakes have been observed in saline marshes as well as in freshwater and brackish wetlands (McCauley 1945). Two hognosed snakes were reported from brackish water by Hardy and Olmon (1971), and one of these was swimming more than 0.5 mile from shore in the York River, Virginia. A copperhead was captured on a sandy barrier island beach (Hardy 1972b), but individuals are more apt to be found in upland areas. In the New Jersey survey, black ratsnakes, northern blackracers, eastern gartersnakes, and northern watersnakes were seen in shrub swamps. Gartersnakes and blackracers also were observed in swamp forests.

Only one lizard generally is associated with wetlands. The bluetailed skink inhabitats baldcypress swamp forests.

The painted turtle is a common species in the channels and along the banks of freshwater wetlands. Several other species, including the spotted turtle, mud turtle, redbellied turtle, and snapping turtle occur in both freshwater and brackish wetlands. The diamondback terrapin is the only turtle of saline marshes (Shuster 1966; Harris 1975). It also ranges into brackish wetlands and, less commonly, into freshwater wetlands (McCauley 1945; Schwartz 1967). Snapping turtles, redbellied turtles, eastern mud turtles, diamondback terrapins, and eastern painted turtles were observed in a freshwater tidal marsh during a yearlong survey in southern New Jersey (McCormick 1976). Snapping turtles, box turtles, redbellied turtles, and eastern painted turtles were noted in shrub swamps.

FISH HABITATS

Coastal wetlands and associated estuaries are vital to the maintenance of commercial and sport fisheries and shellfisheries. At least 60% of the species important to these activities in Maryland are dependent on the estuarine environments during at least part of their lives (Metzgar 1973).

Chesapeake Bay is inhabited, or visited seasonally, by fish of about 200 species. Of these, 60 or more are caught commercially. Observations made in Maryland suggest that saline and brackish wetlands are utilized by a greater variety of fish than are freshwater wetlands.

Submerged aquatic plants are important to juvenile and adult fish as sources of food and cover (Anderson 1972; Metzgar 1973). The plants, as well as bacteria, algae, protozoans, and other small invertebrates that attach to the plants, are eaten by fish. As much as 7.5% of the standing crop of rooted aquatics may be consumed each day. Submerged plants also usually are covered by a gelatinous film of diatoms. These minute, highly specialized algae are eaten by the larvae of insects, worms, crustaceans, and mollusks, and these, in turn, are preyed on by carnivorous fish.

No detailed ecological information on the shellfish of Maryland was found. An investigation in Georgia, however, indicated that oyster reef communities utilize approximately 1% of the production that is exported from adjacent wetlands (Bahr 1976).

Fish enter the wetlands during periods of high water. Except that areas which are flooded most frequently are utilized most intensively, no information was found to describe the relative values to fish of different wetland vegetation types.

2.6 WATER POLLUTION ABATEMENT BY WETLANDS

Many studies have been conducted to determine the effectiveness of coastal and inland wetlands in regard to water pollution abatement. Except for a few unpublished studies, these investigations have been designed to monitor the water that enters the wetland and the water that leaves the wetland. The wetland area, thus, is treated as a "black box," and the results do not describe the relative effectiveness of the several vegetation types present, nor do they allow any determination of the relative effectiveness of the soil, the microbiota, and the macroscopic vegetation of the wetland.

On five occasions, from late July through early October, analyses were made of water as it began to flood over stands of spatterdock (Type 31), cattail (Type 34), and wildrice (Type 36), and as it drained from the stands, in a freshwater tidal marsh adjacent to the Delaware River (Grant and Patrick 1970). The results were not consistent between paired stands of a particular type or between the various dates. On the average, however, the concentrations of dissolved oxygen were increased by 43%, and the concentrations of biochemical oxygen demand, nitrate nitrogen, and phosphates were reduced by 5%, 8%, and 18%, respectively, during the residence of the water on the marsh surface. Four sewage treatment plants discharged directly into the experimental marsh, so these data may not be representative of the nutrient removal efficiency of freshwater coastal wetlands in general.

A saline marsh, covered by smooth cordgrass (Type 71), in Massachusetts also was shown to be effective in the retention of nutrients (Valiela and others 1973). After it was treated with sewage sludge, the wetland held 80 to 94% of the nitrogen and 91 to 94% of the phosphorus that was contained in the material. There were strong seasonal fluctuations in degree of retention of the nutrients, and retention was least during the cold season.

In a similar experiment in Delaware, the production of short form smooth cordgrass (Type 72) increased nearly threefold after it was fertilized with inorganic nitrogen (Sullivan and Daiber 1974). The weight of the vegetation on plots that were treated only with an inorganic phosphate fertilizer, however, did not increase measureably. These results indicate that the supply of nitrogen in the natural marsh environment is limiting, but that of phosphorus is not limiting, to the production of the short form smooth cordgrass.

An earlier investigation in Georgia demonstrated that smooth cordgrass "pumps" phosphorus from depths as great as 3.3 feet (100 cm) or more in the marsh soil (Reimold 1972). Supplies in excess of the requirements of the cordgrass are excreted and dissolve in the water when the plants are flooded or wetted by rain. Phosphorus absorbed by the marsh is retained by the sediments and their microbiota (Pomeroy and others 1972). The capacity of the sediments is so great that the concentration of phosphate in the water varies little from day to day, regardless of the variability of phosphate that enters the wetland system.

Effluent from a secondary sewage treatment plant was applied by spray irrigation to a freshwater tidal marsh in the upper Delaware River estuary by Whigham and Simpson (1976a, 1976b). They found that the high marsh areas apparently act as sinks for nitrogen and phosphate during the summer, then release those nutrients back into the marsh complex slowly during the autumn and winter. Based on the results of their initial experiments, the authors concluded that the freshwater tidal marshes can process as much as 2 to 5 inches of wastewater per day, or about 1 to 2.5 million gallons per day per 18.4 acres.

The effect on nitrogen of wetlands on a tributary to the Hackensack River was evaluated by Mattson (1974) and Mattson and others (1975). During a 12-hour daytime tidal cycle in August, approximately 6% of the nitrogen that entered the wetland system was retained. The rates of removal during tidal cycles in January and April were approximately 0.7% and 1.0%, respectively (Mattson and Vallario 1976). The area occupied by the wetland system, below the level of mean high water, was approximately 260 acres and the overbank area was approximately 222.6 acres. If the removal of nitrogen is equal during the day and the night, and if the rate of removal is equal in the channels and on the marsh surface, the wetland removes approximately 2 kg per acre per day in August, 0.2 kg per acre per day in January, and 0.34 kg per acre per day in April. If only the overbank, largely vegetated area is effective, the rates of removal are 2.37 kg, 0.23kg, and 0.40 kg per day per acre, respectively, during August, January, and April. This ten-fold seasonal variation suggests a significant biological component in the nitrogen removal process.

No study of the removal of nutrients by a tidal swamp forest type is known to have been published, but Boyt and her co-workers (1977) investigated the fate of wastewater effluents discharged to a nontidal ash/baldcypress/blackgum swamp forest in Florida. At a point 0.3 mile (490 m) from the discharge point, the concentrations of total phosphorus and total nitrogen were 6.4 mg/1 and 15.3 mg/1, respectively. After the water had traveled an additional 2 miles (3,200 m), the average concentration of total phosphorus was 0.124 mg/1 and that of total nitrogen was 1.61 mg/1, or reductions of 98% and 89%, respectively. Human fecal bacteria in the dischage were removed before the effluent had traveled 1 mile through the swamp forest. On the basis of these findings, the authors observed that swamp forests can be used as an alternative to tertiary treatment of wastewater. Insofar as their study site was concerned, the authors found that the 20 acres utilized for direct treatment, plus 480 acres used as a buffer zone, provided treatment equivalent to facilities that would cost $2 million to build and maintain if capitalized over a 25 year period.

Based on a review of the European literature, Geller (1972) stated that common reed is able to reduce the concentration of phosphate in water by 74%. She also cited investigations from Russia that indicate that spills and slicks of oil deteriorate two to seven times more rapidly in common reed vegetation than in other, unspecified wetland types that were tested.

No specific evaluation of submerged aquatic plants was found in the literature. Metzgar (1973), however, observed that these plants contribute dissolved oxygen to the water as a by-product of photosynthesis, and also reduce turbidity and expedite sedimentation of suspended solids through the stabilization of the bottom and interference with currents.

Several unpublished studies have been conducted on model wetlands that were established artificially in small test cells. The cells were designed to meter the flow of water and dissolved nutrients as they entered and exited. During the experiments, and at the end of the test periods, which generally correspond to the growing season in the locality, samples of the large plants, the sediments, and the microbiota were collected and analyzed.

The results of these cell experiments are in general agreement. They indicate that the larger plants absorb a relatively small proportion of the applied nutrients, and that the nutrient contents of the plants reach a dynamic balance rather early in the growing season. Subsequently, the plants excrete an amount of nutrients about equal to the amount they absorb. During autumn, when the aerial parts of the plants die, the soluble organic matter and nutrients they contain are leached rapidly—within a few days—into the water, and are absorbed almost immediately by microorganisms.

Large proportions of the nutrients are absorbed throughout the growing season by microorganisms in the sediments, on the surface of the sediments, and on the surfaces of the large plants. Severe frosts, however, may kill many of the microorganisms. The soluble organic materials and nutrients, thus, are freed, and are dissolved in the water column until they are reabsorbed by other, living organisms or adsorbed by the sediments.

The most stable sink for nutrients is the marsh soil. If the amount of nutrients absorbed by the soil microbiota is discounted, however, the mineral and organic sediments retained only about 10% of the total amount of nutrients applied in the various experiments. This component is not affected measureably by temperatures within the normal seasonal range, and does not produce large pulses of dissolved substances at the onset of freezing temperatures as do the larger plants and microorganisms.

Our present knowledge of the pollution abatement capactiy of wetlands is limited in detail, but it is adequate to indicate that all, or most, wetlands act as seasonally variable sinks for nutrients. Data that are available suggest that microorganisms largely are responsible for the purification functions of wetlands; that sediments play an important, but secondary role; and that the net absorption by higher plants is of some significance during the early part of the growing season, but that most of the nutrients are returned to the water in dissolved form when the plants die. Wetlands in which the substrate is composed of 50% or more organic matter appear to be capable of long-term storage of nitrogen and phosphates (Whigham and Bayley 1978).

No definitive information is available to rate the relative effectiveness of different wetland vegetation types in regard to nutrient removal. Similarly, the information that is available is not adequate to determine the relative effectiveness of general wetland groups (saline, brackish, freshwater) or wetland forms (marsh, shrub swamp, swamp forest) in regard to nutrient removal.

2.7 SEDIMENTATION

Tidal wetlands can be formed by any one, or a combination, of several processes. The processes which are of greatest importance along the modern coast of the Middle Atlantic Region are submergence and accretion.

Submergence is a process whereby the surface of the land is lowered, relative to the concurrent mean sea level. This lowering may be produced by crustal movement, whereby the land actually sinks; it may be the result of a rise in sea level; or it may reflect the interaction of both of these subprocesses.

Accretion, in the context of tidal wetlands, implies the appearance of land above the plane of mean low water. This may occur as a result of crustal movement, when the land rises and sections of the bottom of the sea, a bay, or an estuary protrude into the intertidal zone. Accretion to the land also may result from a drop in the level of the sea, by the deposition and accumulation of sediments, or by some combination of these subprocesses acting concurrently or in sequence.

During the past several millennia, submergence has been the predominant force in the formation of tidal wetlands throughout all or most of the world. Sea level fell as much as 100 meters along the Middle Atlantic Coast during late Pleistocene time, and has been rising more or less continuously during the past 10,000 years.

Whereas only a small proportion of the existing coastal wetlands has been formed primarily by accretion, this process appears to be essential to the persistence of the existing wetlands along the Middle Atlantic Coast. Because the level of the sea appears still to be rising, the surface of a wetland must accumulate sediments at the rate of about 0.022 inch (81 cubic feet per acre) per year, if it is to remain in a constant position relative to the tides (Wass and Wright 1969; Metzgar 1973).

Sediments enter a coastal wetland from two general sources. They are carried from the adjacent body of water by tidal currents, and they are carried by runoff from adjacent upland areas (Geller 1972). Because tides normally cover the wetlands only shallowly, and because the flow of water over the surfaces of the wetlands is impeded and intricately diverted by the leaves and stems of abundant plants, the wetlands act as settling basins which trap and retain silt and other suspended solids.

The gradual accumulation of sediments increases the elevation of the wetland relative to the adjacent upland areas. Generally, the rate of sedimentation is so slow that the accretion is not noticeable. Occasionally, however, a severe storm may be accompanied by waves high enough to wash across a barrier island, and to carry tons of sand into the wetlands along the seaside bays. Intense rainfall, which accelerates erosion and runoff, also may result in rapid sedimentation of adjacent wetlands.

The continuous, nearly imperceptible accumulation of sediments by a wetland, as well as the periodic entrapment of great volumes of sediment, is a function that benefits other aquatic resources. Oyster bars, for example, are protected from siltation, and the volume of material that must be dredged to maintain berths, harbors, and shipping channels is reduced (Metzgar 1973). If the sediments form intertidal plateaus and the marsh grows seaward or toward the center of a tidewater stream or bay, the protection afforded the adjacent upland against wave damage and flooding is enhanced.

Investigators in Great Britain found that sediments tend to accumulate along the seaward edges of tidal wetlands during periods of highest salinity. In the Middle Atlantic Region of the United States, salinities at high slack water are greatest during the summer (Aurand and Daiber 1973). At such times, suspended solids are flocculated by the high salinities. Biological activity, which also may be intensive during the summer, results in the coagulation of particles and their more rapid settlement.

Rainfall generally begins to increase during the autumn, and salinities decline. Wind-driven waves during thunderstorms and hurricanes mobilize the sediments, and wash them higher onto the wetland. Because the vegetation commonly is at a peak of development at this time, the sediments fall out of the water column rapidly, and are trapped by the plants.

The particles that are carried into the wetland are rich in nutrients. The British studies, however, indicated that the concentrations of nutrients in the soil decreased from the seaward edge to the landward edge of a salt marsh that was not subject to significant upland runoff. This gradient indicates that the surficial sediments in the wetlands are continuously reworked, and gradually are carried farther and farther from the seaward edge. The sediments at any particular location on the wetland, thus, are derived by the resuspension and redeposition of sediments from the next most seaward location.

The aboveground parts of submerged aquatic plants slow the movement of water and, thus, promote the deposition of suspended solids (Anderson 1972; Good and others 1978). This trapping of sediment generally results in an increase of the elevation of the bottom in areas covered by submerged vegetation as compared to nearby areas without vegetation (Burrell and Schubel 1977). No definitive measurement of the rate of sediment accumulation by submerged vegetation is available from the Middle Atlantic region.

No measurements of the modern rate of accumulation of sediment in wetlands of the Middle Atlantic Coast have been found. Similarly, no study in which the rate of accumulation of sediments in any particular type of vegetation has been measured is known.

2.8 EROSION CONTROL CAPACITY

Coastal wetlands occupy sites which range in elevation from slightly below mean sea level to a few inches or feet above mean high water. The profile of a wetland becomes more nearly plane as its width, perpendicular to the shoreline, increases. Furthermore, shoal waters commonly lie immediately seaward from the wetlands (Metzgar 1973). This system has a high erosion control capacity.

The shoal waters, which are relatively shallow, reduce the energy of waves before the waves reach the wetland. The low profile of an extensive wetland affords no abrupt physical barrier to waves, but dissipates the remaining energy of the waves as the water spreads across the wetland surface. The vegetation of the wetland also absorbs the energy of waves and, thereby, reduces the velocity of the flow of water.

As a result of these functions, areas landward of coastal wetlands are protected from severe damage during storms, and seldom are affected by damaging floods. Owing to this protection, the wetlands have been termed, "nature's counterpart to bulkheads, groins, and revetments for erosion abatement in areas not subject to direct ocean exposure" (Garbisch and others 1975b).

Submerged aquatic plants also minimize coastal erosion owing to the stabilization of the bottom by their perennial root systems (Gosner 1968; Anderson 1972; Good and others 1978). The bottom in areas from which eelgrass beds have been eliminated is subject to rapid erosion (Wilson 1949;Cottam and Munro 1954), and nearby beach areas also may be affected by intensified erosion (Orth 1975).

The value of the protective functions of coastal wetlands is recognized widely. No studies in which the relative effectiveness of different wetland types has been determined are known. Similarly, no investigation was found in which the various energy dissipation mechanisms have been evaluated.

3. ENVIRONMENTAL EVALUATION OF COASTAL WETLANDS

Through the riparian trust doctrine, as well as by purchases and gifts, the Federal government, the state governments, and countless local governments are the trustees or owners of hundreds of thousands of acres of estuarine and coastal waters and wetlands. Furthermore, by legislation and by the exercise of more general police powers, these various levels of government also have promulgated a range of regulatory controls over adjacent wetlands in which there is partial or complete private interest. There is an urgent need, therefore, to develop a rational, objective scheme for the evaluation of coastal wetlands based on their environmental worth. This evaluation can be utilized by public and private owners for specific planning and management purposes, and by governmental agencies as a basic resource for broad regional planning and as a fundamental consideration in regulatory decisions.

3.1. APPROACHES TO WETLAND EVALUATION

Tidal marshes and other coastal wetlands can be evaluated by several techniques. The most traditional technique is that of the open market, in which an owner offers a tract of wetland for sale and, ultimately, negotiates with a buyer to establish a monetary value for his interest in the land. This open market technique is complex and highly subjective. The monetary value, if the purchaser is interested in some potential non-wetland use of the tract, will reflect some combination of several considerations. These may include location, the size and shape of the tract, existing zoning and/or other legal constraints, estimated penalty costs (filling, piling, dredging, legal and technical fees, and so on), and associated speculative issues. The environmental values of the wetland on the tract generally are ignored.

When a marsh or other wetland that is held privately is condemned by a public body, the private owner must be paid a fair and reasonable value for his interests in the property. This value may be determined by an analysis of the prices paid on the open real estate market for similar tracts in the region (Porro 1977). After adjustment for differences between the locations, legal constraints, and other factors of the tracts that were sold on the open market and those of the condemned property, the fair and reasonable value of the condemned property is determined by negotiation or by litigation. This estimated monetary value, of course, is a derivative of the open market value, and is similarly complex.

Another method that commonly is used to estimate property value is known as the capitalization approach (Porro 1977). This usually is employed for tracts that contain structural improvements. The fair rental price for the property is determined, and from this, the costs associated with carrying the property are calculated and deducted. The resulting figure for the annual profit then is capitalized to derive the value of the property.

This capitalization approach can be used to calculate the value of a coastal wetland from which saleable products are harvested. For example, the net annual profit from the sale of marsh hay, oysters, muskrat pelts, beef cattle, forest products, and/or other commodities from a wetland can be capitalized to determine a per-acre monetary value. In Georgia, intensive oyster culture would produce about $350 per acre per year, and intensive raft culture would produce nearly $900 per year. The equivalent income-capitalization values would be $7,000 and $18,000 (Gosselink, Odum, and Pope 1973).

The evaluations described above are techniques to estimate the worth of a wetland, in monetary units, to a private owner. The capitalization method also has been used to estimate the monetary worth of a tidal marsh to society (Gosselink, Odum and Pope 1973). The proration of the total value of the coastal fishery and of recreation, for example, suggests that each acre of marsh is worth about $100 per year, or $2,000 on an income-capitalization basis. Nutrient removal by the marshes was appraised by determining the cost to construct physical-chemical treatment facilities that would be capable of removing the same proportions of nutrients. This cost then was capitalized to obtain an estimate of the monetary value of the marsh to society ($280,000 per acre). Whether or not the capacity of the wetland to remove nutrients actually is being used by society at the present time is not necessarily a factor, because the potential is present.

In another approach, the same authors argued that, because many potential uses are conflicting, it is difficult to integrate the calculated values for different components of use to obtain a total value. They suggested, therefore, that the "total work of nature" be translated into monetary terms. This would avoid the need to specify how "the work flow might be divided into different uses and functions." To accomplish this, the authors noted that 10 quadrillion Kilocalories of energy (10^{16}) are consumed annually to produce a Gross National Product of $10 trillion dollars ($10^{12}$), so that 10 thousand Kilocalories of energy (10^4) is approximately equal to $1. They utilized an estimate of 10,250 Kilocalories per square meter for the annual gross primary production of the tidal marsh, and obtained a value of $4,147 per year. The income-capitalized value, thus, would be $82,940 per acre.

In any event, this capitalization technique results in relatively high estimates of the per-acre value of tidal marshes. But, when capitalization is applied to the value of off-site benefits, it is an expression of value to society as a whole, and not necessarily of value to a private owner, except as he is a member of society.

Another application of the capitalization approach is presented by the estimation of replacement cost in monetary terms (McCormick 1974). On the basis of the best available data, an ecologist familiar with the type of biotic community that is under consideration estimates the amount of plant material and animal material necessary to establish a new stand identical in every way to the stand in question. In the absence of evidence to the contrary, the ecologist assumes that the biotic community must develop through several different stages until the appropriate state is reached. This will require a certain minimum number of years. The initial cost of purchasing materials and preparing the site is calculated, and any costs of maintenance in subsequent years are estimated and discounted back to the initial year. The cost of the land at the new site is added, and the total then is capitalized over the time required to produce the new, identical stand. The capitalized cost can be considered to be equal to the dollar value of the marsh.

A relative replacement cost also can be expressed as the estimated time required to develop a new stand identical to the one in question (McCormick 1974) or as the known or estimated age of the stand under consideration (Graber and Graber 1976). Such an evaluation may be particularly useful in planning and assessment. Community types that can be replaced in 1 to 5 years would be considered to be of less environmental value, in general, than would types with replacement times that are counted in tens or hundreds of years.

The term "replacement cost," was used by Fischer (1970) to describe "the added cost of replacing the sacrificed benefits over what it would have cost in the marsh." In other words, he defined replacement costs as the cost that would be experienced to provide, in alternative ways, all of the benefits to society that derive from a coastal wetland. The construction of tertiary treatment facilities to remove nutrients, for example, would be a cost to replace one wetland function.

Direct measurements of plant vigor and community structure were utilized as scalars by Oviatt and others (1977) in an attempt to rank ten stands of smooth cordgrass in Rhode Island. They employed estimates of the standing crop, height, density, seed production (by weight per stalk), and seed length of cordgrass; the density of fish eggs and larvae, and the density and relative volume of adult fish in spring and autumn; the standing crops of grass shrimp and insects; the density of fiddler crabs; and the number of species of birds and the number of individual birds observed during two hours in each stand.

Oviatt and her co-workers concluded that large variations in most of the parameters that they considered prohibited them from separating the ten stands with statistical significance. In their opinion, the effort necessary to collect information sufficient to permit a statistically significant ranking of stands would not be practical for regular use in wetland evaluation programs.

3.2. PHILOSOPHY OF AN EVALUATION SCHEME FOR MARYLAND

In the introduction to their report, Oviatt and her co-workers (1977) commented that, in Rhode Island, "development interests have not chosen to attack the *general* validity of the ecological rationale for marsh preservation. Instead, . . .the ecological value of *particular* marshes has been questioned by those seeking to convert them into marinas, parking lots, housing plots, etc. As the economic incentives for development have grown, so have the political pressures on management and regulatory agencies to make exceptions, to accept trade-offs, or to establish priorities for marsh preservation. The argument seems simple and appealing: if marshes are valuable, it follows that some marshes are more valuable than others."

The stated purpose, or the assumption of the investigators, in the Rhode Island study was to develop a scheme that will produce a value to be used as a criterion to decide which tidal marshes are to be preserved, and which are to be surrendered for non-wetland development. This approach is unwarranted, at least in other states, and does not appear to reflect an appreciation for the dynamism of our wetland resources or a grasp of their unique role in the total estuarine/near-shore marine system.

The basic assumption of an evaluation scheme for Maryland is that all coastal wetlands are of exceptional value, and that none should be surrendered for alternative, non-wetland uses. Exceptions would be made only when the alternative uses offer overriding benefits to the public or relieve great private hardships, and when those uses cannot be located elsewhere without significant reduction in the benefits or reliefs. In these exceptional cases, the scheme for environmental evaluation that is presented here will aid decision-makers to identify the location that will result in the least sacrifice of existing natural resources.

It is also assumed, on the basis of local, continental, and worldwide evidence, that wetlands are dynamic resources. Some changes are continuous and slow and are perceptible only after years or centuries. Other changes are rapid, even catastrophic, and may be apparent within a few months or even within a few days or hours. Although the value scheme can be applied at any time during this spectrum of change, the values calculated for various wetland types and wetland areas will change eventually. A given set of values, therefore, is similar to a snapshot. It is a static record, at a single point in time, of a continuously changing resource.

The rating derived from a scheme for the environmental evaluation of the coastal wetlands, per se, is not a decision-making tool. If all coastal wetlands are of exceptional value and, in toto, are a unique resource, there is no reason to consider that the least valuable wetlands in the current snapshot should be "written off for development." They still are of exceptional value, and in point of fact, the vegetation that will develop on them at some point in time in the future may be ranked as the most valuable.

3.3. GENERAL PREMISES OF THE MARYLAND SCHEME

Any scheme for the evaluation of the tidal wetlands must be objective, and must be accepted widely as a rational technique to compute a meaningful ranking for all of the units under consideration. It should be based on scientifically substantiated principles; should employ quantified parameters; and should be understandable to laymen.

For regional applications, such a scheme should employ parameters that can be measured at a relatively low cost in time and money per unit area. Because the scheme presented here is pyramidal, or nested, there also must be a continuity of parameters from one level, or scale, of evaluation to another. In other words, similar parameters must be used at each level of application.

Particularly for site-specific management or regulatory considerations, the scheme should employ parameters that are not unreasonably expensive to measure in terms of man-power requirements, level of skill, and cost of equipment. If a scheme employs parameters that require long-term field measurements or measurements that must be made during a particular time of the year, the scheme should include alternative methods to utilize standardized values for appropriate parameters. Specifically, it should be possible to use site-specific data extracted from the regionwide inventory that is described in the present report. If such inventory data are utilized, those data should be verified by a field inspection of the site. In any regional inventory, there may be slight to major inaccuracies from site to site, and, when one deals with a resource that is in constant flux, the condition of a specific site may change between the date of one inspection and the date of the next.

3.4. RESTRICTIONS AND ASSUMPTIONS IN THE MARYLAND SCHEME

Numerous techniques for the evaluation of coastal wetlands were developed and tested during the formulation of the scheme that is presented in this report. The experience gained from these tests resulted in the adoption of the following restrictions and assumptions for the "Maryland scheme."

A. A finite number of subaerial types of vegetation must be recognized and used as standard categories for the analyses of wetland areas of any size.

B. Estimations of the relative value of the different types of subaerial vegetation must be based on characteristics that are common to all of the types and for which measurements are available from, or for which substantiated estimates can be made for, all of the types. The parameters selected, furthermore, generally should reflect the inherent features of the vegetation (productivity, palatability, height, and so on) and not features of the environment (salinity, temperature, and so on).

C. Wetlands of one regime of salinity (fresh, brackish, or saline) ordinarily should not be compared with those of another regime of salinity or with average Statewide values for all coastal wetlands. On a unit area basis, saline wetland types rank well below brackish or fresh wetlands when they are appraised by the current Maryland scheme. When data become available to incorporate parameters to evaluate wetlands as habitats for such other organisms as fish and aquatic invertebrates, including shellfish, the relative values of wetlands in different regimes of salinity may be more nearly equalized. Currently, however, this is not the case. Comparative studies, as alternative site evaluations, could be biased consistently as a result of these inequalities.

D. The Maryland scheme, in its present form, produces numerical relative rankings of the value of the vegetation, the value to wildlife, and the average overall biological value of a particular wetland system. These ranks have no spatial dimension. The actual size of the wetland, in acres, hectares, square miles, square kilometers, or relative square measures, is not considered in the scheme.

E. The Maryland scheme is intended for use in coastal zone planning and management and as an aid in the regulation of coastal wetlands. For these purposes, it was decided that a scheme based on the relative values of natural resources is more useful than a scheme that ranks wetlands on the basis of assumed monetary values. Monetary values are not considered in the scheme, and rankings that are based on monetary considerations could differ markedly from the rankings produced by this scheme.

The Maryland scheme for the evaluation of coastal wetlands, in its current form, is based on the recognition that 31 distinct types of vegetation form the marshes and swamps of the tidewater sections of the State. Relative rankings of these vegetation types are developed in Chapter 4. Parameters for the evaluation of specific areas of wetlands are described in Chapter 5. The application of the scheme is explained and demonstrated in Chapter 6, and guidance is provided for the interpretation of the results.

The computations of the relative rankings of the subaerial types of wetland vegetation require several kinds of information. This information is of greatest relevance when it is obtained by investigations of stands of the types in the area in which the scheme will be applied. Data from stands of the appropriate types that are located in a more extensive region, however, are valid for use in the computations. Adequate information was not available from studies conducted in Maryland, for example, so data from investigations that were conducted in the region from North Carolina to Long Island Sound were utilized in the relative evaluations of vegetation types (Subsections 2.2 and 2.4).

The application of the Maryland scheme requires a detailed inventory of the types of vegetation in the area selected for evaluation. The interpretation of the results of such an evaluation presupposes the existence of a detailed inventory of the types of vegetation throughout the region to which the scheme is to be applied. In the State of Maryland, for example, the vegetation types of the coastal wetlands have been mapped at a scale of 1:2400 (1 inch equals 200 feet), with an accuracy of 0.25 acre, and the acreage of each type of wetland vegetation has been measured and totaled by watersheds (Table 14), by counties (Table 17), and for the State as a whole (Table 2).

4. EVALUATION OF VEGETATION TYPES

To facilitate the description, mapping, and evaluation of the coastal wetlands of the State of Maryland, the plant cover of the wetlands is considered to be composed of 32 types of vegetation (Chapter 1). By definition, these types differ from one another in the species of plants of which they are composed or in the proportion of the total plant mass that is formed by particular species of plants. There are numerous secondary differences between the vegetation types. These include differences in the mass of plant material formed annually per unit area, the nutritional value of that material, the rate of decomposition of dead vegetation, and so on.

Because the vegetation types differ from one another in many ways, it is assumed that the types also vary in their relative values to the total estuarine system. In an attempt to find an objective basis for the determination of these relative values, all available information on the coastal wetlands of Maryland was reviewed (Chapter 2). This review resulted in the identification of two groups of data that contain information that is more or less uniform for all or most of the 32 types of vegetation. One of these groups comprises the estimates of peak standing crops of plant material and the other is formed by the results of studies of wildlife food plants. The other bodies of information that were reviewed, including chemical composition of the plants, energy content, detritus palatability, water pollution abatement capacity, sediment-trapping capacity, erosion control capacity, and secondary productivity, was not addressed to specific vegetation types, was applicable to only one or a few of the types, or was not suitable for quantification.

For the Maryland environmental evaluation scheme, two parameters are developed in the following subsections to evaluate vegetation types. The "Vegetation Type Value" is based largely on the peak standing crops of plant materials and is a relative measure of an intrinsic feature of the vegetation. The "Wildlife Food Value" is derived from analyses of the plants ingested by various species of animals and is a relative measure of an extrinsic feature of vegetation. The two parameters vary independently, and each is dimensionless. That is, the units in which they are expressed are relative numbers that do not relate directly to area, volume, mass, time, or velocity.

4.1. VEGETATION TYPE VALUE

The vegetation type value is based on two assumptions. One of these is that the relative importance of a vegetation type to the estuarine system is related directly to the mass of plant material that is produced per unit area each year. The other assumption is that the proportion of vegetation types that composed the coastal wetlands of Maryland at the time of mapping is ideal. The importance attributed to any vegetation type, therefore, should increase as the time, or money, required to re-establish that type on an appropriate, barren site increases.

To develop the vegetation type value, measures of productivity and measures of replacement cost are combined by weighting the estimated annual production by a factor that represents the replacement cost. This operation is explained in the following subsections of the text. They result in a series of "raw values" that range from 205 to 2,311. To reduce this spread, each raw value is transformed into a percentage of the highest raw value. The maximum spread of the transformed values, therefore, is from some fraction to 100. The actual spread of the transformed values is from 9 to 100.

NET PRIMARY PRODUCTION VARIABLE

Gross primary production is the total amount of energy that is transformed by plants, or the total mass of matter produced by plants, per unit of time. Part of the energy or matter is utilized by the plants in their own metabolism. The remainder is known as the net primary production, and it is this net production that is the base of the consumer food web. All animals, either directly, as herbivores or decomposers, or indirectly, as predators, obtain their energy and nutrients from plant tissue. Bacteria, fungi, and other non-autotrophic microorganisms similarly are dependent upon primary production for energy and nutrients.

The bulk of plant tissue produced annually in the coastal wetlands is formed by vascular plants. Some of this material is consumed in place by herbivores or decay organisms; some falls to the ground and is decomposed at or near the place of production; and some is carried from the wetland into the adjoining estuary and ocean by upland runoff, storm surges, and/or tidal currents. The best available data on the net annual production of the vegetation types of the coastal wetlands of Maryland are estimates of the peak standing crop (Table 45, leftmost column).

The averages listed in Table 45 do not include woody tissues. An adjustment must be made, therefore, in the means from shrub swamp types (Types 11, 12, and 13), swamp forest types (Types 21, 22, and 23), and marsh types that include shrubs (Types 42 and 62). No quantitative measurements of the annual net production of woody tissue in these types are available. Johnson and Risser (1974), however, found that tree leaves and herbaceous undergrowth produced about 40% of the annual net production in an upland oak forest. To be conservative, it is estimated that herbaceous materials contribute 67% of the net production in wetlands. The average peak standing crop of each of the swamp forest types, therefore, should be multiplied by 1.5, and the averages for shrub swamps should be multiplied by 1.33. These adjustment factors also are listed in Table 45.

REPLACEMENT COST FACTOR

With appropriate preparation, and under proper management, it theoretically is possible to produce conditions suitable for the growth of any vegetation type. The conditions required for some types, however, are much less specialized than those necessary for other types. Similarly, the time needed to produce a mature stand of one vegetation type may be a few months, whereas it may require a century or more to produce a mature stand of another type. Replacement value, therefore, is a relative measure of the maturity of an existing stand of vegetation, and it reflects the cost—in dollars or in time—to produce a new stand, of similar age and composition, on another site (McCormick 1974; Graber and Graber 1976).

If the replacement cost is calculated in dollars, it should include: the probable cost to acquire and prepare an alternate site that now is barren or is occupied by a vegetation type considered not to be sensitive or to have a lower replacement value; the cost to acquire and plant suitable transplants or seeds of proven regional genotype; and the cost to tend, protect, and manage the vegetation until it reaches an age and condition identical to the now existing mature vegetation. For certain kinds of projects in certain types of vegetation, a "restoration value" might be more appropriate for consideration than is the replacement value. Rights-of-way for aerial transmission facilities across coastal marshes, for example, may involve construction disturbances, but virtually no long-term loss if the contour of the ground is not altered.

For the purposes of the statewide evaluation of coastal wetland resources, the replacement cost can be expressed as the approximate time required to produce a mature stand of a particular type of vegetation on an appropriate barren site. Although little information currently is available on this subject, considerable effort is being devoted throughout the coastal zone of the nation to determine the most rapid and effective methods to establish new wetlands. These studies have become especially critical since the enactment of Section 150 of the 1976 Water Resources Development Act (PL 94-587), which enables the Corps of Engineers "to plan and establish wetland areas as a part of an authorized water resources development project. . ." Most of the current investigations are directed principally toward the establishment of vegetation on deposits of dredged material, and have led to the development of preliminary techniques for the selection and design of wetland habitats (Anon 1977a, 1977b, 1977c).

In East Bay, on the south shore of Long Island, Terry, Udell and Zandusky (1974) planted seeds, seedlings, and plugs of smooth cordgrass on a 200-foot wide right-of-way in which a sewer pipeline had been installed one or two years earlier. The best results were obtained with transplanted seedlings, but only 50% of the seedlings survived the first year. Sections of the right-of-way in which the substrate was highly organic and physically soft apparently were toxic to the seedlings and plugs of the cordgrass, and the mortality was 100% on these sites.

Woodhouse and others (1974) and Broome and others (1974) experimented with the establishment of smooth cordgrass on dredged material on intertidal sites in North Carolina. Seeding and transplanting both were successful, but the survival and growth of transplants were better than those of newly developed seedlings in areas that are exposed to storm waves and blowing sand. By the second growing season, the primary production of the new stands was equal to that of a long-established marsh.

Garbisch and others (1975a, 1975b) planted potted seedlings of smooth cordgrass, meadow cordgrass, big cordgrass, and spikegrass on dredged material and sandy shores in brackish areas in Chesapeake Bay. Growth generally was rapid during the first growing season at elevations near and above mean high water. On one site that was investigated during the second growing season, nearly 70% of the standing crop had been harvested by Canada geese during the winter. By September, however, the plants developed new crowns and formed a dense, natural-appearing growth. The authors also found that benthic invertebrate populations, comparable in density and diversity to those in natural wetland areas, develop in artificially-established marshes within one year.

A variety of native freshwater wetland plants voluntarily colonized dredged material in a containment area in the James River, Virginia, during the first growing season after completion of the disposal operations (Anon 1975). The operation was designed so that most of the surface of the dredged material would be within the intertidal range. This section was covered largely by pickerelweed and duckpotato.

The present record for marsh reestablishment includes numerous failures, as well as many successes. Long-term studies to document the stability of man-made wetlands are lacking, and most investigators have not considered the populations of algae, diatoms, meiofauna, larger invertebrates, and vertebrates in these areas. Furthermore, only a few types of vegetation have been subject to study, and most of these, but not all, are types characteristic of saline or highly brackish sites. The estimates in Table 44 of the number of years necessary to establish mature, viable, fully populated wetland vegetation of different types, therefore, are professional judgments that are based on the knowledge presently available.

In Table 44, the types of vegetation that are recognized in the coastal wetlands of Maryland are listed. For each type, the approximate time, in years, considered to be necessary to develop a mature, fully populated stand is given in the center column. The number for each type in the column on the right is the replacement cost factor which is used in subsequent calculations.

The replacement cost factors, which are comparative expressions of the time needed to establish particular types of vegetation, are assigned arbitrary values, as follows:

Time Needed to Establish (Years)	Relative Replacement Cost Factor
1 to 10	1
11 to 20	2
21 or more	3

in Chapter 1 was utilized to formulate a list of the predominant genera of plants in each vegetation type. The analyses that are summarized in Section 2.4 of Chapter 2 then were used to express the value of each predominant genus to the several groups of wildlife. Because the wildlife in the several groups are not equally dependent on coastal wetlands, the plant values were weighted differentially. Plants that are eaten by waterfowl and by marsh and shorebirds were weighted most heavily, and those eaten by songbirds were weighted least. The weighted values for each genus were summed and then were utilized to calculate scores for the vegetation types. These raw scores ranged from 2 to 817. To reduce this spread, the raw scores were transformed by percentages of the highest raw score. The lowest transformed value, by definition, is 1 and the highest is 100.

Table 45. Vegetation type values for the coastal wetlands of Maryland.

	Standing Crop g/m²	Adjustment	Replacement Cost Factor	Raw Value	Vegetation Type Value
SHRUB SWAMPS					
11 Swamp rose	669	1.33	1	890	39
12 Smooth alder/Black willow	NA	1.33	2	[1190]	[52]
13 Red maple/Ash	560	1.33	2	1490	64
SWAMP FORESTS					
21 Baldcypress	334	1.5	3	1503	65
22 Red maple/Ash	485	1.5	3	2183	94
23 Loblolly pine	506	1.5	3	2277	99
FRESH MARSHES					
30 Smartweed/Rice cutgrass	1425	1.0	1	1425	62
31 Spatterdock	627	1.0	1	627	27
32 Pickerelweed/Arrowarum	687	1.0	1	687	30
33 Sweetflag	857	1.0	1	857	37
34 Cattail	1136	1.0	1	1136	49
35 Rosemallow	1714	1.0	1	1714	74
36 Wildrice	1218	1.0	1	1218	53
37 Bulrush	NA	1.0	1	[606]	[26]
38 Big cordgrass	2311	1.0	1	2311	100
39 Common reed	1850	1.0	1	1850	80
BRACKISH HIGH MARSHES					
41 Meadow cordgrass/Spikegrass	897	1.0	1	897	39
42 Marshelder/Groundselbush	895	1.33	1	1190	51
43 Needlerush	1290	1.0	1	1290	56
44 Cattail	1361	1.0	1	1361	59
45 Rosemallow	1354	1.0	1	1354	59
46 Switchgrass	2270	1.0	1	2270	98
47 Threesquare	606	1.0	1	606	26
48 Big cordgrass	1085	1.0	1	1085	47
49 Common reed	2155	1.0	1	2155	93
BRACKISH LOW MARSHES					
51 Smooth cordgrass	942	1.0	1	942	41
SALINE HIGH MARSHES					
61 Meadow cordgrass/Spikegrass	467	1.0	1	467	20
62 Marshelder/Groundselbush	154	1.33	1	205	9
63 Needlerush	1160	1.0	1	1160	50
SALINE LOW MARSHES					
71 Smooth cordgrass, tall growth form	1157	1.0	1	1157	50
72 Smooth cordgrass, short growth form	456	1.0	1	456	20
SUBMERGED VEGETATION					
101 Submerged vegetation	409	1.0	1	409	18

CALCULATION OF VEGETATION TYPE VALUES

A relative value, based on intrinsic features of the vegetation, is assigned to each type of vegetated wetland by multiplying the average peak standing crop, with any necessary adjustment for types with woody components, by the replacement cost factor, and dividing that product (the "raw value") by the highest raw value for any type.

(1) APSC × ADJ × RCF = RV
(2) Vegetation Type Value = (RV ÷ HRV) × 100

Where:

ADJ is the adjustment for Woody Production (Page 115)
RCF is the Replacement Cost Factor (Table 44)
RV is the Raw Value
HRV is the Highest Raw Value

The numbers that are applicable to each type of vegetation in the coastal wetlands of Maryand are collected in Table 45, and the raw value and vegetation type value of each type is calculated. The highest raw value is that of Type 38, the freshwater big cordgrass type (2311 points). Each of the raw values was divided by 2311 to transform it to a percentile scale. These range from 9 for the saline marshelder/groundselbush type (Type 62) to 100 for the freshwater big cordgrass type (Type 38).

RECOMMENDATIONS FOR IMPROVEMENT

Estimates of peak standing crops are utilized for the net primary production variable because such estimates are available for nearly all of the vegetation types in the coastal wetlands of Maryland. Measurements of peak standing crops, however, underestimate the net amount of annual primary production. If the degree of underestimation were constant from one type to another, it would have no effect on relative rankings. The underestimation is not constant, however, so that the use of peak standing crops affords a differential weighting to stands composed predominantly of a single species in which the bulk of the plants mature concurrently. The calculation of vegetation type values will be improved by the use of estimates of net annual primary production. Currently, these estimates are available from few vegetation types and from only a small percentage of the stands that have been sampled (Table 22).

Only limited observational information is available in regard to the time required to replace the various types of coastal wetland vegetation. The replacement cost factors, therefore, were based on professional judgments. The utility of this factor will be increased by substituting the times that are determined in the future by investigations conducted in Maryland and in other Middle Atlantic States. Definitive information from such investigations also can be used to narrow the increments of time to intervals of five years, and to expand the range of factors from three to five.

4.2. WILDLIFE FOOD VALUE

The seeds, fruits, leaves, roots, and other organs of plants are eaten by many kinds of animals. The purpose of the wildlife food value is to provide a relative evaluation of the different types of wetland vegetation in regard to their overall usefulness to wildlife as sources of food.

To develop the scores for this parameter, information

Table 44. Replacement cost factors for the vegetation types recognized in the coastal wetlands of Maryland.

	Years to Develop	Replacement Cost Factor
SHRUB SWAMPS		
11 Swamp rose	10	1
12 Smooth alder/Black willow	15	2
13 Red maple/Ash	15	2
SWAMP FORESTS		
21 Baldcypress	50	3
22 Red maple/Ash	50	3
23 Loblolly pine	50	3
FRESH MARSHES		
30 Smartweed/Rice cutgrass	5	1
31 Spatterdock	10	1
32 Pickerelweed/Arrowarum	10	1
33 Sweetflag	10	1
34 Cattail	5	1
35 Rosemallow	5	1
36 Wildrice	5	1
37 Bulrush	5	1
38 Big cordgrass	5	1
39 Common reed	5	1
BRACKISH HIGH MARSHES		
41 Meadow cordgrass/Spikegrass	5	1
42 Marshelder/Groundselbush	5	1
43 Needlerush	5	1
44 Cattail	5	1
45 Rosemallow	5	1
46 Switchgrass	5	1
47 Threesquare	5	1
48 Big cordgrass	5	1
49 Common reed	5	1
BRACKISH LOW MARSHES		
51 Smooth cordgrass	5	1
SALINE HIGH MARSHES		
61 Meadow cordgrass/Spikegrass	5	1
62 Marshelder/Groundselbush	5	1
63 Needlerush	5	1
SALINE LOW MARSHES		
71 Smooth cordgrass, tall growth form	5	1
72 Smooth cordgrass, short growth form	5	1
SUBMERGED VEGETATION		
101 Submerged vegetation	5	1

Table 46. Total weighted food values of the predominant plants in the vegetation types of the coastal wetlands of the Middle Atlantic States. Predominant plants are from Tables 3, 4, 5, 7, and 9. Total values of scores for the plants are from Tables 26, 27, and 28.

	Waterfowl				Marsh and Shore Birds				Songbirds				Upland Game Birds				Mammals				Total
	Total Value of Scores				Total Value of Scores				Total Value of Scores				Total Value of Scores				Total Value of Scores				
	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Weighted Value
Trees																					
Ashes	—	—	2	6	—	—	0	0	—	—	14	14	—	—	5	5	—	—	8	16	41
Baldcypress	—	—	4	12	—	—	0	0	—	—	0	0	—	—	0	0	—	—	0	0	12
Blackgum	—	—	3	9	—	—	0	0	—	—	50	50	—	—	6	6	—	—	12	24	89
Maples	—	—	0	0	—	—	0	0	—	—	25	25	—	—	4	4	—	—	31	62	91
Pines	—	—	0	0	—	—	0	0	—	—	78	78	—	—	9	9	—	—	17	34	121
Sweetbay	—	—	0	0	—	—	0	0	—	—	6	6	—	—	0	0	—	—	4	8	14
Sweetgum	—	—	2	6	—	—	0	0	—	—	20	20	—	—	2	2	—	—	10	20	48
Shrubs																					
Alders	—	—	0	0	—	—	0	0	—	—	3	3	—	—	4	4	—	—	3	6	13
Azaleas	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	10[a]
Groundselbush	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	10[a]
Marshelder	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	10[a]
Mistletoes	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	10[a]
Poison ivy	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	10[a]
Roses	—	—	0	0	—	—	0	0	—	—	2	2	—	—	0	0	—	—	8	16	18
Spicebush	—	—	0	0	—	—	0	0	—	—	21	21	—	—	4	4	—	—	0	0	25
Sweet pepperbush	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	—	—	ND	ND	10[a]
Viburnums[b]	—	—	0	0	—	—	0	0	—	—	19	19	—	—	6	6	—	—	14	28	53
Willows	—	—	0	0	—	—	0	0	—	—	0	0	—	—	3	3	—	—	14	28	31
Shrublike Herbs																					
Spiked loosestrife	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Rosemallow	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Waterwillow	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Forbs																					
Arrowarum	4	0	4	12	2	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	18
Arrowheads[c]	0	31	31	93	3	0	3	9	0	0	0	0	0	0	0	0	0	4	4	8	110
Asters	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Bindweeds	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Burmarigolds[d]	3	0	3	9	0	0	0	0	2	0	2	2	2	0	2	2	0	0	0	0	13
Burreeds	25	0	25	75	6	0	6	18	0	0	0	0	0	0	0	0	0	5	5	10	103
Glassworts	6	2	8	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Goldenclub	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]

Table 46. Total weighted food values of the predominant plants in the vegetation types of the coastal wetlands of the Middle Atlantic States (Concluded).

	Waterfowl				Marsh and Shore Birds				Songbirds				Upland Game Birds				Mammals				
	Total Value of Scores				Total Value of Scores				Total Value of Scores				Total Value of Scores				Total Value of Scores				Total
	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Fruits	Other	Grand Total	Weighted Value	Weighted Value
Goldenrod	0	0	0	0	0	0	0	0	11	0	11	11	0	2	2	2	4	2	6	12	25
Loosestrife	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Muskratweed	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Orach	0	0	0	0	0	0	0	0	10	0	10	10	0	0	0	0	0	0	0	0	10
Pickerelweed	4	0	4	12	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	4	16
Ragweeds	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Sealavenders	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Smartweeds[e]	45	0	45	135	24	0	24	72	28	0	28	28	5	0	5	5	0	0	0	0	240
Spatterdock	3	0	3	9	2	0	2	6	0	0	0	0	0	0	0	0	0	4	4	8	23
Touch-me-nots	0	0	0	0	0	0	0	0	4	0	4	4	6	0	6	6	2	0	2	4	14
Waterhemp	2	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Grasses and Grasslike Plants																					
Bulrushes	66	5	71	213	27	0	27	81	4	0	4	4	0	0	0	0	2	5	7	14	312
Canarygrass	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0	0	0	2
Cattails	0	0	0	0	2	0	2	6	0	0	0	0	0	0	0	0	0	6	6	12	18
Cordgrasses	8	13	21	63	9	0	9	27	11	0	11	11	0	0	0	0	0	0	0	0	101
Rice cutgrass	0	22	22	66	3	0	3	9	6	0	6	6	0	0	0	0	0	4	4	8	89
Panicgrasses[g]	13	0	13	39	9	0	9	27	89	0	89	89	11	0	11	11	0	4	4	8	174
Common reed	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Rushes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	6	6
Spikegrass	0	9	9	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Sweetflag	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10[a]
Wildrice	58	0	58	174	7	0	7	21	22	0	22	22	0	0	0	0	0	0	0	0	217

[a] ND means No Data are available. These plants were assigned a value of 10.
[b] Includes species known as arrowwoods.
[c] Includes duckpotato
[d] Includes species known as beggarticks and Spanishneedles
[e] Includes species known as pinkweed, tearthumb, and waterpepper
[f] Includes species known as threesquares and woolgrass
[g] Includes switchgrass

PREDOMINANT GENERA OF PLANTS

The lists of the floristic components of the vegetation types that are recognized in the coastal wetlands of Maryland (Tables 3, 4, 5, 7, and 9) were utilized to identify the predominant genera of each type. Any genus of plant that is a diagnostic component of a type (i.e., is listed in the name of the type), or any genus that has been reported in three or more investigations to be an associate component of a type, is considered to be a predominant genus. Each of these genera is indicated by an X in Tables 3, 4, 5, 7, and 9. A few predominant genera are shown in the tables to have been reported by at least three investigators, but no single species of a particular genus has been reported frequently enough to be marked by an X. For the baldcypress swamp forest (Table 4, Type 21), any genus that was reported in both of the two available floristic surveys is considered to be a predominant genus.

WILDLIFE VALUES OF PREDOMINANT GENERA

The genera of plants that are predominant in one or more types of vegetation are listed in Table 46. Information on the wildlife food values of many of these taxa is tabulated in Section 2.4. For these taxa, the summary lines, which are labeled "total value of scores" in the tables for fruits or seeds of herbaceous plants (Table 26), for vegetative parts of herbaceous plants (Table 27), and for any parts of woody plants that are eaten by wildlife (Table 28), are entered in Table 46. There are at least five such values for each genus of plant, one each for waterfowl, marsh and shorebirds, songbirds, upland game birds, and mammals. In Table 46, the values are grouped under these five wildlife categories.

WEIGHTING OF WILDLIFE VALUES

The "total values of scores" for the five groups of wildlife in Table 46 were weighted differentially to reflect the fact that wetlands generally are of greatest value to waterfowl and to marsh and shore birds (values multiplied by three), are of major value to relatively few kinds of mammals (values multiplied by two), and are one of several habitats that are utilized by upland game birds and most kinds of songbirds (values multiplied by one). Although the ratio of 3:2:1 is arbitrary, there currently is no objective basis for the assignment of other weighting factors.

CALCULATION OF SCORES FOR VEGETATION TYPES

The weighted values for the five groups of wildlife are summed to produce the total weighted food value for each kind of plant in Table 46. Four tables then were constructed to indicate the predominant genera of plants in shrub swamps and swamp forests (Table 47), in fresh marshes (Table 48), in brackish marshes (Table 49), and in saline marshes (Table 50). The total weighted value of each genus is entered in these tables in the appropriate cells and, for each type of vegetation, the values of the predominant genera are summed to produce a total wildlife food score for the type.

The total wildlife food score of the smartweed/rice cutgrass fresh marsh (Type 30) is the highest of the 39 total scores that were calculated. To compute the wildlife food values of these types, the total score for each type is divided by the score for Type 30 and the dividend is multiplied by 100 to express it as a percentage. All values are rounded to the nearest 1%, and any value that is less than 1% is raised to 1% to avoid fractions.

The wildlife food values of the 31 types of subaerial vegetation that are recognized in the coastal wetlands of Maryland are summarized in Table 51. In this table, the values are rounded to the nearest 5%, and any value that is less than 5% is set equal to 5%. These adjustments were made to avoid any suggestion that the methodology is sensitive enough to distinguish differences that are less than 5%.

Table 47. Computation of wildlife food values of the vegetation types of the shrub swamps and swamp forests of the coastal wetlands of Maryland. The predominant plants were selected from Tables 3 and 4. The total weighted food values entered in this table are from Table 46.

	Vegetation Types					
	11	12	13	21	22	23
Trees						
Green ash			41	41	41	
Baldcypress				12		
Blackgum				89		
Red maple			91	91	91	
Loblolly pine				121		121
Sweetbay				14		
Sweetgum				48		
Shrubs and Vines						
Smooth alder		13				
Southern arrowwood				53		
Clammy azalea				10		
American mistletoe				10		
Poison ivy				10		
Swamp rose	18					
Spicebush				25		
Sweet pepperbush				10		
Black willow		31				
Shrubform Herbs						
Waterwillow				10		
Forbs						
Muskratweed				10		
Spatterdock				23		
Spotted touch-me-not				14		
Total	18	44	132	591	132	121
Wildlife Food Value	2	5	16	72	16	15

Table 48. Computation of wildlife food values of the vegetation types of the fresh marshes of the coastal wetlands of Maryland. The predominant plants were selected from Table 5. The total weighted food values entered in this table are from Table 46.

	Vegetation Types																
	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3L	3R	3S	3G
Shrubform Herbs																	
Spiked loosestrife														10			
Rosemallow	10				10	10				10							
Forbs																	
Arrowarum	18	18	18	18	18		18			18							
Arrowheads[1]			110		110		110					110				110	
Bindweeds										10							
Burmarigolds[2]	13											13					
Burreeds	103																
Goldenclub																	10
Pickerelweed			16				16										
Giant ragweed															10		
Smartweeds	240		240	240	240				240	240	240	240				240	
Spatterdock		23															
Touch-me-nots	14		14		14					14							
Waterhemp				6			6				6	6					
Grasses and Grasslike Plants																	
Bulrushes	312		312					312									
Reed canarygrass													2				
Cattails	18				18												
Cordgrasses									101								
Rice cutgrass	89																
Common reed										10							
Sweetflag				10													
Wildrice		217					217										
Total	817	258	710	274	410	10	367	312	341	302	246	369	2	10	10	350	10
Wildlife Food Value	100	32	87	34	50	1	45	38	42	37	30	45	1	1	1	43	1

[1]Includes duckpotato
[2]Includes beggarticks and tearthumbs

Table 49. Computation of wildlife food values of the vegetation types of the brackish marshes of the coastal wetlands of Maryland. The predominant plants were selected from Table 7. The total weighted food values entered in this table are from Table 46.

	Vegetation Types									
	41	42	43	44	45	46	47	48	49	51
Shrubs										
Groundselbush		10								
Marshelder	10	10								
Shrubform Herbs										
Rosemallow		10		10	10		10			
Forbs (Broadleaf Herbs)										
Waterhemp										6
Narrowleaf loosestrife	10						10			
Seaside goldenrod	25	25								
Grasses and Grasslike Plants										
Bulrushes	312	312		312			312			312
Cattails				18						
Cordgrasses	101	101	101				101	101		101
Common reed									10	
Rushes			6							
Spikegrass	27	27					27			
Switchgrass		174				174				
Total	485	669	107	340	10	174	460	101	10	419
Wildlife Food Value	59	82	13	42	1	21	56	12	1	51

Table 50. Computation of wildlife food values of the vegetation types of the saline marshes of the coastal wetlands of Maryland. The predominant plants were selected from Table 9. The total weighted food values entered in this table are from Table 46.

	Vegetation Types						
	61	62	63	71	72	7A	7M
Shrubs							
Groundselbush		10					
Marshelder	10	10					
Forbs							
Asters	10						
Glassworts	24			24	24		
Orach						10	
Sealavender	10			10	10		
Grasses and Grasslike Plants							
Cordgrasses	101			101	101		101
Needlerush			6				
Spikegrass	27						
Total	182	20	6	135	135	10	101
Wildlife Food Value	22	2	1	17	17	1	12

RECOMMENDATIONS FOR IMPROVEMENT

More accurate wildlife food values could be obtained for certain vegetation types by obtaining more comprehensive qualitative data on the predominant plant genera in those types. Data are needed particularly for the shrub swamp and swamp forest types. At present, the wildlife food values in Table 47 are biased towards Type 21 (baldcypress) due to the more comprehensive floristic surveys available for this type. Another example is the computation of the score for Type 62 (marshelder/groundselbush) (Table 50). Meadow cordgrass may be present as an understory in a stand of this type. However, because this genus has not been reported frequently enough in floristic surveys, the total weighted food value of 101 for cordgrasses (Table 46) is not included in the wildlife food value for Type 62.

The wildlife food variable will be more useful when quantitative data are available for its computation. Comprehensive investigations of the utilization of plants by wildlife in Maryland can produce more complete and relevant information than was available for this first approximation. Quantitative studies of all of the vegetation types will permit the wildlife food values to be weighted to reflect the role of the various plants in the vegetation or, more appropriately, in terms of the standing crop of the material that is eaten by wildlife. In the current scheme, owing to the absence of such quantitative studies, all floristically predominant plants are treated as equal in terms of the amount of food that is available.

Food values should be expanded to encompass the animal foods available in the various types of vegetation. Several investigations indicate that such species as the ribbed mussel, marsh fiddler crab, and periwinkle are most abundant in the smooth cordgrass marsh; that salt marsh snails are most abundant in the meadow cordgrass zone; and that many invertebrates abound in beds of eelgrass and other submerged plants. No comprehensive study has been made, however, to evaluate the animal foods that are available in all of the vegetation types of the coastal wetlands. No uniform base of data is available, therefore, to permit the formulation of a scheme for rating animal food values of the 31 types that are recognized in Maryland.

Table 51. Wildlife food values for the thirty-one types of subaerial vegetation in the coastal wetlands of Maryland. The values are rounded to the nearest 5% from the values listed in Tables 47 through 50.

TYPE		VALUE
SHRUB SWAMP		
11	Swamp rose	5
12	Smooth alder/Black willow	5
13	Red maple/Ash	15
SWAMP FORESTS		
21	Baldcypress	70
22	Red maple/Ash	15
23	Loblolly pine	15
FRESH MARSHES		
30	Smartweed/Rice cutgrass	100
31	Spatterdock	30
32	Pickerelweed/Arrowarum	90
33	Sweetflag	35
34	Cattail	50
35	Rosemallow	5
36	Wildrice	45
37	Bulrush	40
38	Big cordgrass	40
39	Common reed	35
BRACKISH HIGH MARSHES		
41	Meadow cordgrass/Spikegrass	60
42	Marshelder/Groundselbush	80
43	Needlerush	15
44	Cattail	40
45	Rosemallow	5
46	Switchgrass	20
47	Threesquare	55
48	Big cordgrass	10
49	Common reed	5
BRACKISH LOW MARSHES		
51	Smooth cordgrass	50
SALINE HIGH MARSHES		
61	Meadow cordgrass/Spikegrass	20
62	Marshelder/Groundselbush	5
63	Needlerush	5
SALINE LOW MARSHES		
71	Smooth cordgrass, tall growth form	15
72	Smooth cordgrass, short growth form	15

5. EVALUATION OF WETLAND SITES

Values are assigned to vegetation types, without regard to specific geographic positions, in the preceding chapter. The purpose of the present chapter is to describe parameters which are utilized in a scheme to evaluate specific wetland complexes and specific tracts of wetland.

Geographical scalars are characteristic of a wetland complex that can be identified and quantified from aerial photographs or maps equivalent in detail to the topograpic quadrangles of the United States Geological Survey. They represent information that is useful to provide an areal context to the resource evaluations.

Biological variables are included in resource groups that are intended to appraise the values of the vegetation and the terrestrial wildlife of coastal wetland complexes and tracts. Owing to the lack of appropriate information, the evaluation scheme does not incorporate scalars for the invertebrates of wetlands.

5.1. VEGETATION RESOURCE GROUP

The maps of the vegetation types of the coastal wetlands of Maryland, on which this report is based, were prepared from aerial photographs that were taken during 1971. The photographs and maps are changeless, but the wetlands are dynamic. Owing to the various natural processes and to direct and indirect actions of man, the types of vegetation that occupy a particular area of wetland may change over a period of years. The configuration of the wetland area and the proportional distribution of land and water also may change, particularly as a result of severe storms.

When a specific wetland site is to be appraised, the maps on which the area is depicted should be compared with the existing condition of the site. Any error in the original interpretations and any changes in the types of wetland vegetation, in the distribution of types, or in the areal extent of the types should be noted. The existing condition is to be used in the following analyses.

In some cases, a new map of the wetland vegetation of a site may be prepared to provide a greater detail of information. To insure that the new mapping is compatible with this environmental evaluation scheme, the tidal wetland types that are listed in Table 1 should be utilized. If a greater range of distinctions is required, new categories should be treated as subtypes of the 35 types listed in Table 1.

Eight wetland vegetation types that have been recognized in other middle Atlantic states, but not in Maryland, are listed in Table 21 (Types 3A, 3B, 3C, 3L, 3R, 3S, 7A, and 7M). Should one or more of these types occupy a significant acreage of a site for which a new or revised map is prepared, the data in Table 21 can be utilized to compute the vegetation type values.

WETLAND PRODUCTION VARIABLE

The wetland production variable is the weighted average of the wetland type values of the vegetation types that cover a specific wetland site. The percentage of the site that is occupied by each type is used as the weighting factor.

To provide specific scalars for the interpretation of the scores for the wetland production variable, the Statewide measurements of acreages of vegetation types (Table 14, rightmost column) were used with the vegetation type values (Table 45) to calculate weighted mean vegetation group values for the different hierarchical categories of coastal wetlands. The results of these calculations are summarized in Table 52.

The weighted mean values range from 16, for the Saline High Marshes, to 87 for Swamp Forests. The weighted mean for all of the Brackish Marshes, which compose the bulk (72%) of the subaerial vegetated wetlands, is 46 and the weighted mean for all subaerial herbaceous wetlands is 45.

Table 52. Weighted means of vegetation type values for categories of vegetation types of the coastal wetlands of Maryland.

Category	Weighted Means
All Wetland Vegetation Types (Types 11-72, 101)	43
All Subaerial Vegetated Types (Types 11-72)	48
Wooded Wetlands (Types 11-23)	84
Shrub swamp types (Types 11-13)	61
Swamp forest types (Types 21-23)	87
Herbaceous Subaerial Wetlands (Types 30-72)	45
Fresh marshes (Types 30-39)	49
Brackish marshes (Types 41-49, 51)	46
Brackish high marshes (Types 41-49)	47
Brackish low marshes (Type 51)	41
Saline marshes (Types 61-63, 71, 72)	19
Saline high marshes (Types 61-63)	16
Saline low marshes (Types 71, 72)	20
Submerged Aquatic Vegetation (Type 101)	18

These statewide averages for wetland vegetation groupings suggest that the values for freshwater marshes and brackish marshes generally are comparable. An average score would be about 46 to 49 points. Scores significantly less or greater than this range would indicate wetlands that are less or more productive than the average.

Procedure: The area of each vegetation type in the subject wetland is measured, and then expressed as a fraction (percentage) of the total area of the wetland. The vegetation type value of each type is multiplied by the corresponding fractional area, and the products are summed to produce the score for this variable. This method of calculation is demonstrated in Table 53.

Supplementary Procedure: If measurements of the peak standing crops of the various vegetation types in

Table 53. Example of the calculation of the value of the wetland production variable. Data are for the fresh marsh category of the coastal wetlands of Maryland and were obtained from Table 14. Vegetation type values are from Table 45.

	Vegetation Type	Acres	Percent of Total (a)	Vegetation Type Value (b)	Product (a × b)
30	Smartweed/Rice cutgrass	2,924	11.44	62	7.1
31	Spatterdock	1,774	6.94	27	1.9
32	Pickerelweed/Arrowarum	3,925	15.35	30	4.6
33	Sweetflag	431	1.69	37	0.6
34	Cattail	9,018	35.28	49	17.3
35	Rosemallow	1,256	4.91	74	3.6
36	Wildrice	776	3.04	53	1.6
37	Bulrush	2,808	10.98	[26]	2.9
38	Big cordgrass	1,904	7.45	100	7.4
39	Common reed	747	2.92	80	2.3
	TOTAL	25,563	100.00		49.3

the subject wetland are available, they can be substituted for the average statewide values utilized in Table 45. If this alternative is employed, the standard calculation also should be made to permit comparisons.

VEGETATION RICHNESS FACTOR

Thirty-one subaerial types of vegetation are recognized in the coastal wetlands of Maryland (Table 1, Types 11 through 72). The vegetation richness factor is an arbitrary measure of the number of vegetation types that are present in the wetland area that is being evaluated.[1]

Various investigations that are reviewed in Section 2.5 of this report demonstrate that the vegetation richness of a wetland is correlated positively with the diversity of animals that inhabit a wetland. Different types of vegetation make different species of plants available as food and cover to animals, and different types may vary greatly in structure and vertical development. The floristic information that is presented in Sections 1.2 and 2.2 is evidence that vegetation richness also is an index of the variety of plant foods that may be exported to the estuarine waters with which the subject wetland is associated. A greater variety of foods presumably will provide sustenance for a wider range of estuarine organisms.

Vegetation richness also is related to the biological stability of a wetland. Any particular type of vegetation, especially if it is composed principally of one species, is susceptible to severe defoliation by insects or other herbivores (McCormick 1970; McCormick and Ashbaugh 1972); or to damage or death by disease. A wetland that is covered by only one type of vegetation, therefore, potentially is subject to great instability. Wetlands with a larger variety of vegetation types, especially if the areas occupied by those types are more or less equal, is less susceptible to wholesale instability because it is not likely that all types will be defoliated or become diseased simultaneously.

Procedure: The weights assigned to different ranges of the number of vegetation types present in a particular wetland are listed below. The appropriate weight is used as a multiplier to adjust the score of the wetland production variable, and to produce the number that is known as the "Vegetation Resource Group Score" (Table 61).

10 or more	6-9	4-5	2-3	1
1.50	1.38	1.25	1.13	1.00

5.2. WILDLIFE RESOURCE GROUP

Detailed investigations of wildlife populations are available only for a few types of wetlands. The data from these studies are not an adequate basis for the development of quantitative scalars to compare the wildlife values of all types of coastal wetlands. It is necessary, therefore, to rely on professional judgments for relative evaluations. These are articulated by various qualitative appraisals of the habitat features of the wetland (Golet 1972).

VEGETATION/WATER INTERSPERSION VARIABLE

Wildlife biologists generally consider that wetlands which are of greatest value to wildlife are composed of equal proportions of vegetated areas and areas of open water and that the vegetation and water are thoroughly interspersed (Golet 1972, 1973a, 1973b; Larson 1973). The values of the vegetation/water interspersion variable are arbitrary and are based on the percentage of the

[1]Vegetation richness, thus, is a measure of the diversity of vegetation types in a particular wetland area. In contrast, floristic diversity (page 144) is a measure of the number of species that are present in a single type of vegetation. There is no uniform relationship between vegetation richness and combined floristic diversity. For example, the floristic diversity of one type [e.g., the fresh smartweed/rice cutgrass marsh (Type 30)] may be greater than the combined floristic diversity of two or more other types, such as the saline meadow cordgrass/spikegrass marsh (Type 61), the saline needlegrass marsh (Type 63), and the saline tall growth smooth cordgrass marsh (Type 71). Within a particular salinity regime, however, vegetation richness generally, but not invariably, will be paralleled by total floristic diversity.

wetland that is occupied by open water and on the degree to which the water and the vegetation are interspersed.

The range of values of the vegetation/water interspersion variable is displayed in a 5 × 3 matrix in Table 54. The five horizontal divisions of the matrix are constructed to recognize spans of approximately 20% in the proportion of a wetland that is occupied by open water. The values in each horizontal array are related in the ratio 1:2:3:2:1. This reflects that the greatest values to wildlife are associated with wetlands that are composed of nearly equal areas of vegetation and water, and that the value to wildlife diminishes as the proportion of water increases or decreases.

The vertical divisions of the matrix are assigned to three degrees of interspersion (Table 54). The open water area in a wetland is considered to be of least value to wildlife when it is collected into a single body that is edged by more or less concentric or parallel bands of vegetation (Golet 1972). The open water area is of greatest value when it is represented by anastomosing channels and/or ponds that are distributed evenly throughout the vegetated area. To reflect the relative values to wildlife associated with the degrees of vegetation/water interspersion, the values in each vertical array are related in the ratio 3:2:1.

The interaction of the horizontal and vertical ratios in the matrix results in a series of fifteen values that differ by ratios as great as 1:9. The highest value (135) is assigned to a wetland in which open water represents 40% to 59% of the total area and is dispersed throughout the vegetated area. The lowest values (15) are assigned to wetlands in which open water represents 0% to 19% or 80% to 100% of the total area and is contained in a single body that surrounds an island of wetland vegetation or is fringed by wetland vegetation.

Table 54. Values of the vegetation/water interspersion variable.

Dispersion of Water	Open Water as Percentage of Total Area				
	0-19	20-39	40-59	60-79	80-100
Throughout	45	90	135	90	45
Intermediate	30	60	90	60	30
Single Body	15	30	45	30	15

Procedure: By visual estimate, or by measurements with a planimeter or other device, the examiner calculates the percentage of the area of the wetland complex that is occupied by ponds, small channels, and ditches that contain water at all normal stages of tide. The examiner then estimates the degree to which the open water is dispersed through the vegetated parts of the wetland. The appropriate value for the vegetation/water interspersion factor is obtained from Table 54.

VEGETATION FORM VARIABLE

Animals relate primarily to the general form and structure of the vegetation, and secondarily to floristic types within a particular form. For example, many of the species of birds and mammals that inhabit forested wetlands are absent from, or scarce in, nearby grassy marshes. There also may be differences between the forests and the marshes.

The vegetation form variable ignores the individual floristic vegetation types and serves as an evaluation of the relative diversity of gross vegetation forms in a wetland complex (Golet 1972, 1973a, 1973b). Five vegetation form categories are recognized in the coastal wetlands of Maryland, and each category includes from two to eighteen floristic vegetation types. The allocation of vegetation types to the form categories is shown in Table 55.

The percentages of the total areas of fresh, brackish, and saline coastal wetlands of Maryland and of the total area of coastal wetlands that are covered by each of the five vegetation forms are displayed in Table 56. The maximum percentages, which range from 3% to 92% for the various forms, were the basis for the establishment of the four ranges of percentages that are utilized in the matrix of relative values (Table 57).

The span from 3% to 92% is too wide to define a useful range for the assignment of relative values. Three of the five maxima, however, are 20% or less. The lowest range, therefore, was set equal to 1 to 25%.

The next highest maximum, that for the swamp forest form, is equal to 36%. The second range was established to include that value, and it was set equal to 26 to 50%.

The highest maximum is 92%, for grasslike marshes in the brackish wetland series. The third range of percentages was equated to the span from 51 to 95% to incorporate this maximum. The fourth range, from 96 to 100%, will accommodate forms that cover all, or nearly all, of the wetland that is subject to analysis.

Relative values of 20, 15, 10, and 5 were assigned to the four percentile ranges that were established. The highest relative value is associated with the range from 1 to 25% to reflect the fact that a wetland that contains several vegetation forms generally is of greatest value to wildlife. When several forms are present, most will occupy 25% or less of the wetland area. The lowest relative value is associated with the range from 96 to 100%. In this range, the vegetation form is so homogeneous that the wetland generally will be of value only to the types of wildlife that are associated with the predominant form.

The standard progression of relative values is interrupted in the columns for the swamp forest form and the grasslike marsh form. A value of 20 is entered in these columns for the ranges of percentages that include the maximum percentages of these two forms (36 and 92%, respectively, from Table 56). The intermediate range (26 to 50%) in the column for grasslike marshes (GM), which includes the percentage for freshwater coastal wetlands (36% , from Table 56), also was assigned a relative value of 20.

Table 55. Correlation of the types of coastal wetlands designated by DNR with vegetation form categories that are used in the evaluation scheme.

			Total Acres	% Grand Total
SS		Shrub Swamp Vegetation Form	14,939	7.10
	11	Swamp Rose		
	12	Smooth alder/Black willow		
	13	Red maple/Ash		
	42	Marshelder/Groundselbush (brackish)		
	62	Marshelder/Groundselbush (saline)		
SF		Swamp Forest Vegetation Form	16,798	7.99
	21	Baldcypress		
	22	Red maple/Ash		
	23	Loblolly pine		
SM		Shrubform Herb Marsh Vegetation Form	1,537	0.73
	35	Rosemallow (fresh)		
	45	Rosemallow (brackish)		
FM		Forb Marsh Vegetation Form	8,623	4.10
	30	Smartweed/Rice cutgrass (fresh)		
	31	Spatterdock (fresh)		
	32	Pickerelweed/Arrowarum (fresh)		
GM		Grasslike Marsh Vegetation Form	168,461	80.08
	33	Sweetflag (fresh)		
	34	Cattail (fresh)		
	36	Wildrice (fresh)		
	37	Bulrush (fresh)		
	38	Big cordgrass (fresh)		
	39	Common reed (fresh)		
		Subtotal Fresh Marshes	*(15,684)*	*(7.45)*
	41	Meadow cordgrass/Spikegrass (brackish)		
	43	Needlerush (brackish)		
	44	Cattail (brackish)		
	46	Switchgrass (brackish)		
	47	Threesquare (brackish)		
	48	Big cordgrass (brackish)		
	49	Common reed (brackish)		
	51	Smooth cordgrass (brackish)		
		Subtotal Brackish Marshes	*(140,808)*	*(66.94)*
	61	Meadow cordgrass/Spikegrass (saline)		
	63	Needlerush (saline)		
	71	Smooth cordgrass, tall growth form (saline)		
	72	Smooth cordgrass, short growth form (saline)		
		Subtotal Saline Marshes	*(11,969)*	*(5.69)*
		TOTAL	210,358	100.00

Table 56. Percentage of the total area of wetlands in each of the three principal salinity ranges, and in the entire Statewide area of coastal wetlands, covered by each of the five vegetation forms. Abbreviations are identified in Table 55. Acreages were derived from Table 14.

	SS	SF	SM	FM	GM
Fresh	6	36	3	20	36
Brackish	7	1	1	0	92
Saline	13	0	0	0	87
Statewide	7	8	1	4	80
Maximum %	13	36	3	20	92
Minimum %	6	1	1	4	36

Table 57. Relative values, by percentage of the total wetland area occupied, for the five vegetation forms. The use of this table is explained in the text in a subsection headed "Procedure."

Percentage of Area	Relative Value of Vegetation Form				
	SS	SF	SM	FM	GM
1 to 25	20	20	20	20	20
26 to 50	15	20	15	15	20
50 to 95	10	10	10	10	20
96 to 100	5	5	5	5	5

Procedure: To compute the value of the vegetation form variable, the percentage measurements of the areas of the various vegetation types in the wetland are grouped according to their vegetation forms (Table 55); the total acreage of each vegetation form is determined; and the total is converted to the corresponding percentage of the total acreage of the entire wetland. Any value that is more than zero (0), but less than 1%, is set equal to 1%.

The percentage of the area of the wetland that is covered by each vegetation form is translated to a relative value by reference to the matrix in Table 57. The relative values then are summed, and the total is multiplied by the number of vegetation forms that are represented in the wetland. The product of this multiplication is compared with the tabulation in Table 58 to determine the score for this variable.

To illustrate the method by which the value of the vegetation form variable is calculated, data for the brackish vegetation types in the coastal wetlands of Maryland were utilized (Table 59). Relative values were obtained from Table 57 after the percentage of the wetland area that is covered by each form was calculated. The final score of 40 was obtained from the tabulation in the preceding text.

Table 58. Relation of the vegetation form product to the score of the vegetation form variable. The use of this table is explained in the text in a subsection headed "Procedure."

Product:	5-15	20-55	60-70	75-140
Score:	5	10	15	20
Product:	145-200	205-240	245-300	305-500
Score:	25	30	35	40

Table 59. Example of the calculation of the value of the vegetation form variable. Data are for the brackish vegetation types in the coastal wetlands of Maryland (Table 14).

Vegetation Form/Type			Type Acres	Form Acres	Form %	Relative Value
SS	Shrub Swamp			10,559	6.91	20
	42	Marshelder/Groundselbush	10,559			
SF	Swamp Forest			1,253	0.82	20
	23	Loblolly pine	1,253			
SM	Shrubform Herb Marsh			281	0.18	20
	45	Rosemallow	281			
FM	Forb Marsh			0	0	0
	(None)		0			
GM	Grasslike Marsh			140,808	92.09	20
	41	Meadow Cordgrass/Spikegrass	31,072			
	43	Needlerush	48,685			
	44	Cattail	5,691			
	46	Switchgrass	2,165			
	47	Threesquare	18,965			
	48	Big cordgrass	8,196			
	49	Common reed	955			
	51	Smooth cordgrass	25,079			
		TOTAL	152,901	152,901	100.00	80

Number of vegetation forms = 4

4 × 80 = 320

Score for vegetation form variable (from Table 58) = 40

VEGETATION INTERSPERSION FACTOR

Most kinds of animals require more than one form of vegetation to satisfy their needs for food, cover, and nesting. Generally, therefore, the density and diversity of wildlife are greater in places where two or more forms of vegetation occur in proximity (Golet 1972). Large expanses of a homogeneous habitat commonly are of least value to wildlife. Maximum wildlife values generally are associated with wetlands in which stands of different vegetation forms are thoroughly intermingled.

The vegetation interspersion factor is a measure of the degree to which different forms of vegetation in a wetland are represented by patches that are intermingled with one another (Golet 1972). An aerial photograph or a map of the area is examined, and the pattern of vegetation is determined and compared with the following descriptions.

Procedure: The appropriate weighting factor is selected from the four outlined below. It then is used in the application that is explained in Chapter 6 as a multiplier to adjust the score of the vegetation form variable.

The wetland area is covered largely (75% or more) by one form of vegetation. Associated forms occur along channels or ditches and/or they are developed principally near the upland boundary. Extensive areas are covered by more or less homogeneous vegetation 1.00x

Each vegetation form occupies less than 75% of the wetland area. The different forms of vegetation occur principally in more or less distinct bands that are parallel to channels and ditches or to the upland boundary 1.33x

Each vegetation form occupies less than 75% of the wetland area. The vegetation forms occur partially in bands or large polygonally shaped areas and interdigitation or mingling is moderate 1.67x

Each vegetation form occupies no more than 60% of the wetland area. The vegetation forms occur principally in island-like stands that are mixed thoroughly with one another in a more or less random or haphazard pattern 2.00x

WILDLIFE FOOD SCORE

The wildlife food score is the weighted average of the wildlife food values of the vegetation types that cover the wetland that is subject to analysis. The percentage of the wetland that is covered by each type of vegetation is used as the weighting factor.

The wildlife food score for all of the subaerial vegetation in the coastal wetlands of Maryland is 39. Owing to their extent and relatively high wildlife food value, the brackish wetlands, including the types and total acreages listed in Table 14, contribute 74% of the Statewide score (29 points). Freshwater marshes contribute 17%; swamp forests contribute 6%; saline wetlands contribute 2%; and shrub swamps contribute less than 1%.

The total score for each major grouping of the coastal wetlands also was determined by dividing the acreage of each type of vegetation by the total acreage of the group and multiplying that fraction times the wildlife food value of the type. The sum of the products, multiplied by the vegetation richness factor, is the total score for the grouping.

The fresh marsh category exhibits the highest wildlife food score (56), and the brackish wetlands have the second highest score (40). The wildlife food score for swamp forests is 29. Saline wetlands (14) and shrub swamps (13) have nearly equal scores.

Procedure: To determine the wildlife food score for a particular wetland, the area occupied by each vegetation type, expressed as a percentile fraction, is multplied by the appropriate wildlife food value from Table 51.[1] The products are summed, and the total is the wildlife food score. An example of these computations is presented in Table 60.

[1]If, by site visit, the biologist can expand upon the list of predominant plant genera for a given type at a specific site, it is suggested that a new, more accurate wildlife food value be calculated using Table 46 and the technique described in Section 4.2.

Table 60. Example of the calculation of the wildlife food score. Data are for the fresh marsh category of the coastal wetlands of Maryland and were obtained from Table 14. Wildlife food values are from Table 51.

	Vegetation Type	Acres	Percent of Total (a)	Wildlife Food Value (b)	Product (a × b)
30	Smartweed/Rice cutgrass	2,924	11.44	100	11.44
31	Spatterdock	1,774	6.94	30	2.08
32	Pickerelweed/Arrowarum	3,925	15.35	90	13.82
33	Sweetflag	431	1.69	35	0.59
34	Cattail	9,018	35.28	50	17.64
35	Rosemallow	1,256	4.91	5	0.25
36	Wildrice	776	3.04	45	1.37
37	Bulrush	2,808	10.98	40	4.39
38	Big cordgrass	1,904	7.45	40	2.98
39	Common reed	747	2.92	35	1.02
	TOTAL	25,563	100.00		55.58

6. APPLICATION OF THE EVALUATION SCHEME

A recommended standard evaluation sheet is presented as Table 61. The sheet is designed to facilitate the entry of data for a specific wetland; it arranges the types by vegetation forms; and it contains the type values and wildlife food values that are needed to compute the wetland production value and the wildlife food score.

6.1. APPLICATION TO ALL THE COASTAL WETLANDS AND TO EACH SALINITY CATEGORY

Copies of the standard evaluation sheet are utilized in Tables 62, 63, 64, and 65 to demonstrate the use of the form. The information in these tables is from the survey of the coastal wetlands of Maryland.

The values in Tables 62 through 65 are utilized to calculate the wetland value scores for the entire area of coastal wetlands and for the three salinity categories of the coastal wetlands. The steps in these computations are recorded fully and cross references are included to pages on which methods are detailed.

DESCRIPTIONS OF NEW CALCULATIONS

In the following subsections, steps in the computation of the wetland value score that are not explained in Chapter 5 are described. The approximate ranges of the intermediate values also are given. These subsections are lettered to correspond with the steps in the computation (Table 61).

(d) Vegetation Resource Group Score

The product of the wetland production value (b) and the vegetation richness factor (c) is a relative estimate of the value of the quantity and diversity of the plant material that is produced by the subject wetland. The lowest possible value (9.00) represents a hypothetical saline wetland that is covered entirely by marshelder/groundselbush vegetation (Type 62). The highest possible value (145.34) represents a fresh wetland in which 91% of the area is covered by big cordgrass (Type 38) and each of the nine other types occur on 1% of the ground. Neither of these configurations is expected to occur on any large wetland area, but they do define the potential limits of the value of this step in the calculations.

The value of the vegetation resource group score for all of the subaerial types of vegetation in the coastal wetlands of Maryland is 73 (Table 62). The scores for the principal salinity groups are 95 for fresh wetlands, 70 for brackish wetlands, and 24 for saline wetlands (Tables 63, 64, and 65).

(h) Adjusted Vegetation Form Variable

The product of the vegetation form variable (f) times the vegetation interspersion factor (g) adjusts the vegetation form variable to integrate the description of the degree to which the forms are interspersed. The potential range of values is from 5 to 80. Owing to the complexities of the methods used to calculate the two component values, similar scores for this adjusted value can result from widely different field conditions. The highest values, however, will be associated with wetlands that are composed of several forms of vegetation that occur in patches of varying sizes.

The adjusted vegetation form value for all of the subaerial vegetation types in the coastal wetlands of Maryland is 40 (Table 62). The value for the brackish wetlands is identical (Table 64). The highest value (67) is associated with the fresh wetlands (Table 63), and the lowest value (20) is that for the saline wetlands (Table 65).

(j) Adjusted Wildlife Food Score

The wildlife food score (i) is multiplied by the vegetation richness factor (c) to reflect the relative diversity of food types that are available in the subject wetland. The potential range of values is from 5 to 150, but the actual range is expected to be from about 10 to 70.

(k) Wildlife Resource Group Score

The value of this score is calculated by adding the vegetation/water interspersion variable (e), the adjusted vegetation form variable (h), and the adjusted wildlife food score (j) and dividing the sum by three. The potential range of values of the wildlife resource group is approximately 8 to 105.

The wildlife resource group score for all subaerial vegetation types in the coastal wetlands of Maryland is 43 (Table 62). The value for the brackish wetlands (43) is the same (Table 64). The highest value (54) is that for the fresh wetlands (Table 63), and the lowest value (23) is associated with the saline wetlands (Table 65).

(l) Total Resource Score

This score is computed by adding the vegetation resource group score (d) to the wildlife resource group score (k). The potential range of the values of these scores is from 14 to 239, but the expected range is from about 40 to 160 or less. The score for all of the subaerial vegetation types in the coastal wetlands in the State is 116 (Table 62). The scores for the fresh brackish, and saline wetlands, respectively, are 149, 114, and 47 (Tables 63, 64, and 65).

INTERPRETATIONS OF THE SCORES

Three scores produced by the Maryland scheme are useful for the relative evaluations of wetlands. These are the vegetation resource group score (d), the wildlife resource group score (k), and the total resource score (l).

The values of these scores differ substantially for wetlands of the three ranges of salinity (Table 66). The values for saline wetlands consistently are the lowest and the values for fresh wetlands consistently are the highest. Owing to the predominance of brackish wetlands, which form the bulk of the coastal wetlands of Maryland, the scores for brackish wetlands are similar to the Statewide averages.

Table 61. Wetland evaluation sheet for statistical analyses of wetlands. Type values are from Table 45 and wildlife food values are from Table 51. The use of the form is explained in the text.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—			—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42				—	—	51		80	
62				—	—	9		5	
	SF	—	—			—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—			—	—	—	—
35				—	—	74		5	
45				—	—	59		5	
	FM	—	—			—	—	—	—
30				—	—	62		100	
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—			—	—	—	—
33				—	—	37		35	
34				—	—	49		50	
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39				—	—	80		35	
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		(a)					(b)		(i)

Acreage	
Vegetation (a)	_____
Water	_____
Total	_____

Veg/Water Interspersion	
Water as %	_____
Interspersion:	
Throughout	_____
Intermediate	_____
Single Body	_____

Vegetation Form	
Sum	_____
Number of forms	_____
Product	_____
Number of Vegetation Types	_____

Parameter	Value
Wetland Production Variable (Page 125)	_____ (b)
Vegetation Richness Factor (Page 126)	_____ (c)
Vegetation Resource Group Score = (b × c)	_____ (d)
Vegetation/Water Interspersion Variable (Page 126)	_____ (e)
Vegetation Form Variable (Page 127)	_____ (f)
Vegetation Interspersion Factor (Page 130)	_____ (g)
Adjusted Vegetation Form Variable = (f × g)	_____ (h)
Wildlife Food Score (Page 130)	_____ (i)
Vegetation Richness Factor (Page 126)	_____ (c)
Adjusted Wildlife Food Score = (i × c)	_____ (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	_____ (k)
Total Resource Score = (d + k)	_____ (l)

Table 62. Wetland evaluation sheet with entries for all of the subaerial coastal wetlands of Maryland to illustrate the use of the form. Acreages are from Table 14.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	7.10	20	—	—	—	—
11		51	0.02	—	—	39	0.008	5	0.001
12		524	0.25	—	—	[52]	0.130	5	0.012
13		2,025	0.96	—	—	64	0.614	15	0.144
42		10,559	5.02	—	—	51	2.560	80	4.016
62		1,780	0.85	—	—	9	0.077	5	0.042
	SF	—	—	7.99	20	—	—	—	—
21		4,154	1.97	—	—	65	1.281	70	1.379
22		11,391	5.42	—	—	94	5.094	15	0.813
23		1,253	0.60	—	—	99	0.594	15	0.090
	SM	—	—	0.73	20	—	—	—	—
35		1,256	0.60	—	—	74	0.444	5	0.030
45		281	0.13	—	—	59	0.076	5	0.006
	FM	—	—	4.10	20	—	—	—	—
30		2,924	1.39	—	—	62	0.861	100	1.390
31		1,774	0.84	—	—	27	0.226	30	0.252
32		3,925	1.87	—	—	30	0.561	90	1.683
	GM	—	—	80.10	20	—	—	—	—
33		431	0.20	—	—	37	0.074	35	0.070
34		9,018	4.29	—	—	49	2.102	50	2.145
36		776	0.37	—	—	53	0.196	45	0.166
37		2,808	1.33	—	—	[26]	0.345	40	0.532
38		1,904	0.91	—	—	100	0.910	40	0.364
39		747	0.36	—	—	80	0.288	35	0.126
41		31,072	14.77	—	—	39	5.760	60	8.862
43		48,685	23.14	—	—	56	12.958	15	3.471
44		5,691	2.71	—	—	59	1.598	40	1.084
46		2,165	1.03	—	—	98	1.009	20	0.206
47		18,965	9.02	—	—	26	2.345	55	4.961
48		8,196	3.90	—	—	47	1.833	10	0.390
49		955	0.45	—	—	93	0.418	5	0.022
51		25,079	11.92	—	—	41	4.887	50	5.960
61		2,304	1.10	—	—	20	0.220	20	0.220
63		121	0.06	—	—	50	0.030	5	0.003
71		95	0.05	—	—	50	0.025	15	0.007
72		9,449	4.49	—	—	20	0.898	15	0.673
Total:		210,358(a)	100.02	100.02	100		48.422 (b)		39.120(i)

Acreage

Vegetation (a)	210,358
Water	5,556
Total	215,914

Veg/Water Interspersion

Water as %	2.57
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	31

Parameter	Value
Wetland Production Variable (Page 125)	48.42 (b)
Vegetation Richness Factor (Page 126)	1.50 (c)
Vegetation Resource Group Score = (b × c)	72.63 (d)
Vegetation/Water Interspersion Variable (Page 126)	30 (e)
Vegetation Form Variable (Page 127)	40 (f)
Vegetation Interspersion Factor (Page 130)	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score (Page 130)	39.12 (i)
Vegetation Richness Factor (Page 126)	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	58.68 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	42.89 (k)
Total Resource Score = (d + k)	115.52 (l)

Table 63. Wetland evaluation sheet with entries for fresh vegetation types in the coastal wetlands of Maryland. Acreages are from Table 14.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	5.95	20	—	—	—	—
11		51	0.12	—	—	39	0.05	5	0.01
12		524	1.20	—	—	[52]	0.62	5	0.06
13		2,025	4.63	—	—	64	2.96	15	0.69
42				—	—	51		80	
62				—	—	9		5	
	SF	—	—	35.56	20	—	—	—	—
21		4,154	9.50	—	—	65	6.18	70	6.65
22		11,391	26.06	—	—	94	24.50	15	3.91
23				—	—	99		15	
	SM	—	—	2.87	20	—	—	—	—
35		1,256	2.87	—	—	74	2.12	5	0.14
45				—	—	59		5	
	FM	—	—	19.73	20	—	—	—	—
30		2,924	6.69	—	—	62	4.15	100	6.69
31		1,774	4.06	—	—	27	1.10	30	1.22
32		3,925	8.98	—	—	30	2.69	90	8.08
	GM	—	—	35.89	20	—	—	—	—
33		431	0.99	—	—	37	0.37	35	0.35
34		9,018	20.63	—	—	49	10.11	50	10.32
36		776	1.78	—	—	53	0.94	45	0.80
37		2,808	6.42	—	—	[26]	1.67	40	2.57
38		1,904	4.36	—	—	100	4.36	40	1.74
39		747	1.71	—	—	80	1.37	35	0.60
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		43,708(a)	100.00	100.00	100		63.19(b)		43.83(i)

Acreage	
Vegetation (a)	43,708
Water	1,093
Total	44,801

Veg/Water Interspersion	
Water as %	2.44
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	15

Parameter	Value
Wetland Production Variable (Page 125)	63.19 (b)
Vegetation Richness Factor (Page 126)	1.50 (c)
Vegetation Resource Group Score = (b × c)	94.79 (d)
Vegetation/Water Interspersion Variable (Page 126)	30 (e)
Vegetation Form Variable (Page 127)	40 (f)
Vegetation Interspersion Factor (Page 130)	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score (Page 130)	43.83 (i)
Vegetation Richness Factor (Page 126)	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	65.75 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	54.18 (k)
Total Resource Score = (d + k)	148.97 (l)

Table 64. Wetland evaluation sheet with entries for all brackish vegetation types in the coastal wetlands of Maryland. Acreages are from Table 14.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	6.91	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42		10,559	6.91	—	—	51	3.52	80	5.53
62				—	—	9		5	
	SF	—	—	0.82	20	—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23		1,253	0.82	—	—	99	0.81	15	0.12
	SM	—	—	0.18	20	—	—	—	—
35				—	—	74		5	
45		281	0.18	—	—	59	0.11	5	0.01
	FM	—	—			—	—	—	—
30				—	—	62		100	
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—	92.08	20	—	—	—	—
33				—	—	37		35	
34				—	—	49		50	
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39				—	—	80		35	
41		31,072	20.32	—	—	39	7.92	60	12.19
43		48,685	31.84	—	—	56	17.83	15	4.78
44		5,691	3.72	—	—	59	2.19	40	1.49
46		2,165	1.42	—	—	98	1.39	20	0.28
47		18,965	12.40	—	—	26	3.22	55	6.82
48		8,196	5.36	—	—	47	2.52	10	0.54
49		955	0.62	—	—	93	0.58	5	0.03
51		25,079	16.40	—	—	41	6.72	50	8.20
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		152,901(a)	99.99	99.99	80		46.81(b)		39.99(i)

Acreage	
Vegetation (a)	152,901
Water	3,825
Total	156,726

Veg/Water Interspersion	
Water as %	2.44
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	80
Number of forms	4
Product	320
Number of Vegetation Types	11

Parameter	Value
Wetland Production Variable (Page 125)	46.81 (b)
Vegetation Richness Factor (Page 126)	1.50 (c)
Vegetation Resource Group Score = (b × c)	70.22 (d)
Vegetation/Water Interspersion Variable (Page 126)	30 (e)
Vegetation Form Variable (Page 127)	40 (f)
Vegetation Interspersion Factor (Page 130)	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score (Page 130)	39.99 (i)
Vegetation Richness Factor (Page 126)	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	59.99 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	43.33 (k)
Total Resource Score = (d + k)	113.55 (l)

Table 65. Wetland evaluation sheet with entries for saline vegetation types in the coastal wetlands of Maryland. Acreages are from Table 14.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	12.95	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42				—	—	51		80	
62		1,780	12.95	—	—	9	1.17	5	0.65
	SF	—	—			—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—			—	—	—	—
35				—	—	74		5	
45				—	—	59		5	
	FM	—	—			—	—	—	—
30				—	—	62		100	
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—	87.05	20	—	—	—	—
33				—	—	37		35	
34				—	—	49		50	
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39				—	—	80		35	
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61		2,304	16.76	—	—	20	3.35	20	3.35
63		121	0.88	—	—	50	0.44	5	0.04
71		95	0.69	—	—	50	0.35	15	0.10
72		9,449	68.72	—	—	20	13.74	15	10.31
Total:		13,749(a)	100.00	100.00	40		19.05 (b)		14.45(i)

Acreage		Veg/Water Interspersion		Vegetation Form	
Vegetation (a)	13,749	Water as %	4.43	Sum	40
Water	638	Interspersion:		Number of forms	2
Total	14,387	Throughout	____	Product	80
		Intermediate	x	Number of Vegetation Types	5
		Single Body	____		

Parameter	Value
Wetland Production Variable (Page 125)	19.05 (b)
Vegetation Richness Factor (Page 126)	1.25 (c)
Vegetation Resource Group Score = (b × c)	23.81 (d)
Vegetation/Water Interspersion Variable (Page 126)	30 (e)
Vegetation Form Variable (Page 127)	20 (f)
Vegetation Interspersion Factor (Page 130)	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	20 (h)
Wildlife Food Score (Page 130)	14.45 (i)
Vegetation Richness Factor (Page 126)	1.25 (c)
Adjusted Wildlife Food Score = (i × c)	18.06 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	22.69 (k)
Total Resource Score = (d + k)	46.50 (l)

Table 66. Comparison of scores for wetlands in the three ranges of salinity and of scores for all coastal wetlands in Maryland.

Resource Group	Range of Salinity Fresh	Brackish	Saline	All Coastal Wetlands
Vegetation	95	70	24	73
Wildlife	54	43	23	43
Total	149	114	47	116

Based on this comparison, it is not considered to be appropriate to compare wetlands from different ranges of salinity or to use the Statewide averages for all coastal wetlands as standards for the quality to be expected in the wetlands of some smaller area. The tabulated data, however, do provide standards for the quality to be expected in wetlands within each of the three ranges of salinity.

6.2. APPLICATION TO THREE TEST MARSHES

No available study conducted in Maryland was found that includes data suitable for analysis by the present scheme. Three detailed investigations of fresh marshes in the estuary of the Delaware River, however, do include such data and can be utilized to demonstrate the application of the scheme for comparison of different wetland areas (McCormick and Ashbaugh, 1972; and McCormick, 1970). The sites of the three studies are Oldmans Creek Marsh in Salem and Gloucester Counties, New Jersey; Salisbury Marsh in Gloucester County, New Jersey; and Tinicum Marsh in Delaware and Philadelphia Counties, southeastern Pennsylvania.

The detailed computations on the wetland evaluation sheets for the three marshes are contained in Appendix 4 (Tables 108-110). For comparative purposes in this discussion, the vegetation resource group, wildlife resource group, and total resource scores resulting from the computations are presented in Table 67. The scores indicate that the vegetation resource group is of highest quality in Tinicum Marsh. The wildlife resource group, however, is of greatest quality in Oldmans Marsh. On the basis of the total resource scores, Oldmans Creek is of the greatest quality; Tinicum Marsh ranks second; and Salisbury Marsh is of the lowest quality of the three areas.

For the purposes of demonstration, the three test marshes can be treated as if they were located in Maryland. The scores for all of the freshwater wetlands of the State (Table 66), therefore, are utilized as standards to provide a greater degree of uniformity to the comparisons of the test marshes. This is accomplished by transforming the original scores (Table 67) to percentages of the standard scores and rounding the results to the nearest 5% (Table 68). This process does not alter the proportional relationships between the scores for the three marsh areas, but it does facilitate an evaluation of the relative importances of the marshes in a Statewide context.

Table 67. Comparison of scores for Oldmans Marsh (838 acres), Salisbury Marsh (37.1 acres), and Tinicum Marsh (577.68 acres) in the freshwater section of the Delaware River, near Chester, Pennsylvania. Computations are presented in Tables 108 through 110 in Appendix 4.

Resource Group	Oldmans	Salisbury	Tinicum
Vegetation	58	47	62
Wildlife	57	43	41
Total	115	90	103

Table 68. Data in Table 67 expressed as percentages of the scores from all freshwater wetlands in Maryland. Parenthetical values are rounded to nearest 5%.

Resource Group	Oldmans	Salisbury	Tinicum
Vegetation	61 (60)	49 (50)	65 (65)
Wildlife	106 (105)	80 (80)	76 (75)
Total	77 (80)	60 (60)	69 (70)

The following narrative categories are recommended to describe the transformed values. These categories reflect the assumption that the Statewide average for the wetlands in a particular range of salinities is an ideal. Individual wetland areas are unlikely to contain all of the types of vegetation included in the range and, therefore, generally will exhibit scores that are lower than the Statewide weighted averages.

Percentile Range	Narrative Category
40% or less	Lower Quality
45% to 65%	Average Quality
70% to 90%	High Quality
95% or more	Very High Quality

The quality of the vegetation resource group in the three test areas is average (Table 68). The rounded scores range from 50% (Salisbury Marsh) to 65% (Tinicum Marsh). In Tinicum Marsh (75%) and Salisbury Marsh (80%), the wildlife resource group is of high quality. In Oldmans Marsh, the quality of the wildlife resource group is very high (105%). On the basis of the total resource group, Salisbury Marsh (60%) is of average quality and Tinicum Marsh (70%) and Oldmans Marsh (80%) are of high quality.

6.3. APPLICATION TO THE MAJOR COASTAL WATERSHEDS AND TO THE TIDEWATER COUNTIES

The use of the weighted Statewide averages will serve as a unifying procedure for all wetland evaluations. Comparisons of the scores for a specific evaluation with the weighted averages for the relevant major watershed, however, will provide information directly applicable to the estuarine section in which the subject wetland is located.

The scores for each of the 15 major coastal watersheds are listed in Table 69.[1] To provide an evaluation of the relative qualities of the coastal wetlands in these watersheds, a "composite base" was calculated for each watershed by dividing the acreages of fresh, brackish, and saline wetlands by the total acreage of vegetated subaerial wetlands in the watershed (Table 70). The resulting fractions were multiplied by the total resource score for the appropriate salinity range (Table 66), and the products were summed to yield the composite base, or average total resource score. When the total resource score for the coastal wetlands in a watershed is expressed as a percentage of the composite base for the watershed, the percentage is a comparative measurement of the quality of the wetlands of the watershed. Any percentage that is greater than 100% suggests that the combination of types present in the watershed is of higher quality than would be expected on the basis of Statewide averages.

The average weighted resource scores for the coastal wetlands of each of the sixteen tidewater counties are listed in Table 71. The total resource group score for each county is compared with the composite base score that was calculated in the way described above. The analyses listed in Table 72 were used in the calculations.

The resource scores for the county in which an evaluated wetland is located also can be used to determine whether the quality of the wetland is of low, average, high, or very high quality in terms of the particular political unit. Such evaluations do not relate to closely integrated hydrologic systems, but they are useful for resource management purposes and will contribute to the rational basis for local resource decision-making.

[1] *Detailed computations for each coastal watershed and each tidewater county are contained in Appendix 5.*

Table 69. Comparison of scores for wetlands in the major coastal watersheds of Maryland. Locations of watersheds are shown in Figure 39. The composite base is explained in the text.

Watershed	Resource Group			Composite	% of
	Vegetation	Wildlife	Total	Base	Base
Lower Susquehanna River	75	60	135	149	91
Coastal Area	30	31	61	50	122
Pocomoke River	79	44	124	121	102
Nanticoke River	73	43	116	120	97
Choptank River	76	44	120	120	100
Chester River	74	60	134	120	112
Elk River	80	61	141	147	96
Bush River	79	54	133	148	90
Gunpowder River	74	47	121	148	82
Patapsco River	80	49	129	141	91
West Chesapeake Bay	75	49	124	115	108
Patuxent River	78	56	134	131	102
Chesapeake Bay	80	28	108	114	95
Lower Potomac River	71	46	117	121	97
Washington Metropolitan Area	91	57	148	149	99

Table 70. Acreage of subaerial fresh, brackish, and saline vegetated coastal wetlands in the major watersheds of Maryland.* This summary is based on data from Table 14. The extent of each watershed is illustrated in Figure 39.

Watershed	Fresh	Brackish	Saline	Total
Lower Susquehanna River	40	0	0	40
Coastal Area	70	543	13,749	14,362
Pocomoke River	8,408	34,004	0	42,412
Nanticoke River	13,566	66,372	0	79,938
Choptank River	4,461	21,826	0	26,287
Chester River	1,093	5,764	0	6,857
Elk River	3,239	190	0	3,429
Bush River	5,420	216	0	5,636
Gunpowder River	2,143	79	0	2,222
Patapsco River	567	173	0	740
West Chesapeake Bay	56	2,018	0	2,074
Patuxent River	3,080	3,321	0	6,401
Chesapeake Bay	15	13,531	0	13,546
Lower Potomac River	1,252	4,864	0	6,116
Washington Metropolitan Area	298	0	0	298
STATE TOTAL	43,708	152,901	13,749	210,358

*The types included in each salinity category are:
Fresh—Types 11, 12, 13, 21, 22, and 30-39.
Brackish—Types 23, 41-49, and 51.
Saline—Types 61-63, 71, and 72.

Table 71. Comparison of scores for coastal wetlands in the tidewater counties of Maryland. The composite base is explained in the text.

County	Resource Group			Composite	% of
	Vegetation	Wildlife	Total	Base	Base
Anne Arundel	77	59	136	126	108
Baltimore	73	48	121	146	83
Calvert	73	46	119	120	99
Caroline	84	58	142	141	101
Cecil	77	64	141	149	95
Charles	72	46	118	124	95
Dorchester	73	43	116	118	98
Harford	79	54	133	148	90
Kent	77	58	135	129	105
Prince George's	84	62	146	141	104
Queen Anne's	75	59	134	117	115
St. Mary's	70	56	126	115	110
Somerset	74	42	116	115	101
Talbot	77	63	140	127	110
Wicomico	78	42	120	124	97
Worcester	57	50	107	82	130

Table 72. Acreage of subaerial fresh, brackish, and saline vegetated coastal wetlands in the tidewater counties of Maryland.* This summary is based on data from Table 17.

County	Fresh	Brackish	Saline	Total
Anne Arundel	776	1,523	0	2,299
Baltimore	1,904	199	0	2,103
Calvert	452	2,210	0	2,662

Table 72. Acreage of subaerial fresh, brackish, and saline vegetated coastal wetlands in the tidewater counties of Maryland.* This summary is based on data from Table 17 (Concluded).

County	Fresh	Brackish	Saline	Total
Caroline	2,566	801	0	3,367
Cecil	2,346	0	0	2,346
Charles	1,231	2,877	0	4,108
Dorchester	9,738	73,509	0	83,247
Harford	6,212	227	0	6,439
Kent	1,667	2,283	0	3,950
Prince George's	2,190	611	0	2,801
Queen Anne's	297	3,125	0	3,422
St. Mary's	80	3,087	0	3,167
Somerset	1,630	49,159	0	50,789
Talbot	1,765	3,016	0	4,781
Wicomico	3,867	9,721	0	13,588
Worcester	6,987	553	13,749	21,289
STATE TOTAL	43,708	152,901	13,749	210,358

*The types included in each salinity category are:
Fresh—Types 11, 12, 13, 21, 22, and 30-39.
Brackish—Types 23, 41-49, and 51.
Saline—Types 61-63, 71, and 72.

The data for Oldmans Marsh (Table 67) can be employed to demonstrate the use of the Statewide values for particular salinity ranges (Table 66), the average scores for watersheds (Table 69), and the average scores for the tidewater counties (Table 71) for evaluative purposes. For this demonstration, Oldmans Marsh will be assumed to be located in the Elk River watershed in Cecil County. The scores from Oldmans Marsh are shown as rounded percentages of the corresponding baseline scores in Table 73.

Table 73. Resource group scores for Oldmans Marsh expressed as rounded percentages of the corresponding scores for all fresh coastal wetlands in Maryland, for all coastal wetlands in the Elk River watershed, and for all coastal wetlands in Cecil County. Narrative interpretations are explained in the text.

	Resource Group		
	Vegetation	Wildlife	Total
Statewide	60 (Average)	105 (Very high)	80 (High)
Watershed	75 (High)	95 (Very high)	80 (High)
County	75 (High)	90 (High)	80 (High)

This comparative analysis yields a consistent rating of "High Quality" at all levels for the total resource group of Oldmans Marsh (Table 73). The vegetation resource group is rated as of "Average Quality" on a statewide basis, and of "High Quality" on the local scale. In contrast, the wildlife resource group is rated as of "Very High Quality" on a statewide basis and in the watershed and of "High Quality" in the county. These evaluations suggest that the subject wetland is a prime candidate for preservation, and that any proposal to alter the tract should include provisions for substantial public benefit or private relief as well as extraordinary measures to mitigate any reduction in the quality of the wetland.

6.4. WETLAND SIZE AS A CONSIDERATION

The area of the subject wetland is not considered directly in the evaluations produced by the Maryland scheme. The scores produced by the scheme are relative evaluations, or dimensionless averages, of the quality of the entire area that was subject to analysis. Because the number of vegetation types and the number of forms of vegetation included in a wetland generally will increase as the area encompassed becomes larger, size is treated indirectly. In the examples listed in Tables 67 and 68, for example, the scores apply to areas of 37 acres, 578 acres, and 838 acres, and their values are related in the same order as their sizes.

Green (1972) believed that area is an important scalar for wetland evaluations. In Virginia, Silberhorn, Dawes, and Bernard (1974) declared that, "any marsh which is greater than 1/10 of an acre in size may have, depending on type and viability, significant values in terms of productivity, detritus availability and wildlife habitat."

No universally applicable formula for the consideration of the size of a wetland area has been determined for use in relation to the Maryland scheme. Concern for size generally will be related to a purpose, and the concern will vary from one purpose to another. Quality scores that are produced by the scheme will serve as general guidance to the relative resource values of two or more areas. If the areas are similar in size, the scores will be directly comparable.

For purposes of environmental assessment, it may be useful to employ a proportional analysis of size. For example, if a particular project proposes to eliminate 50 acres of fresh wetlands, this would represent 71% of the fresh wetland resource in the Coastal Area watershed in contrast to 0.37% of the fresh wetlands in the Nanticoke River watershed (Table 70). Wherever the project is proposed for location, it potentially would usurp 0.11% of the total area of fresh wetlands in the State.

Another analytic approach that may be useful for some considerations is that of effective size. For example, Tinicum Marsh (578 acres), if it were in Maryland, would represent 1.32% of the total area of fresh wetlands (Table 72). The total resource score for Tinicum Marsh, however, is 70% as great as the weighted score for all freshwater wetlands in the State (Table 68). The "effective acreage" of the Marsh, therefore, is 578 acres x 0.70, or 405 acres. This represents 0.93% of fresh marsh resource value. If one project, such as an express highway, was proposed to eliminate approximately 1% of a resource as valuable as the fresh wetlands, an especially thorough and critical investigation of the justification of the project and feasible alternatives to the proposed plan would be mandatory.

Proportional analyses, either of actual acreage or effective acreage, are expected to be most relevant when they are applied to data for the watershed in which the subject wetland is located. Analyses with Statewide data will provide a uniform scale for evaluations, but impact assessments will be most meaningful when they are based on localized evaluations.

6.5. OVERRIDING FACTORS

Certain characteristics of the types of coastal wetland vegetation and of wetland complexes are of such importance to society that they override the relative values that are determined by the multivariate scheme for evaluation. These overriding factors indicate areas that should be protected and conserved, and types that should be considered for special management and for emphasis in programs to develop new wetland areas.

OVERRIDING FACTORS ASSOCIATED WITH VEGETATION TYPES

The inventory of the types of vegetation of the coastal wetlands of Maryland can be utilized to identify certain important facts about the relative supplies of the different types and about critical geographical relations. Types and/or stands that are identified as scarce, unusual, or unique, are worthy of protection regardless of their ranking on the basis of multivariate tests.

Statewide Scarcity

The acreages of the 35 types of coastal wetlands that are recognized in Maryland are presented in Table 2, and they also are expressed as percentages of the total acreage of wetlands. These data indicate that 5 of 32 vegetated types of wetlands compose, collectively, 63.56% of the coastal wetlands of the State [brackish smooth cordgrass (Type 51), 9.59%; brackish meadow cordgrass/spikegrass (Type 41), 11.89%; submerged vegetation (Type 101), 16.19%; brackish needlerush (Type 43), 18.63%; and brackish threesquare (Type 47), 7.26%].

Twenty of the 32 types of vegetated wetlands compose, individually, less than 1% of the total wetland area. All of these types can be considered to be underrepresented areally in the coastal wetland complex of the State. Nevertheless, the total area of the wetlands is large (261,309 acres, or about 408 square miles). A type that occupies only 1% of this area still would cover about 4 square miles, and could not be considered scarce.

On a statewide basis, it is reasonable to consider a type of vegetation to be scarce if it contributes 0.50% (1,300 acres) or less of the total wetland acreage. By this criterion, 10 of the 32 vegetated types of wetlands are scarce (Table 74). These range from the swamp rose shrub swamp (Type 11), which covers 51 acres, to the loblolly pine swamp forest (Type 23), which covers 1,253 acres. Two notable inclusions are the freshwater wildrice marsh (Type 36), which also is of unusual importance to migratory waterfowl and other wetland birds, and the tall form of the saline smooth cordgrass marsh, which is developed extensively in the coastal wetlands of the southeastern United States.

Two of the ten types of wetland that are considered to be scarce by the application of this criterion are represented by nearly pure stands of common reed. This grass is a natural component of the coastal wetlands of the Middle Atlantic Region, as well as of other coastal areas, but it also exhibits weedy characteristics on disturbed sites. During evaluations of specific areas of wetland, therefore, stands of common reed should be examined to determine if they occupy characteristic wetland sites or if the sites are atypical owing to increased elevation or unusual substrate composition (i.e., building rubble, solid waste, or other exotic substances) as the result of the deposition of dredged material or fill material. A stand should be considered to represent one of the scarce types only if it is at an elevation similar to those in the surrounding wetland, and if it is rooted in a substrate composed of natural materials, even if they have been transported to the site.

Local Scarcity, By Watershed

The total area of vegetated wetlands that was mapped in the various sub-basins ranges from 298 acres in the Washington Metropolitan Region to 81,036 acres in the Nanticoke River watershed (Table 75). Because scarcity is based on the relative areal abundance of types of vegetation that differ from one another in floristic composition, and because no floristic types were differentiated in the diverse grouping that is characterized as submerged vegetation (Type 101), submerged vegetation is eliminated from the appraisal of local scarcity. When data become available to determine the distribution and acreage of each of the floristic types of submerged vegetation, they can be included or can be assessed independently.

Table 74. Types of vegetated wetlands that are considered to be scarce in the coastal zone of Maryland. Excerpted from Table 2.

Type	Acres	Percentage
SHRUB SWAMPS		
11 Swamp rose	51	0.02
12 Smooth alder/black willow	524	0.20
SWAMP FORESTS		
23 Loblolly pine	1,253	0.48
FRESH MARSHES		
33 Sweetflag	431	0.16
36 Wildrice	776	0.30
39 Common reed	747	0.29
BRACKISH MARSHES		
45 Rosemallow	281	0.11
49 Common reed	955	0.36
SALINE MARSHES		
63 Needlerush	121	0.05
71 Smooth cordgrass, tall growth	95	0.04

Vegetated, subaerial types of wetlands occupy from 40 acres to 79,938 acres in the various sub-basins (Table 75). Owing to this great range in areal extent, it is not rational to consider as locally scarce any vegetation type that composes 0.5% or less of the subaerial wetlands in a particular watershed. If this criterion were applied, the threshold area would be 0.2 acre in the Lower Susquehanna River sub-basin region and 399.3 acres in the Nanticoke River watershed.

To provide continuity from place to place within the State, locally scarce wetland types are defined as: (1) those types that are considered to be scarce on a statewide basis, and/or (2) those types that are represented by stands whose areas cumulate to 100 or fewer acres within the particular watershed (Table 14). A type that is judged to be scarce in one watershed by the second of these criteria, however, may not be scarce in another watershed.

The first of these two criteria is designed to render local scarcity subsidiary to statewide scarcity. For example, wildrice (Type 36) is considered to be scarce on a statewide basis. In each of 4 of the 15 sub-basins, the aggregate areas of stands of wildrice exceed 100 acres (Table 14), and wildrice would not be designated as locally scarce if only the second criterion were utilized.

Local Scarcity, By County

Subaerial vegetated types of coastal wetlands cover from 2,103 acres in Baltimore County to 83,247 acres in Dorchester County (Table 76). Based on the considerations that are discussed in the preceding subsection, locally scarce wetland types are defined as: (1) those types that are considered to be scarce on a statewide scale, and (2) those types that are represented by stands whose areas cumulate to 100 or fewer acres within the particular county (Table 17).

Because any particular coastal wetland is located in one of the 16 tidewater counties and in one of the 15 major tidally influenced watersheds of the State, any type of vegetation that is present in the wetland will be considered locally scarce if it is designated as such for the county or for the watersheds. For example, stands of smartweed/rice cutgrass (Type 30) in the watershed of the Patuxent River are not considered to be locally scarce. If such a stand were located on the Patuxent River at a location in Calvert County, however, it would be designated as locally scarce owing to the fact that the type is considered to be scarce in that county. Conversely, a stand of Type 34, the cattail fresh marsh type, in Harford County would not be considered to be locally scarce unless it is situated in Lower Susquehanna River sub-basin.

Specially Significant Stands

Certain stands of vegetation have a special significance owing to their geographic location, large size, the environment in which they occur, some intrinsic feature, or any unusual association with other vegetation types. A stand that is at the limit of the distribution of the vegetation type, for example, is of special significance. Similarly, the most upstream or downstream stand of a vegetation type on a particular river system is especially significant. A stand that occupies an area in an environment that is not typical of the vegetation type also is significant. And natural stands that occur in a unique or very unusual positional relationship to stands of other kinds of vegetation have a special significance. All of these examples are of unusual scientific interest and should be protected as potential research sites.

OVERRIDING FACTORS ASSOCIATED WITH WETLAND AREAS

Certain characteristics of wetland complexes or specific tracts override all other characteristics in a determination of relative value. Even if the particular complex or tract might score in a medial or low rank if it were evaluated by a multivariate technique, it should be considered to possess outstanding value if it exhibits at least one of the following features.

Essential Habitats

Pursuant to Federal and State laws, species of plants and animals that are considered to be in danger of extinction may be designated as Endangered Species. Other taxa, although not presently in danger of extinction, are considered to be so susceptible to changes induced by man or nature that they may become endangered in the foreseeable future. These taxa may be designated as Threatened Species. Wetlands that provide nest sites and/or food resources that are essential to the survival of one or more endangered or threatened species are considered to be essential habitats.

Specially Significant Habitats

In addition to species that are designated as endangered or threatened under Federal or State law, other kinds of plants and animals may deserve special consideration owing to their local rarity or other characteristics. Wetland areas that provide nest sites and/or food resources that are essential to the survival of such species are considered to be specially significant habitats.

Table 75. Areas of watersheds occupied by vegetated coastal wetlands.

DESIGNATION	WATERSHED	TOTAL[1] TYPED	UNVEGE-TATED	VEGETATED		
				TOTAL	SUBMERGED	SUB-AERIAL
02-12-02	Lower Susquehanna River	841	4	837	797	40
02-13-01	Coastal Area	17,225	1,277	15,948	1,586	14,362
02-13-02	Pocomoke River	53,246	1,777	51,469	9,057	42,412
02-13-03	Nanticoke River	83,382	2,346	81,036	1,098	79,938
02-13-04	Choptank River	36,877	481	36,396	10,109	26,287
02-13-05	Chester River	16,204	422	15,782	8,925	6,857
02-13-06	Elk River	3,848	137	3,711	282	3,429
02-13-07	Bush River	5,992	97	5,895	259	5,636
02-13-08	Gunpowder River	2,599	57	2,542	320	2,222
02-13-09	Patapsco River	819	78	741	1	740
02-13-10	West Chesapeake Bay	3,419	113	3,306	1,232	2,074
02-13-11	Patuxent River	6,652	200	6,452	51	6,401
02-13-99	Chesapeake Bay	21,321	275	21,046	7,500	13,546
02-14-01	Lower Potomac River	7,297	89	7,208	1,092	6,116
02-14-02	Washington Metropolitan Area	298	0	298	0	298
	Total	260,020	7,353	252,667	42,309	210,358

[1]Does not include untyped acreage figures (see Table 14).

Table 76. Areas of counties occupied by vegetated coastal wetlands.

COUNTY	TOTAL[1] TYPED	UNVEGE-TATED	VEGETATED		
			TOTAL	SUBMERGED	SUB-AERIAL
Anne Arundel	3,643	112	3,531	1,232	2,299
Baltimore	2,400	118	2,282	179	2,103
Calvert	2,695	33	2,662	0	2,662
Caroline	3,392	25	3,367	0	3,367
Cecil	3,212	5	3,207	861	2,346
Charles	4,507	16	4,491	383	4,108
Dorchester	95,217	2,579	92,638	9,391	83,247
Harford	7,036	125	6,911	472	6,439
Kent	7,974	233	7,741	3,791	3,950
Prince George's	2,801	0	2,801	0	2,801
Queen Anne's	7,912	262	7,650	4,228	3,422
Somerset	67,963	1,966	65,997	15,208	50,789
St. Mary's	4,176	249	3,927	760	3,167
Talbot	9,183	188	8,995	4,214	4,781
Wicomico	13,753	165	13,588	0	13,588
Worcester	24,156	1,277	22,879	1,590	21,289
Total	260,020	7,353	252,667	42,309	210,358

[1]Does not include untyped acreage figures (see Table 17).

The following criteria are proposed for the recognition of "specially considered species":

1. Native species of animals and plants are specially considered species if they are endangered or threatened with extirpation from a county, watershed, or estuarine system in the judgment of experienced field biologists. Such species always may have been represented by few individuals, and/or they may occupy habitats which are of very limited areal extent or which are liable to be destroyed, modified significantly, or otherwise affected detrimentally by the actions of man or nature.

2. Some native species of animals or plants are sufficiently abundant that they are neither endangered nor threatened, but their numbers may be declining as a result of natural causes or human activities. These are specially considered species, and can be termed "depleted species."
3. Native species of animals or plants that are represented by local populations with unique or unusual genotypical characteristics are specially considered species. The qualifying genotypical characteristics should not be those that are related to normal geographical variations within the species population.

Noteworthy Specimens

Whether or not they are representatives of species regarded as specially significant, and whether or not they are native, individual plants may be considered to be "noteworthy specimens." This recognition of uniqueness or unusualness may be made on the basis of great age, large size, atypical form or color, hybrid origin, or some other characteristic. Where such a noteworthy specimen is present, it should be considered to be an overriding factor in the evaluation of the wetland area that is essential for its maintenance or survival.

Certain plant novelties[1] may qualify as noteworthy specimens on the basis of age, size, or some other characteristic. Individuals or clones of taxa that are plant novelties also should be considered to be eligible for designation as noteworthy specimens if they represent the only specimen, or one of a few specimens, of that taxon in the State, watershed, or county. Many troublesome weeds, however, once were novelties. Any plant novelty, therefore, should be examined carefully for potential pest traits before it is afforded a degree of protection.

[1]Plant novelties are representatives of exotic taxa which appear spontaneously or are persisting in semi-natural habitats long after planting.

Exceptional Primary Production

The average peak standing crop of most coastal wetlands in the Middle Atlantic States probably ranges from about 3 to 6 tons per acre (670 to 1350 grams per square meter). Wetlands on which the average peak standing crop (for all vegetation types over the entire area) exceeds 7.5 tons per acre (1680 grams per square meter) should be considered exceptional. Stands of a single vegetation type in which the standing crop exceeds 15 tons per acre (3370 grams per square meter) also are exceptional.

Exceptional Secondary Production

This designation is for wetland complexes or wetland tracts, usually in association with adjacent open waters, which are outstanding breeding areas for waterfowl, shorebirds, wading birds, songbirds, mammals, reptiles, amphibians, fish, shellfish, or some other form of animal life. Significant pests or important vectors of communicable diseases should be excluded from this evaluation.

Exceptional Habitats for Migrants or Winter Residents

Migratory waterfowl, shorebirds, marshbirds, and wading birds depend on wetlands for feeding and resting areas along their flyways. Thousands of such birds also reside in the coastal marshes of Maryland during the winter, and are even more dependent upon them for survival than are the transients. Similarly, swamp forests are used intensively by songbirds and other animals. Areas of outstanding value to these species should be afforded special protection.

Outstanding Examples of Geomorphological Processes

The many processes which shape and reform the features of coastal areas operate universally. In most localities, however, several forces operate simultaneously or sequentially, and it is difficult to identify, study, and appreciate the dynamics of any one of the forces. Structures built by man in the water or on the land also modify or obscure the processes of nature, and their effects may extend far beyond the actual locations of the structures. Areas in which natural processes have not been altered significantly and, particularly, those areas in which one process or a series of related processes is operating with little or no obfuscation by a second process, are of exceptional value for educational and research purposes.

Type Localities

Each species of animal or plant that now is recognized and labeled with a scientific name is based on a "type specimen." These specimens are valuable records to which scientists refer to determine evolutionary relationships and to compare with other specimens which are suspected to be new, but related, species. The area from which a type specimen was collected is known as the "type locality," and it should be afforded the status of a scientific memorial or landmark. These areas also may be used as environmental monitoring stations. Reanalyses of the modern populations of the species originally described from a type locality may provide early warnings of potential imbalances, pollution, or other problems.

Research Sites

The societal values of wetland complexes or tracts are enhanced immensely by their use as sites of intensive and/or long-term biological, chemical, geological, climatological, historical, archaeological, or other research related directly and intimately to the features and processes of the wetland. Such areas are of exceptional value to educational programs, and particularly, for continuing research (Golet 1972; McCormick 1971). The Rhode River estuary, south of Annapolis, for example, is used intensively by scientists from the Smithsonian Institution (Jenkins and Williamson 1973).

Contaminated Areas

The sediment in the subject wetland area should be analyzed to determine the concentrations of arsenic, cadmium, chromium, copper, lead, mercury, zinc, and any other heavy metals that may be present in greater than normal concentrations. The concentrations should be expressed as the ratios between the observed concentrations and the normal background concentrations expected in uncontaminated tidal marsh sediments. The background concentration for mercury, for example, is 0.05 ppm. An observed concentration of 1 ppm would be expressed as a score of 20. If the score of any metal is greater than 1.0, special consideration should be given to a more intensive testing program. Should any score exceed 10.0, a more intensive testing program can be considered mandatory.

Manmade compounds may be present in the sediment of certain areas at concentrations that are hazardous to the biota and, at least indirectly, to human beings. Gas chromatograph scans for chlorinated hydrocarbons that have been used as pesticides, including kepone, DDT, aldrin, and dieldrin, and for such toxic industrial compounds as PCB's (polychlorinated biphenyls), should be included in investigations of areas considered for public acquisition or which are proposed as the sites for private or public actions. There are no natural background levels for these substances, but the State can establish maximum concentrations that are considered to be safe in sediments.

6.6. OTHER POTENTIAL SCALARS

Several other scaling parameters could be developed for the environmental evaluation of coastal wetlands if sufficient information were available. These are described in the following subsections. The discussion also highlights areas of research that are in critical need of investigation, and suggests that some standardization of wetland classification in Maryland and other states of the Middle Atlantic Region could enhance the practical value of research.

OTHER POTENTIAL SCALARS FOR VEGETATION TYPES

Several other features could be useful for the evaluation of the vegetation types of coastal wetlands. For some of these features, insufficient information now is available to permit their utilization. Others, after examination, seem to be more appropriate for detailed planning and/or management, rather than for broad-scale planning or overall regulatory strategy development.

Aesthetic Value

Some types of coastal wetland vegetation, owing to their general appearance, seasonal colors, flowers, fruits, or other, less tangible features, probably appeal to the human emotions more than do other types. To utilize aesthetic value as an objective parameter for wetland evaluation, area-wide scales of aesthetic rankings of vegetation types should be developed by interviews or other techniques (Gupta and Foster 1973).

Floristic Diversity

Floristic diversity is the relationship between the number of plant species which compose a vegetation type and the area that is occupied by the vegetation type and/or the number of individual plants that compose the vegetation type. The greater the floristic diversity of a particular type, the greater is the number of species and species populations present per unit area. (When diversity formulas are based on the number of species and the number of individuals, the concept of area becomes relative, and diversity values for vegetation types composed of plants of widely different sizes may not be directly comparable.)

Floristic diversity also is believed to be related to stability and wildlife habitat values. It also may be a factor in aesthetics, replacement value, and productivity. At present, scientists have not quantified these relationships.

Data that presently are available are not adequate to calculate diversity indexes for any vegetation type in the coastal wetlands. The floristic data are summarized in another section of this report, but no extensive, quantitative information has been collected.

Stability

No vegetation is changeless or everlasting. Some types, however, are not self-perpetuating on a particular site and gradually mature, stagnate in growth, degenerate, and are replaced by another type.

In the herbaceous vegetation that develops on fallow agricultural lands, changes may be rapid and may occur from one summer to the next. Certain forest types, such as the Virginia pine forest, may mature in 50 to 60 years, and then deteriorate rapidly. Other types of vegetation are self-perpetuating. Although individual plants do succumb to disease, climatic damage, or other agencies, they are replaced by other individuals of species characteristic of the type. These vegetation types are said to undergo fluctuations, and some of them may be referred to as "climax" vegetation types.

The more stable a vegetation type, or the longer its life expectancy, the more likely it will be that efforts to preserve it will assure that the type will be a component of the natural landscape in perpetuity. The less stable the vegetation type, the less likely it will be that efforts to preserve it will result in long-term maintenance of the type without intrusive management.

No long-term investigation of the stability of coastal wetland vegetation types of the Middle Atlantic States has been conducted. Except for forested wetlands, no method has been developed to determine the approximate age of the perennial plants which are predominant in many wetlands. Research on this aspect of wetlands is needed, and the information that it will develop will be useful in wetlands planning, regulation and evaluation.

Resistivity

The ability of a vegetation type to accept and encapsule a limited disturbance can be termed its resistivity. The original boundaries of a small clearing in one type of swamp forest, for example, might remain unchanged indefinitely, whereas in another type the boundaries would expand outwardly as a result of windfalls, disease, sunscorch, and other mechanisms. Similarly, intensive feeding by waterfowl, mammals, or other animals in some types may result in eat-outs that develop into barren flats, pans, or ponds. This is a phenomenon which the Blackwater River wetlands of Dorchester County are experiencing. In other types, feeding damage may be repaired rapidly by rhizome proliferation, sprouting, or seedling development.

Characteristics of the site also might be included in the consideration of resistivity. Most wetland types, for example, will be affected adversely by slight but prolonged changes in water level or salinity. A project that directly impacts only a few acres, thus, might have extensive secondary effects if it were to block the flow of the tides, impound surface water, or otherwise change water levels.

Information on resistivity has not been collected systematically, and it has not been organized. Although it may be useful for the evaluation of wetlands, such information probably will be more appropriate for direct application to planning and management.

Environmental Protection

No comprehensive, systematic studies have been conducted, but it virtually is certain that wetland vegetation types differ in their relative abilities to reduce soil erosion, absorb pollutants from the water, absorb and adsorb pollutants from the air, induce sedimentation, and to perform other environmentally protective functions. Although information about these functions could be of great relevance in the evaluation of wetlands, our knowledge presently is inadequate to discriminate between the functions of various types of vegetation.

Flood storage capacity, or water storage potential (Neafsey 1974), is a function of all coastal wetlands as a result of their locations adjacent to tidal waters and their relatively low elevations. This capacity, however, varies inversely with distance from the body of tidal water and with the elevation of the substrate above the mean high water level. It is not related directly to the type of wetland vegetation present.

All wetlands also have the ability to absorb nutrients and other constituents from the water and, thus, to perform a water purification function. This aspect of wetlands currently is receiving considerable research attention, especially in relation to the potential for the use of natural or artificially-established wetlands as sewage treatment facilities. These studies generally indicate that vascular plants are of relatively little importance in pollution abatement. They have a limited capacity to absorb nutrients, reach an equilibrium stage during the seasonal growth cycle, and lose nutrients rapidly by leaching when their aerial parts die back during the autumn. Silt/clay size particles, organic components, and microorganisms in the soil of a wetland are the major agents in pollution abatement. In areas in which the soil freezes, however, the microorganisms also are subject to winter killing, and return nutrients to the water in large "pulses." Abatement functions, thus, are substantially curtailed throughout the winter. The ability of other components of the aquatic system, particularly algae and submerged aquatic plants, to absorb nutrients and to grow rapidly also may be limited in areas in which the water freezes during the winter. Thus, nutrient loads that are contributed by human activities may move to the bays and ocean with only minor effects on the upstream sections of the estuarine system.

Sediment Trapping Capability

Few quantitative data are available to describe or predict the ability of different vegetation types or different wetlands to trap and retain sediments. Ranwell (1972) developed a regression equation to describe sediment entrapment by English grass marshes:

Accretion = 0.643 (mean height of site above O.D.,[1] in meters)+
0.0462 (mean height of vegetation, in centimeters)+
0.00135 (average dry weight of vegetation in grams per meter square)-1.143

The three additive factors in this equation are based on units of measurement which bear a numerical relationship of 1 (meters):100 (centimeters):1000 (grams of dry matter per square meter, generally). When these relative values are multiplied by the appropriate coefficients, the ratio between elevation, standing crop, and vegetation height is approximately 1:2:7. This suggests that sediment trapping capability largely is a function of the height of the vegetation (70%) and the bulk of vegetation present (20%). Big cordgrass, common reed, cattail, and wildrice, among the grass types present in Maryland, which are tall (Table 6), would be considered to be of greatest value according to Ranwell's equation.

[1]Ordinance datum, O.D., is approximately equivalent to mean sea level.

OTHER POTENTIAL GEOGRAPHIC SCALARS

Wetland Interface Variable

The boundary of the wetland complex, as delineated on the map or aerial photograph, can be measured to provide information for several geographic scalars. The simplest of these is the "Shoreline Development Factor," or "Wetland Interface Variable." It is calculated by dividing the length of the wetland boundary by the length of the perimeter of a circle with an area equal to that of the subject wetland (Shuster 1966). The resulting value, which always is 1.0 or greater, is a dimensionless number that serves as a relative measure of the amount of edge.

Specifications: The following subspecifications are preliminary, and should be revised on the basis of actual measurements of wetland boundaries. The values of the preliminary ratio calculations are presented as column headings and associated values are listed beneath the headings.

1.0-1.25	1.26-1.50	1.51-1.75	1.76-
25	50	75	100

Interpretation: Accessibility to a wetland, both from adjacent uplands and from the water, enhances its values in many ways. Terrestrial wildlife has a greater opportunity to venture into the wetland, and various edge-nesting species are benefited as upland edges increase in length. As the interface with the water increases, it is likely that tidal flushing is more widespread, and that aquatic organisms will have more effective access to the wetland (Odum and Skjei 1974; Gucinski 1978). The two subsequent variables embellish this information, and require more definitive measurements.

Water and Upland Interface Variable

A more detailed analysis of the wetland edge requires the measurement of those segments which are adjoined by water and those adjoined by terrestrial habitats. If the area that is being evaluated is a real estate tract, and if the wetlands on the tract are adjacent to other wetlands, the adjoining wetlands should be considered to be water for this characterization. The data are presented as percentages of the total perimeter.

Specifications: Two sets of values are presented in the tabulation of specifications. The column headings represent the percentage of the interface that abuts on water. The first line in the table contains values to be used in association with terrestrial resource evaluations. The values in the second line are intended for use in evaluations of aquatic resources.

0-20%	21-40%	41-60%	61-80%	81-100%
100	80	60	40	20
20	40	60	80	100

Interpretation: The terrestrial and aquatic values are reversed, and reflect decreasing accessibility from the upland and increasing accessibility from the water, from left to right in the table.

Adjacent Use Variable

Still more detail can be extracted from wetland edge measurements if the information available from the map or aerial photographs permits. In this step, the wetland perimeter is measured in segments which are characterized by different adjoining features or uses. Such features as open water (OW), wetland (WL), forest (F), and scrub (S), and such uses as cultivated land (CL), pasture (P), residential (R), commercial (Co), industrial (In), and transportation (Tr), should be recognized. The data are presented as percentages of the total perimeter.

Specifications: Values for this variable are related to specific features and uses in the following table. Abbreviations in the headings are defined in the previous paragraph. The first column of values is for application to terrestrial evaluations; and the second column contains values for use in aquatic evaluations.

			Terrestrial	Aquatic
Water (OW) 0-20%				
I	II	III[a]		
≥75	≤10	0	100	20
50-74	9-20	0-20	75	20
25-49	21-50	21-50	50	15
0-24	≥51	≥51	25	10
Water (OW) 21-40%				
I	II	III[a]		
50-74	≤10	0	80	40
25-49	≤20	≤20	80	40
0-24	≥20	≥20	60	20
Water (OW) 41-60%				
I	II	III[a]		
25-49	≤10	≤10	60	60
0-24	≤60	≤60	20	40
Water (OW) 61-80%				
I	II	III[a]		
25-39	≤10	≤10	40	80
0-24	≤39	≤39	20	60
Water (OW) 81-100%				
I	II	III[a]		
10-19	≤9	≤9	20	100
0-10	≤19	≤19	10	80

[a]Group I: Wetland, forest, scrub, pasture
Group II: Cultivated land, residential land
Group III: Commercial, industrial, transportation uses

Interpretation: The basic concept, in regard to the interface with water and the interface with land, is the same as that expressed in the explanation for the water and upland interface factor. This section includes, in addition, the characterization of the natural features and the human uses on the upland areas. As the intensity of utilization increases, the value to terrestrial natural resources becomes less. There also is a reduction in the value to aquatic resources, but this value is not so sensitive as that for terrestrial resources.

Isolation Variable

A linear measurement, in feet or meters, is made of the distance from the midpoint of the wetland to the nearest area of upland. The value is half of the average of several measurements of the distance from the upland to water, or from the upland on one side of the wetland to the upland on the opposite of a "pocket" wetland, at equally spaced points along the upland boundary.

Specifications: Values are assigned to the linear measurements from the following table. The column headings are distances in feet.

<500	501-1000	1001-1500	1501-2000	>2000
20	40	60	80	100

Interpretation: The isolation variable is a relative indication of one dimension of the size of a wetland. Originally, it was intended principally as an index to the degree of disturbance to which animals in the wetland may be exposed, particularly from upland uses. It also is of value in regard to aesthetics, because it provides a concept of the breadth of the view across the wetlands from the adjoining uplands and from the water. It also may have some value as a gross index to tidal flushing. The greater the value of the isolation variable, the greater is the probability that a large proportion of the wetland area is not subject to regular, diurnal flows.

Wetland Location Factor

Stream orders usually are assigned from the headwaters to the mouth of a river. To evaluate tidal wetland locations, a system of reverse ordering is employed.

Specifications: Complexes that front on the ocean or on a bay that is connected directly to the ocean are designed as first order wetlands (value = 5). Second order wetlands are located on the main stems of streams that discharge into the bays or directly into the ocean (value = 4). Wetlands on the main stems of tributaries that discharge to streams which support second order wetlands are of the third order (value = 3), and so on. No value is to be less than 1. The final value is used as a weighting factor.

Wetland Longevity Factor

Wetlands that are exposed to strong wave action and/or to wakes from boats or ships may be subject to accelerated erosion, and may be receding rapidly. Other wetlands are subject to accelerated sedimentation from upland or upstream sources, and the accretion of sediments may be sufficient to eliminate the wetland characteristics of the site. Still other areas may be at or near equilibrium, and may show no evidence of imminent loss by erosion or by sedimentation.

No special consideration need be given to wetlands that are in apparent equilibrium. Wetlands that are eroding at a rate that is readily measured generally cannot be preserved without special structural protection, and their values should be reduced in proportion to their probably restricted longevity. Wetlands that are subject to accelerated sedimentation from upland sources may be susceptible to preservation if the source can be abated. Upstream sources generally are more diffuse, and much of the sediment may originate from bank erosion. Wetlands that are receiving sediments from these upstream sources generally are a benefit to water quality. As long as a wetland of this type has a capacity to accept and retain sediments, the value assigned to it should not be reduced.

Preliminary Specifications: No quantitative analysis of the rate of erosion of a wetland area has been found, so there is no objective basis for specification for this factor. Generally, however, erosion appears to be a function of wave energy, and it is correlated with fetch length in relation to wind vectors. There also may be a relation to ship and boat traffic owing to erosion by wakes.

The specifications for this parameter should be formulated from measurements of fetch length, or the distance across open water that adjoins the wetland. Fetch lengths should be measured along transects that represent the major compass points (N, NNE, NE, ENE, E, and so on) so that they can be correlated with data on frequencies of wind directions and wind velocities (Personal communication, 1977, Dr. Robert Reimold, University of Georgia). The component for water traffic should be based on wake energy related to the size and speed of the ship or boat, the distance of the navigation channel from the wetland, and an index of traffic for the area.

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8. GLOSSARY OF SELECTED TERMS USED IN THE TEXT

Biomass. The total amount of organic material present during a specific instant in a community or in a particular population or other component of the community. Also termed "standing crop" (q. v.).

Community. The plants, animals and/or microorganisms that occur together in a particular place, and which interact with one another in various ways.

Consumer. An organism that feeds on living or dead organic matter and, thus, obtains energy and nutrients by digesting complex organic matter rather than by synthesizing such matter from inorganic substances. Consumers are said to be heterotrophic (other-feeding), whereas green plants and certain other organisms that synthesize organic matter from inorganic substances are said to be autotrophic (self-feeding).

Decomposer. A plant or animal that feeds on dead organic matter and causes its mechanical disintegration or chemical decomposition. Decomposers include saprophytes and scavengers, and may be microscopic (bacteria, many fungi) or large (vulture).

Detritivore. An animal that utilizes particulate organic matter for at least a part of its food supply. Suspension feeders filter organic particles from the water column. Deposit feeders utilize particulate organic matter that collects on bottom in a body of water. Some detritivores are listed in Table 25.

Detritus. Loose material produced by disintegration. Most organic detritus is produced by the disintegration and decay of plant tissues, principally of leaves and stems.

Food chain. A linear series of plants and animals that are interrelated by the feeding habits of the animals. A green plant, a leaf-eating insect, and an insect-eating bird would form the links in a simple food chain.

Food web. A complex network formed by the numerous interlocking food chains characteristic of any community. Because any particular organism usually represents a link in two to many food chains, when all possible food chains are represented in a single diagram, the chains cross and interlink in the form of a matrix or web.

Forb. A broadleaf herbaceous plant.

Grass. Any plant of the Family Gramineae. Characteristically, grasses have long, narrow leaves which grow from hollow, herbaceous stems (most bamboos have woody stems). Perennial grasses develop from rhizomes, or underground stems. The aerial stems, or culms, are able to elongate from the base and, thus, can persist when grazed by animals or mowed. Grasses economically are the most valuable family of plants because they are the sources of most sugar, forage, and other useful products. They also are used widely in landscaping and erosion control.

Herb. Any seed-producing annual, biennial, or perennial forb, grass, or grasslike plant that has a soft, rather than woody, stem and dies back at least to the soil surface during the winter.

Herbivore. An animal whose diet consists wholly or largely of plant material.

Population. All of the individuals of a particular taxon which inhabit a particular area or which are related structurally, genetically, or spatially in some way that is defined by the author.

Producer. An individual, population, or community of organisms, usually of green plants, that synthesizes organic matter from inorganic raw materials and, in the process, transforms free energy into a fixed condition in chemical bonds.

Productivity, gross primary. The rate at which energy is fixed by a particular population or community of producers.

Productivity, net primary. The rate of increase in the energy that is contained in a particular population or community of producers after the amount of energy that is lost by respiraton is deducted from the gross productivity.

Saprophyte. A plant which obtains energy, nutrients or other raw materials from dead plant or animal bodies.

Scavenger. An animal that feeds on the wastes or dead bodies of other animals or on refuse.

Shrub. A woody plant that usually has two or more stems which arise from the root, and which generally does not exceed 12 feet in height at maturity.

Standing crop. See Biomass. Standing crop may be limited by specific definition to the amount of a particular constituent, such as carbon.

Taxon (plural=taxa). A term that is used to describe any classificatory unit or level. It generally is employed to distinguish two or more individuals or populations that differ from one another in a way that is known or unknown, or to allow for future distinctions. For example, one may refer to "ten taxa" in a case in which seven individuals are of different genera and three individuals represent one genus, but are of different species.

Tree. A woody plant with a single main stem (trunk), a more or less distinct crown of leaves, and which is 12 or more feet tall.

Vascular plants. Plants that have a specialized system through which fluids are conducted; this group includes horsetails, clubmosses, ferns, conifers, and flowering plants.

APPENDIX 1.
COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS THAT ARE MENTIONED IN THE TEXT AND TABLES

Table 77. Common and scientific names of submerged aquatic plants that are known to grow in the coastal waters of Maryland (Stewart 1962; Thompson 1974; Bayley and others 1978).

Common Names	Scientific Names
Green algae	Phylum Chlorophyta
Enteromorpha	*Enteromorpha* spp.
Sealettuce	*Ulva lactuca*
Spirogyra	*Spirogyra* spp.
Nitella	*Nitella* spp.
Muskgrasses	*Chara* spp.
Brown algae	Phylum Phaeophyta
Red algae	Phylum Rhodophyta
Mosses	
Water moss	*Leptodictyum riparium*
Flowering Plants	
Coontail	*Ceratophyllum demersum*
Eelgrass	*Zostera marina*
Naiads	*Najas* spp.
Naiad, northern	*Najas flexilis*
Naiad, small	*Najas minor*
Naiad, southern	*Najas guadalupensis*
Pondweeds	*Potamogeton* spp.
Pondweed, curlyleaf	*Potamogeton crispus*
Pondweed, flatstem	*Potamogeton zosteriformis*
Pondweed, floating	*Potamogeton nodosus*
Pondweed, grassleaf	*Potamogeton pusillus*
Pondweed, horned	*Zannichellia palustris*
Pondweed, largeleaf	*Potamogeton amplifolius*
Pondweed, leafy	*Potamogeton foliosus*
Pondweed, redhead	*Potamogeton perfoliatus bupleuroides*
Pondweed, ribbonleaf	*Potamogeton epihydrus nuttallii*
Pondweed, Richardson	*Potamogeton richardsonii*
Pondweed, Robbins	*Potamogeton robbinsii*
Pondweed, sago	*Potamogeton pectinatus*
Pondweed, spotted	*Potamogeton pulcher*
Pondweed, variableleaf	*Potamogeton gramineus*
Watermilfoil, Eurasian	*Myriophyllum spicatum*
Watermilfoil, pinnate	*Myriophyllum pinnatum*
Watermilfoil, slender	*Myriophyllum tenellum*
Waternymph	*Najas gracillima*
Waterstargrass	*Heteranthera dubia*
Waterstarwort	*Callitriche heterophylla*
Waterweed, common	*Elodea canadensis*
Waterweed, giant	*Elodea densa*
Waterweed, Nuttall	*Elodea nuttallii*
Wigeongrass	*Ruppia maritima*
Wildcelery	*Vallisneria americana*

Table 78. Common and scientific names of trees, shrubs, and woody vines that are cited in the text and tables. Scientific nomenclature is that of Fernald (1950).

Alders	*Alnus* spp.
Alder, seaside	*Alnus maritima*
Alder, smooth	*Alnus serrulata*
Arrowwood, southern	*Viburnum dentatum*
Ashes	*Fraxinus* spp.
Ash, green	*Fraxinus pensylvanica subintegerrima*
Ash, red	*Fraxinus pensylvanica*
Azalea, clammy	*Rhododendron viscosum*
Azalea, pink	*Rhododendron nudiflorum*
Baldcypress	*Taxodium distichum*
Bayberry	*Myrica pensylvanica*
Beech	*Fagus grandifolia*
Birch, river	*Betula nigra*
Blackberries	*Rubus* spp.
Black cherry	*Prunus serotina*
Blackgum	*Nyssa sylvatica*
Blackgum, swamp	*Nyssa sylvatica biflora*
Blackhaw	*Viburnum prunifolium*
Bluebeech	*Carpinus caroliniana*
Blueberry, highbush	*Vaccinium corymbosum*
Bullbrier	*Smilax rotundifolia*
Buttonbush	*Cephalanthus occidentalis*
Chokeberry, red	*Pyrus arbutifolia*
Cottonwood, swamp	*Populus heterophylla*
Crossvine	*Bignonia capreolata*
Dogwoods	*Cornus* spp.
Dogwood, silky	*Cornus amomum*
Elms	*Ulmus* spp.
Fringetree	*Chionanthus virginicus*
Grapes	*Vitis* spp.
Greenbriers	*Smilax* spp.
Greenbrier, laurelleaf	*Smilax laurifolia*
Greenbrier, redberry	*Smilax walteri*
Groundselbush	*Baccharis halimifolia*
Holly, American	*Ilex opaca*
Honeysuckle, Japanese	*Lonicera japonica*
Leuchothoe, swamp	*Leucothoe racemosa*
Maleberry	*Lyonia ligustrina*
Maples	*Acer* spp.
Maple, red	*Acer rubrum*
Marshelder	*Iva frutescens*
Mistletoe	*Phoradendron flavescens*
Muscadine	*Vitis rotundifolia*
Myrtles	*Myrica* spp.
Nightshade, bittersweet	*Solanum dulcamara*
Oaks	*Quercus* spp.
Oak, pin	*Quercus palustris*
Oak, white	*Quercus alba*
Oak, willow	*Quercus phellos*
Oxeye, sea	*Borrichia frutescens*
Pawpaw	*Asimina triloba*
Persimmon	*Diospyros virginiana*
Pine, loblolly	*Pinus taeda*
Pine, pond	*Pinus serotina*
Poison ivy	*Rhus radicans*
Possumhaw	*Ilex decidua*
Red cedar	*Juniperus virginiana*
Rose, multiflora	*Rosa multiflora*
Rose, swamp	*Rosa palustris*
Spicebush	*Lindera benzoin*
Sumac, shining	*Rhus copallina*
Sweetbay	*Magnolia virginiana*
Sweetgum	*Liquidambar styraciflua*
Strawberrybush	*Euonymus americanus*
Sweet pepperbush	*Clethra alnifolia*

Table 78. Common and scientific names of trees, shrubs, and woody vines cited in the text and tables (Concluded).

Sycamore	*Platanus occidentalis*
Trumpetvine	*Campsis radicans*
Tuliptree	*Liriodendron tulipifera*
Virginiacreeper	*Parthenocissus quinquefolia*
Waxmyrtle	*Myrica cerifera*
White cedar, southern	*Chamaecyparis thyoides*
Willows	*Salix* spp.
Willow, black	*Salix nigra*
Willow, Virginia	*Itea virginica*
Winterberry	*Ilex verticillata*
Witherod	*Viburnum cassinoides*
Witherod, smooth	*Viburnum nudum*

Table 79. Common and scientific names of the broadleaf herbaceous plants that are cited in the text and tables. Scientific nomenclature is that of Fernald (1950).

Shrubform Herbs	
Loosestrife, spiked	*Lythrum salicaria*
Mallow, seashore	*Kosteletzkya virginica*
Rosemallow, pink	*Hibiscus palustris*
Rosemallow, white	*Hibiscus moscheutos*
Waterwillow	*Decodon verticillatus*
Forbs (Other broadleaf herbs)	
Arrowarum	*Peltandra virginica*
Arrowgrass, maritime	*Triglochin maritima*
Arrowheads	*Sagittaria* spp.
Asters	*Aster* spp.
Aster, annual marsh	*Aster subulatus*
Aster, perennial marsh	*Aster tenuifolius*
Aster, smooth heath	*Aster pilosus demotus*
Aster, southern annual marsh	*Aster subulatus euroauster*
Bedstraw, stiff marsh	*Galium tinctorium*
Beggarlice	*Desmodium* spp.
Beggarticks	*Bidens* spp.
Beggarticks, black	*Bidens frondosa*
Beggarticks, leafybract	*Bidens comosa*
Beggarticks, swamp	*Bidens connata*
Bindweed	*Convolvulus* spp.
Bindweed, field	*Convolvulus arvensis*
Bindweed, hedge	*Convolvulus sepium*
Bishopweed, mock	*Ptilimnium capillaceum*
Bluecurls	*Trichostema dichotomum*
Boghemp	*Boehmeria cylindrica*
Bugleweeds	*Lycopus* spp.
Bugleweed, European	*Lycopus europaeus*
Bugleweed, reddot	*Lycopus rubellus*
Burmarigolds	*Bidens* spp.
Burmarigold, rayless	*Bidens discoidea*
Burmarigold, smooth	*Bidens laevis*
Burreeds	*Sparganium* spp.
Burreed, branching	*Sparganium americanum*
Burreed, great	*Sparganium eurycarpum*
Camphorweed	*Pluchea camphorata*
Cardinal flower	*Lobelia cardinalis*
Clearweed	*Pilea pumila*
Coastblite	*Chenopodium rubrum*
Cocklebur, beach	*Xanthium echinatum*
Coneflower	*Rudbeckia laciniata*
Corncockle, tall	*Agrostemma githago*
Cowbane	*Oxypolis rigidor ambigua*
Crowfoot, seaside	*Ranunculus cymbalaria*
Dock, swamp	*Rumex verticillatus*
Dodders	*Cuscuta* spp.

Table 79. Common and scientific names of the broadleaf herbaceous plants that are cited in the text (Continued).

Dodder, swamp	*Cuscuta compacta*
Duckpotato	*Sagittaria latifolia*
Duckweeds	*Lemna* spp.
Duckweed, small	*Lemna minor*
Fern, cinnamon	*Osmunda cinnamomea*
Fern, marsh	*Dryopteris thelypteris*
Fern, netted chain	*Woodwardia aerolata*
Fern, resurrection	*Polypodium polypodioides*
Fern, royal	*Osmunda regalis spectabilis*
Fern, sensitive	*Onoclea sensibilis*
Fleabane, marsh	*Pluchea purpurascens succulenta*
Fleabane, stinking	*Pluchea foetida*
Gentian, Catesby	*Gentiana catesbei*
Gerardia, purple	*Gerardia purpurea*
Gerardia, seaside	*Gerardia maritima*
Germander, American	*Teucrium canadense*
Glassworts	*Salicornia* spp.
Glasswort, dwarf	*Salicornia bigelovii*
Glasswort, perennial	*Salicornia virginica*
Glasswort, slender	*Salicornia europaea*
Goldenclub	*Orontium aquaticum*
Goldenrods	*Solidago* spp.
Goldenrod, seaside	*Solidago sempervirens*
Groundnut	*Apios americana cleistogama*
Hempweed, climbing	*Mikania scadens*
Joe-Pye-weed	*Eupatorium fistulosum*
Knotweed, bushy	*Polygonum ramosissimum*
Knotweed, seabeach	*Polygonum glaucum*
Knotweed, shore	*Polygonum prolificum*
Ladysthumb	*Polygonum persicaria*
Lilaeopsis	*Lilaeopsis chinensis*
Lizardtail	*Saururus cernuus*
Loosestrifes	*Lysimachia* spp.
Loosestrife, narrowleaf	*Lythrum lineare*
Marshpink	*Sabatia stellaris*
Marshpink, white	*Sabatia stellaris albiflora*
Meadowbeauty	*Rhexia virginica*
Mermaidweed	*Prosperpinaca palustris*
Milkweed, swamp	*Asclepias incarnata pulchra*
Milkwort, sea	*Glaux maritima*
Milkwort, whorled	*Polygala verticillata*
Morningglory, red	*Ipomoea coccinea*
Muskratweed	*Thalictrum polygamum*
Nettles	*Urtica* spp.
Nightshade, bittersweet	*Solanum dulcamara*
Orach, seabeach	*Atriplex arenaria*
Orach, spreading	*Atriplex patula*
Orach, hastate	*Atriplex patula hastata*
Pennywort, water	*Hydrocotyle umbellata*
Pickerelweed	*Pontederia cordata*
Pigweed, seabeach	*Amaranthus pumilis*
Pimpernel, false	*Lindernia dubia*
Pinkweed	*Polygonum pensylvanicum*
Plantain, marsh	*Plantago major scopulorum*
Plantain, seaside	*Plantago juncoides decipiens*
Primrosewillow, creeping	*Jussiaea repens glabrescens*
Ragweed, giant	*Ambrosia trifida*
Saltwort	*Salsola kali*
Saltwort, smooth	*Salsola kali caroliniana*
Sandspurrey, common	*Spergularia canadensis*
Sandspurrey, marsh	*Spergularia marina*
Sandwort, seabeach	*Arenaria peploides*
Seablite, hairy	*Bassia hirsuta*
Seablite, matted	*Suaeda americana*
Seablite, tall	*Suaeda linearis*
Sealavenders	*Limonium* spp.
Sealavender, Carolina	*Limonium carolinianum*

Table 79. Common and scientific names of the broadleaf herbaceous plants that are cited in the text (Concluded).

Sealavender, Nash	*Limonium nashii trichogonum*
Seapurslane	*Sesuvium maritimum*
Searocket	*Cakile edentula*
Seedbox	*Ludwigia alternifolia*
Smartweeds	*Polygonum* spp.
Smartweed, common	*Polygonum hydropiper*
Smartweed, dotted	*Polygonum punctatum*
Smartweed, pale	*Polygonum lapathifolium*
Smartweed, southern	*Polygonum densiflorum*
Smartweed, swamp	*Polygonum coccineum*
Spanishneedles	*Bidens bipinnata*
Spatterdock	*Nuphar advena*
Stickseed, Virginia	*Hackelia virginiana*
Sunflower, tickseed	*Bidens coronata*
Tearthumbs	*Polygonum* spp.
Tearthumb, arrowleaf	*Polygonum sagittatum*
Tearthumb, halberdleaf	*Polygonum arifolium*
Touch-me-nots	*Impatiens* spp.
Touch-me-not, spotted	*Impatiens capensis*
Turtlehead	*Chelone glabra*
Waterchestnut	*Trapa natans*
Waterhemlock	*Cicuta maculata*
Waterhorehound, cutleaf	*Lycopus americanus*
Waterhemp	*Acnida cannabina*
Waterlilly, white	*Nymphaea odorata*
Waterparsnip	*Sium suave*
Waterpepper, mild	*Polygonum hydropiperoides*
Waterplantain	*Alisma subcordatum*
Waterpurslane	*Ludwigia palustris*
Wildbean, marsh	*Strophostyles umbellata paludigena*
Yam, whorled	*Dioscorea quaternata*
Yerba-de-toga	*Eclipta alba*

Table 80. Common and scientific names of grasses and grasslike plants that are cited in the text and tables. Scientific nomenclature is that of Fernald (1950).

Autumnsedge	*Fimbristylis autumnalis*
Alkaligrass, spreading	*Puccinellia fasciculata*
Bermuda grass	*Cynodon dactylon*
Blackrush	*Juncus gerardi*
Blueflag	*Iris versicolor*
Bristlegrass, giant	*Setaria magna*
Bristlegrass, knotroot	*Setaria geniculata*
Broomsedge, bushy	*Andropogon virginicus abbreviatus*
Bulrushes	*Scirpus* spp.
Bulrush, river	*Scirpus fluviatilis*
Bulrush, softstem	*Scirpus validus creber*
Bulrush, stout	*Scirpus robustus*
Canarygrass, reed	*Phalaris arundinacea*
Cattails	*Typha* spp.
Cattail, blue	*Typha glauca*
Cattail, common	*Typha latifolia*
Cattail, narrowleaf	*Typha angustifolia*
Cattail, southern	*Typha domingensis*
Chesnutsedge	*Fimbristylis castanea*
Cordgrasses	*Spartina* spp.
Cordgrass, big	*Spartina cynosuroides*
Cordgrass, meadow	*Spartina patens*
Cordgrass, smooth	*Spartina alterniflora*
Corn (cultivated)	*Zea mays*
Crabgrasses	*Digitaria* spp.
Cutgrass, rice	*Leersia oryzoides*
Foxtails	*Setaria* spp.
Gamagrass	*Tripsacum dactyloides*

Table 80. Common and scientific names of grasses and grasslike plants cited in the text and tables (Concluded).

Hornrush	*Rhynchospora corniculata*
Iris, yellow	*Iris pseudacorus*
Knucklegrass	*Panicum dichotomiflorum*
Lovegrass, creeping	*Eragrostis hypnoides*
Lovegrass, purple	*Eragrostis spectabilis*
Mannagrass, peat	*Glyceria obtusa*
Meadowgrass, tufted	*Diplachne fascicularis*
Millet, German	*Setaria italica*
Millet, tropical	*Echinochloa crus-pavonis*
Millet, Walter	*Echinochloa walteri*
Millet, water	*Zizaniopsis miliacea*
Needlerush	*Juncus roemerianus*
Panicgrasses	*Panicum* spp.
Paspalums	*Paspalum* spp.
Plumegrass, narrow	*Erianthus strictus*
Reed, common	*Phragmites communis*
Reedgrass	*Cinna arundinacea*
Rushes	*Juncus* spp.
Rush, bristly	*Juncus biflorus*
Rush, flatleaf	*Juncus platyphyllus*
Rush, sharpfruit	*Juncus acuminatus*
Rush, Torrey	*Juncus torreyi*
Rush, twopart	*Juncus dichotomus*
Sedges	*Carex* spp.
Sedge, bladder	*Carex intumescens*
Sedge, broadwing	*Carex alata*
Sedge, fringed	*Carex crinita*
Sedge, hair	*Bulbostylis capillaris*
Sedge, hop	*Carex lupulina*
Sedge, long	*Carex folliculata*
Sedge, sallow	*Carex lurida*
Sedge, softstem	*Carex seorsa*
Sedge, spreading	*Carex squarrosa*
Sedge, stalked	*Carex debilis*
Sedge, stretched	*Carex extensa*
Softrush	*Juncus effusus*
Sorghum (cultivated)	*Sorghum vulgare*
Spikegrass	*Distichlis spicata*
Spikerushes	*Eleocharis* spp.
Spikerush, beaked	*Eleocharis rostellata*
Spikerush, creeping	*Eleocharis palustris*
Spikerush, dwarf	*Eleocharis parvula*
Sweetflag	*Acorus calamus*
Switchgrass	*Panicum virgatum*
Threesquares	*Scirpus* spp.
Threesquare, common	*Scirpus americanus*
Threesquare, Olney	*Scirpus olneyi*
Twigrush	*Cladium mariscoides*
Umbrellasedges	*Cyperus* spp.
Umbrellasedge, beach	*Cyperus filiculmis*
Umbrellasedge, fragrant	*Cyperus odoratus*
Umbrellasedge, strawcolor	*Cyperus strigosus*
Wheat (cultivated)	*Triticum aestivum*
Whitegrass	*Leersia virginica*
Wildrice	*Zizania aquatica*
Woolgrass	*Scirpus cyperinus*

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland. Most of these animals occur in the coastal wetlands of Maryland and adjacent waters. Nomenclature for invertebrates is that of Gosner (1971).

Phylum Porifera	Sponges
Microciona prolifera	Red sponge
Phylum Cnidaria	Hydroids, anemones, medusae
	Hydromedusa
Chrysaora quinquecirrha	Jellyfish
Phylum Ctenophora	Comb-jellies
Mnemiopsis leidyi	Pear comb-jelly
Phylum Mollusca	Mollusks
Class Gastropoda	Snails and slugs
Acetocina canaliculata	
Ambloxis decisum	
Amnicola spp.	
Amnicola limosa	
Anachis avara	
Bittium spp.	
Bittium varium	
Cerithiopsis subulata	
Clathurella jewetti	
Gillia altilis	
Gyraulus spp.	[Orb snails]
Ilyanassa obsoleta	
Littoridinops spp.	
Littorina irrorata	Marsh periwinkle
Lora spp.	
Melampus bidentatus	Saltmarsh snail
Mitrella lunata	
Nassarius spp.	Dog whelks
Nassarius obsoletus	Common mud snail
Nassarius trivittatus	New England dog whelk
Odostomia impressa	
Oxytrema virginica	
Physa spp.	[Pouch snails]
Planorbis spp.	
Pleurotoma spp.	
Pyramidella spp.	
Retrusa canaliculata	
Rissoidae	
Sayella chesapeakea	
Triphora perversa	
Turbonilla spp.	
Valvata tricarinata	
Class Bivalvia	Bivalve mollusks
Anodonta spp.	
Brachidontes recurvus	Bent mussel
Congeria leucopheata	Platform mussel
Crassostrea virginica	Eastern oyster
Cyrenoida floridana	
Elliptio complanatum	Freshwater mussel
Gemma gemma	Gem shell
Laevicardium mortoni	Morton's cockle
Macoma balthica	Baltic macoma
Macoma phenax	
Mercenaria mercenaria	Quahog
Modiolus demissus	Atlantic ribbed mussel
Mulinia lateralis	Coot clam
Mya arenaria	Common soft-shelled clam
Mytilidae	
Pisidium atlanticum	
Sphaerium spp.	
Spisula spp.	
Tagelus divisus	Small razor clam
Tagelus plebeius	Stout razor clam
Unionidae	
Veneridae	
Phylum Annelida	Segmented worms
Nereis spp.	Clam worms
Phylum Arthropoda	Arthropods
Class Merostoma	Horseshoe crabs
Limulus polyphemus	Horseshoe crabs
Class Arachnida	Mites, spiders, pseudoscorpions

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland (Continued).

	Unidentified spiders
Hydrachnellae	Water mites
Class Insecta	Insects
Ephemeroptera	Mayfly larvae
Libelluloidea	Dragonfly nymphs
Gryllotalpa spp.	Mole crickets
Corixidae	Water boatmen
Belostomatidae	Giant water bugs
Sialidae	Alderfly larvae
Coleoptera	Beetles, unidentified
Dytiscidae	Predacous diving beetles
Hydrophilidae	Water scavenger beetles
Curculionidae	Weevils
Trichoptera	Caddisfly larvae
Diptera	Fly larvae
Culicidae	Mosquito larvae
Chironomidae	Midge larvae
Formicidae	Ants
Class Crustacea	Crustaceans
Subclass Branchiopoda	
Order Cladocera	
Daphnia spp.	Water fleas
Unidentified species	Cladocerans
Subclass Ostracoda	
Unidentified species	Ostracods
Subclass Copepoda	
Unidentified species	Copepods
Subclass Cirripedia	
Balanus spp.	Acorn barnacles
Unidentified species	Barnacles
Subclass Malacostraca	
Series Eumalacostraca	
Superorder Peracardia	
Order Tanaidacea	Tanaids
Leptochelia savignyi	
Order Isopoda	Isopods
Suborder Anthuridea	
Cyathura spp.	
Suborder Valvifera	
Chiridotea coeca	
Erichsonella spp.	
Erichsonella attentuata	
Erichsonella filiformis	
Suborder Onoscoidea	
Philoscia vittata	
Order Amphipoda	Amphipods
Suborder Gammaridea	
Family Ampithoidea	Ampithoids
Family Corophiidae	
Corophium spp.	
Family Gammaridea	Gammarids
Crangonyx ssp.	
Gammarus tigrinus	
Family Talitridae	
Orchestia grillus	Sand flea
Orchestia platensis	Beach flea
Superorder Eucarida	
Order Decapoda	Decapods
Infraorder Caridea	Caridean shrimp
Crangon septemspinosa	Sand shrimp
Palaemonetes vulgaris	Common prawn
Infraorder Brachyura	True crabs
Callinectes sapidus	Blue crab
Neopanope texana sayi	
Ovalipes ocellatus	Lady crab
Panopeus herbstii	Mud crab
Sesarma spp.	
Sesarma reticulatum	Marsh crab
Uca minax	Red-jointed fiddler crab
Uca pugilator	Sand fiddler crab

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland (Continued).

Scientific name	Common name
Uca pugnax	Marsh fiddler crab
Family Xanthidae	Mud crabs
Phylum Chordata	Chordates
Subphylum Urochordata	Tunicates
Molgula spp.	
Molgula manhattensis	Sea grapes
Subphylum Vertebrata	Vertebrates
Superclass Pisces	Fish
Class Chondrichthyes	
Subclass Eleasmobranchii	
Family Rajiidae	
Rhinopterus bonasus	Cownose ray
Class Osteichtyes	
Family Clupeidae	
Alosa mediocris	Hickory shad
Alosa sapidissima	American shad
Clupea harrengus	Herring
Family Esocidae	
Esox niger	Chain pickerel
Family Cyprinidae	
Undetermined species	
Family Ictaluridae	
Ictalurus nebulosus	Brown bullhead
Family Anguillidae	
Anguilla rostrata	American eel
Family Cyprinodontidae	
Cyprinodon variegatus	Broad killifish
Fundulus spp.	Killifish
Fundulus heteroclitus	Mummichog
Fundulus majalis	Striped killifish
Family Percichthyidae	
Morone americanus	White perch
Morone saxatilis	Striped bass
Family Centrarchidae	
Lepomis gibbosus	Pumpkinseed
Micropterus salmoides	Largemouth bass
Pomoxis annularis	White crappie
Family Percidae	
Etheostoma nigrum	Johnny darter
Perca flavescens	Yellow perch
Family Pomatomidae	
Pomatomus saltatrix	Bluefish
Family Sciaenidae	
Cynoscion regalis	Weakfish
Leiostomus xanthurus	Spot
Micropogon undulatus	Croaker
Family Bothidae	
Paralichthys dentatus	Summer flounder
Superclass Tetrapoda	Four-limbed animals
Class Amphibia[1]	Amphibians
Order Anura	
Family Bufonidae	Toads
Bufo woodhousei fowleri	Fowler's toad
Family Hylidae	Tree frogs
Hyla crucifer	Northern spring peeper
Family Ranidae	True frogs
Rana catesbiana	Bullfrog
Rana clamitans melanota	Green frog
Rana palustris	Pickerel frog
Rana utricularia	Southern leopard frog
Class Reptilia	Reptiles
Order Squamata	Lizards and snakes
Suborder Lacertilia	Lizards
Family Scincidae	Skinks
Eumeces fasciatus	Five-lined skink
Suborder Serpentes	Snakes
Family Colubridae	Colubrid snakes
Coluber constrictor constrictor	Northern black racer
Elaphne obsoleta obsoleta	Black rat snake

[1]*Nomenclature for amphibians and reptiles is that of Conant (1975).*

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland (Continued).

Heterodon platyrhinos	Eastern hog-nosed snake
Lampropeltis getulus getulus	Eastern kingsnake
Natrix sipedon sipedon	Northern water snake
Opheodrys aestivus	Rough green snake
Storeria occipitomaculata occipitomaculata	Red-bellied water snake
Thamnophis sauritus sauritus	Eastern ribbon snake
Thamnophis sirtalis sirtalis	Eastern garter snake
Family Viperidae	Pit vipers
Agkistrodon contortrix mokasen	Northern copperhead
Order Testudinata	Turtles
Family Chelydridae	Snapping turtles
Chelydra serpentina serpentina	Snapping turtle
Family Emydidae	Water turtles
Chrysemys picta picta	Eastern painted turtle
Chrysemys rubiventris	Spotted turtle
Clemmys guttata	Red-bellied turtle
Malaclemmys terrapin terrapin	Northern diamondback terrapin
Terrapene carolina carolina	Eastern box turtle
Family Kinosternidae	Musk and mud turtles
Kinosternon subrubrum subrubrum	Eastern mud turtle
Class Aves[1]	Birds
Order Anseriformes	Waterfowl
Family Anatidae	Waterfowl
Subfamily Cygninae	Swans
Cygnus olor	Mute swan
Olor columbianus	Whistling swan
Subfamily Anserinae	Geese
Branta canadensis	Canada goose
Branta bernicla	Brant
Chen caerulescens	Snow goose
Subfamily Anatinae	Surface-feeding ducks
Anas platyrhynchos	Mallard
Anas rubripes	Black duck
Anas acuta	Pintail
Anas strepera	Gadwall
Anas americana	American wigeon
Anas clypeata	Northern shoveller
Anas discors	Blue-winged teal
Anas crecca	Green-winged teal
Aix sponsa	Wood duck
Subfamily Athyinae	Diving ducks
Aythya americana	Redhead
Aythya valisneria	Canvasback
Aythya collaris	Ring-necked duck
Aythya marila	Greater scaup
Aythya affinis	Lesser scaup
Bucephala clangula	Common goldeneye
Bucephala albeola	Bufflehead
Clangula hymaelis	Oldsquaw
Subfamily Oxyurinae	Ruddy and masked ducks
Oxyura jamaicensis	Ruddy duck
Subfamily Merginae	Mergansers
Mergus merganser	Common merganser
Lophodytes cucullatus	Hooded merganser
Order Falconiformes	Vultures, hawks, and falcons
Family Accipitridae	Kites, hawks, and eagles
Subfamily Circinae	Harriers
Circus cyaneus	Marsh hawk
Subfamily Buteoninae	Hawks and eagles
Buteo jamaicensis	Red-tailed hawk
Buteo lineatus	Red-shouldered hawk
Order Galliformes	Gallinaceous birds
Family Phasianidae	Quails, partridges, and pheasants
Colinus virginianus	Bobwhite
Order Ciconiiformes	Herons and allies
Family Ardeidae	Herons, bitterns
Casmerodius albus	Great egret
Egretta thula	Snowy egret
Bubulcus ibis	Cattle egret

[1] *Taxonomic arrangement is that of Robbins, Bruun, and Zim (1966); common and scientific names are from American Ornithologists Union (1957), (1973), 1976).*

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland (Continued).

Ardea herodias	Great blue heron
Hydrynassa tricolor	Louisiana heron
Florida caerula	Little blue heron
Butorides striatus	Green heron
Nycticorax nycticorax	Black-crowned night heron
Nyctanassa violacea	Yellow-crowned night heron
Botaurus lentiginosus	American bittern
Ixobrychus exilis	Least bittern
Family Threskiornithidae	Ibises and spoonbills
Plegadis falcinellus	Glossy ibis
Family Rallidae	Rails, gallinules, and coots
Rallus limicola	Virginia rail
Porzana carolina	Sora
Laterallus jamaicensis	Black rail
Rallus longirostris	Clapper rail
Rallus elegans	King rail
Gallinula chloropus	Common gallinule
Fulica americana	American coot
Order Charadriformes	Shorebirds, gulls, and alcids
Family Charadriidae	Plovers, turnstones, surfbirds
Pluvialis squatarola	Black-bellied plover
Charadrius semipalmatus	Semipalmated plover
Family Scolopacidae	Woodcocks, snipes, sandpipers
Numenius phaeopus	Whimbrel
Catopirophorus semipalmatus	Willet
Tringa melanoleucus	Greater yellowlegs
Tringa flavipes	Lesser yellowlegs
Micropalama himantopus	Stilt sandpiper
Limnodromus griseus	Short-billed dowitcher
Limnodromus scolopaceus	Long-billed dowitcher
Calidris melanotus	Pectoral sandpiper
Calidris canutus	Red knot
Calidris alpina	Dunlin
Calidris minutilla	Least sandpiper
Calidris pusillus	Semipalmated sandpiper
Calidris mauri	Western sandpiper
Philohela minor	American woodcock
Capella gallinago	Common snipe
Family Laridae	Gulls and terns
Subfamily Larinae	Gulls
Larus marinus	Great black-backed gull
Larus argentatus	Herring gull
Larus delawarensis	Ring-billed gull
Larus atricilla	Laughing gull
Subfamily Sterninae	Terns
Sterna hirundo	Common tern
Sterna forsteri	Forster's tern
Order Columbiformes	Pigeons and doves
Family Columbidae	Pigeons and doves
Zenaida macroura	Mourning dove
Order Cucliformes	Cuckoos, roadrunners, anis
Family Cuculidae	Cuckoos, roadrunners, anis
Coccyzus americanus	Yellow-billed cuckoo
Coccyzus erythrophthalmus	Black-billed cuckoo
Order Strigiformes	Owls
Family Strigidae	True owls
Bubo virginianus	Great horned owl
Order Coraciiformes	Kingfishers
Family Alcedinidae	Kingfishers
Megaceryle alcyon	Belted kingfisher
Order Piciformes	Woodpeckers
Family Picidae	Woodpeckers
Colaptes auratus	Common flicker
Melanerpes carolinus	Red-bellied woodpecker
Picoides villosus	Hairy woodpecker
Picoides pubescens	Downy woodpecker
Order Passeriformes	Perching birds
Family Tyrannidae	Tyrant flycatchers
Tyrannus tyrannus	Eastern kingbird

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland (Continued).

Myriarchus crinitus	Great-crested flycatcher
Sayornis phoebe	Eastern phoebe
Empidonax traillii	Willow flycatcher
Contopus virens	Eastern wood pewee
Family Corvidae	Crows, jays, magpies
Cyanocitta cristata	Blue jay
Corvus brachyrhynchos	Common crow
Corvus ossifragus	Fish crow
Family Paridae	Chickadees, titmice, bushtits
Parus carolinensis	Carolina chickadee
Parus bicolor	Tufted titmouse
Family Sittidae	Nuthatches
Sitta canadensis	Red-breasted nuthatch
Family troglodytidae	Wrens
Troglodytes aedon	House wren
Thryothorus ludovicianus	Carolina wren
Telmatodytes palustris	Long-billed marsh wren
Cistothorus platenis	Short-billed marsh wren
Family Mimidae	Mockingbirds, thrashers
Dumetella carolinensis	Gray catbird
Family Turdidae	Thrushes
Turdus migratorius	American robin
Hylocichla ustulata	Swainson's thrush
Family Sylviidae	Kinglets, gnatcatchers
Regulus calendula	Ruby-crowned kinglet
Family Sturnidae	Starlings
Sturnus vulgaris	Starling
Family Vireonidae	Vireos
Vireo griseus	White-eyed vireo
Vireo olivaceus	Red-eyed vireo
Family Parulidae	Wood warblers
Mniotilta varia	Black-and-white warbler
Vermivora peregrina	Tennessee warbler
Parula americana	Northern parula
Dendroica petechia	Yellow warbler
Dendroica magnolia	Magnolia warbler
Dendroica tigrina	Cape May warbler
Dendroica coronata	Yellow-rumped warbler
Dendroica caerulescens	Black-throated blue warbler
Dendroica striata	Blackpoll warbler
Seiurus aurocapillus	Ovenbird
Seiurus noveboracensis	Northern waterthrush
Geothlypis trichas	Yellowthroat
Icteria virens	Yellow-breasted chat
Wilsonia canadensis	Canada warbler
Setophaga ruticilla	American redstart
Family Ploceidae	Weavers
Passer domesticus	House sparrow
Family Icteridae	Meadowlarks, blackbirds, orioles
Dolichonyx oryzivorus	Bobolink
Sturnella magna	Eastern meadowlark
Agelaius phoeniceus	Red-winged blackbird
Euphagus carolinus	Rusty blackbird
Quiscalus mexicanus	Boat-tailed grackle
Quiscalus quiscula	Common grackle
Icterus galbula	Northern oriole
Piranga olivacea	Scarlet tanager
Family Fringillidae	Grosbeaks, buntings, finches, sparrows
Cardinalis cardinalis	Cardinal
Passerina cyanea	Indigo bunting
Carpodacus purpureus	Purple finch
Carpodacus mexicanus	House finch
Spinus tristis	American goldfinch
Pipilo erythrophthalmus	Rufous-sided towhee
Ammospiza caudacuta	Sharp-tailed sparrow
Ammospiza maritima	Seaside sparrow
Spizella arborea	Tree sparrow
Zonotrichia albicollis	White-throated sparrow
Passerella iliaca	Fox sparrow
Melospiza georgiana	Swamp sparrow

Table 81. Common and scientific names of animals in the coastal wetlands of Maryland (Concluded).

Melospiza melodia	Song sparrow
Class Mammalia[1]	Mammals[1]
Order Marsupalia	Pouched Mammals
Family Didelphidae	Opossums
Didelphis marsupalis	Opossum
Order Insectivora	Insect-eating mammals
Family Soricidae	Shrews
Blarina brevicauda	Shorttail shrew
Cryptotis parva	Least shrew
Order Carnivora	Flesh-eating mammals
Family Procyonidae	Racoons
Procyon lotor	Racoon
Family Mustelidae	
Lutra canadensis	River otter
Mephitis mephitis	Striped skunk
Mustela frenata	Longtail weasel
Mustela vison	Mink
Family Canidae	
Urocyon cinereoargenteus	Gray fox
Vulpes fulva	Red fox
Order Rodentia	Rodents
Family Sciuridae	
Castor canadensis	Beaver
Glaucomys volans	Southern flying squirrel
Sciurus carolinensis	Eastern gray squirrel
Family Cricetidae	
Microtus pennsylvanicus	Meadow vole
Ondatra zibethicus	Muskrat
Oryzomys palustris	Rice rat
Peromyscus leucopus	White-footed mouse
Family Muridae	Old World rats and mice
Mus musculus	House mouse
Rattus norvegicus	Norway rat
Family Zapodidae	Jumping mice
Zapus hudsonius	Meadow jumping mouse
Family Capromyidae	
Myocastor coypus	Nutria
Order Lagomorpha	Pikas, hares, and rabbits
Family Leporidae	Hares and rabbits
Sylvilagus floridanus	Eastern cottontail
Order Artiodactyla	Even-toed hoofed mammals
Family Cervidae	Deer
Cervus nippon	Sika deer
Odocoileus virginianus	Whitetail deer

[1]*Nomenclature is that of Burt (1964).*

APPENDIX 2.
FIELD INVESTIGATION OF THE PRODUCTIVITY AND DIVERSITY OF SELECTED TYPES OF VEGETATION IN THE COASTAL WETLANDS OF MARYLAND

A field study was conducted during the late summer and autumn of 1976 to obtain supplemental information on wetland productivity and diversity. Herbaceous standing crops of all erect plant materials were harvested in two stands of each of twenty-two wetland types. Litter crop collections also were made in six of these wetland types that are composed partly or predominantly of shrubs or trees. Observations also were made of the diversity of plant species in each stand. The samples of standing crop and litter were dried in a forage dryer and then weighed. The results of the study are presented in Tables 83 to 107.

METHODS

Sampling Locations

On the basis of the literature review for the value assessment, twenty-two wetland types were identified for which supplemental productivity and diversity data were desired. These wetland types are:

Shrub Swamps
- 11 Swamp rose
- 13 Red maple/Ash

Swamp Forests
- 21 Baldcypress
- 22 Red maple/Ash
- 23 Loblolly pine

Fresh Marshes
- 30 Smartweed/Rice cutgrass
- 31 Spatterdock
- 32 Pickerelweed/Arrowarum
- 33 Sweetflag
- 35 Rosemallow
- 36 Wildrice
- 38 Big cordgrass
- 39 Common reed

Brackish High Marshes
- 41 Meadow cordgrass/Spikegrass
- 42 Marshelder/Groundselbush
- 43 Needlerush
- 44 Cattail
- 45 Rosemallow
- 46 Switchgrass
- 47 Threesquare
- 49 Common reed

Brackish Low Marshes
- 51 Smooth cordgrass

Sampling locations were chosen by utilizing the type classifications and delineations on the wetland photomaps. The criteria for location selection were accessibility and variety of wetland types in close proximity. The principal sampling locations were along Hunting Creek, a tributary to the Choptank River, in Caroline and Dorchester Counties; and along Elliott Island Road near Savannah Lake in Dorchester County. Additional locations were situated on the Chester River east of Crumpton in Queen Anne's County; Choptank River west of Tanyard in Caroline County; Little Blackwater River north of Seward in Dorchester County; and Pocomoke River at Mattaponi landing in Worcester County. The locations are indicated specifically on Table 82 and Figures 40 to 45.

Herbaceous Standing Crops

In two stands of each of the twenty-two wetland types, all above-ground herbaceous vegetation was harvested from three 0.25 meter square (0.0625 square meter) plots. The stands were selected during the field work and plots were chosen that typified the overall condition of the stands. Harvesting was conducted on 17, 19, 23, 24, 30, and 31 August 1976. The harvested material was dried in an electric forage dryer, and then removed and weighed on 14 October.

Litter Crop

Six of the wetland types are composed partly or predominantly of shrubs or trees:

Shrub Swamps
- 11 Swamp rose
- 13 Red maple/Ash

Swamp Forests
- 21 Baldcypress
- 22 Red maple/Ash
- 23 Loblolly pine

Brackish High Marshes
- 42 Marshelder/Groundselbush

Three baskets were installed in each of two stands of each of these types to collect deciduous leaves and branches of woody trees and shrubs. The baskets were standard fruit baskets with an inside diameter of 35.0 centimeters (0.096 square meter), and were installed on stakes to be above the anticipated level of flood tides. The baskets were installed at the time of the herbaceous sampling, and were collected about three months later on 15 through 18 November 1976. The collected litter was dried in an electric forage dryer, and then removed and weighed on 5 January 1977. The estimated litter crop production was combined with the estimated herbaceous standing crop to produce an estimate of the total autumnal standing crop of deciduous non-woody material for each of the shrub and wooded swamp types.

Plant Species Diversity

Observations on diversity were made during the herbaceous sampling. The principal plant species associated with each stand were noted.

RESULTS

The results of the herbaceous standing crop and litter crop sampling are presented in Tables 83 through 104. The measurements are presented in two forms: the dry weight of the plants from each 0.0625 square meter sample plot, in grams; and the mean dry weight, calculated from the several samples, in grams per square meter, in tons per acre, and in kilograms per hectare. Plant species diversity data are displayed in Tables 105 through 107.

Table 82. Herbaceous standing crop and litter crop sampling locations. Locations are referenced to county, nearest town and watershed. Distances are approximate.

TYPE	STAND	LOCATION	WETLANDS MAP	PHOTOGRAPH
11 Swamp Rose	A	Caroline, Preston; Hunting Creek-Choptank River. 3,250 feet northeast of Back Landing Road	CA42	CA1-13RL-89
	B	Dorchester, Ellwood, Gravel Run-Hunting Creek-Choptank River. 3,250 feet east of Back Landing Road	DO53	CA1-13RL-89
13 Red maple/Ash, shrub	A&B	Caroline, Preston; Hunting Creek-Choptank River. A, 2,750 feet and B, 2,500 feet east of Back Landing Road	CA42	CA1-13RL-89
21 Baldcypress	A&B	Worcester, Klej Grange; Pocomoke River. A, 250 feet and B, 500 feet west of Mattaponi Landing.	WO125	WO1-20RL-119
22 Red maple/Ash, wooded	A&B	Caroline, Preston; Hunting Creek-Choptank River. A, 2,750 feet and B, 2,500 feet east of Back Landing Road	CA42	CA-13RL-89
23 Loblolly Pine	A&B	Dorchester, Henrys Crossroads; Savannah Lake, Pokata Creek-Island Creek-Fishing Bay. A, 1,750 feet northeast of Savannah Lake and 250 feet south of Elliott Island Road; B, 500 feet north of Elliott Island Road at north side of Savannah Lake.	DO50	DO1-18RL-14
30 Smartweed/Rice cutgrass	A&B	Caroline, Preston; Hunting Creek-Choptank River. A, 2,750 feet east and B, 3,250 feet northeast of Back Landing Road	CA42	CA1-13RL-89
31 Spatterdock	A	Dorchester, Ellwood; Gravel Run-Herring Creek-Choptank River. 3,250 feet east of Back Landing Road.	DO53	CA1-13RL-89
	B	Caroline, Preston; Hunting Creek—Choptank River. 2,500 feet east of Back Landing Road.	CA42	CA1-13RL-89
32 Pickerelweed/Arrowarum	A	Dorchester, Ellwood; Gravel Run-Hunting Creek-Choptank River. 3,000 feet east of Back Landing Road	DO53	CA1-13RL-89
	B	Caroline, Preston; Hunting Creek-Choptank River. 3,250 feet east of Back Landing Road	CA42	CA1-13RL-89
33 Sweetflag	A&B	Queen Anne's, Crumpton; Chester River. A, 1,250 feet and B, 1,500 feet northeast of Kirby Landing.	QA108	QA1RL-5
35 Rosemallow, fresh	A&B	Caroline, Preston; Hunting Creek-Choptank River. 2,750 feet east of Back Landing Road	CA42	CA1-13RL-89
36 Wildrice	A&B	Dorchester, Ellwood; Gravel Run-Hunting Creek-Choptank River. A, 1,000 feet and B, 500 feet northwest of Route 331.	DO43	CA-DO-2RL-101
38 Big Cordgrass, fresh	A&B	Caroline, Choptank; Hunting Creek-Choptank River. 4,500 feet southwest of Back Landing Road	CA42	CA1-13RL-89
39 Common Reed, fresh	A&B	Caroline, Tanyard; Choptank River. 2,750 feet southeast of Dover Bridge, and A, 250 feet and B, 500 feet south of Route 331	CA33	CA1-14RL-15
41 Meadow cordgrass/Spike-grass, brackish	A&B	Caroline, Choptank; Hunting Creek-Choptank River. A, 2,000 feet northeast of Choptank bridge; B, 250 feet northwest of Choptank bridge	CA41	CA1-13RL-109
	C	Dorchester, Henrys Crossroads; Savannah Lake, Pokata Creek-Island Creek-Fishing Bay. 500 feet south of Elliott Island Road at north side of Savannah Lake	DO50	DO1-18RL-14
42 Marshelder/Groundselbush, brackish	A&B	Dorchester, Henrys Crossroads; Savannah Lake. Pokata Creek-Island Creek-Fishing Bay. 1,750 feet northeast of Savannah Lake and A, north side of Elliott Island Road and B, 500 feet south of Elliott Island Road	DO50	DO1-18RL-14
43 Needlerush, brackish	A&B	Dorchester, Henrys Crossroads; Island Creek-Fishing Bay. West side of Elliott Island Road between Savannah Lake and Little Savannah Lake	DO61	DO1-18RL-44

Table 82. Herbaceous standing crop and litter crop sampling locations (concluded).

TYPE	STAND	LOCATION	WETLANDS MAP	PHOTOGRAPH
44 Cattail, brackish	A&B	Dorchester, Henrys Crossroads; Savannah Lake, Pokata Creek—Island Creek—Fishing Bay. A, 250 feet and B, 500 feet south of Elliott Island Road at north side of Savannah Lake.	DO50	DO1-18RL-14
45 Rosemallow, brackish	A&B	Dorchester, Seward; Little Blackwater River-Blackwater River, 9,750 feet north of Seward bridge, and A, 1,000 feet and B, 750 feet west of River.	DO199	DO1-7RL-53
46 Switchgrass	A&B	Dorchester, Seward; Little Blackwater River-Blackwater River. 9,750 feet north of Seward bridge, and A, 1,000 feet and B, 750 feet west of River	DO199	DO1-7RL-53
47 Threesquare	A&B	Dorchester, Henrys Crossroads; Savannah Lake, Pokata Creek-Island Creek-Fishing Bay. A, north side of Elliott Island Road, 1,750 feet northeast of Savannah Lake; B, east side of Road between Savannah Lake and Little Savannah Lake	(A) DO50 (B) DO61	DO1-18RL-14 DO1-18RL-44
49 Common Reed, brackish	A&B	Caroline, Choptank; Hunting Creek-Choptank River. North end of Choptank bridge.	CA41	CA1-13RL-109
51 Smooth cordgrass, brackish	A&B	Caroline, Choptank; Hunting Creek-Choptank River. A, 3,250 feet southwest of Back Landing Road; B, west end of Choptank bridge	(A) CA42 (B) CA41	CA1-13RL-89 CA1-13RL-109

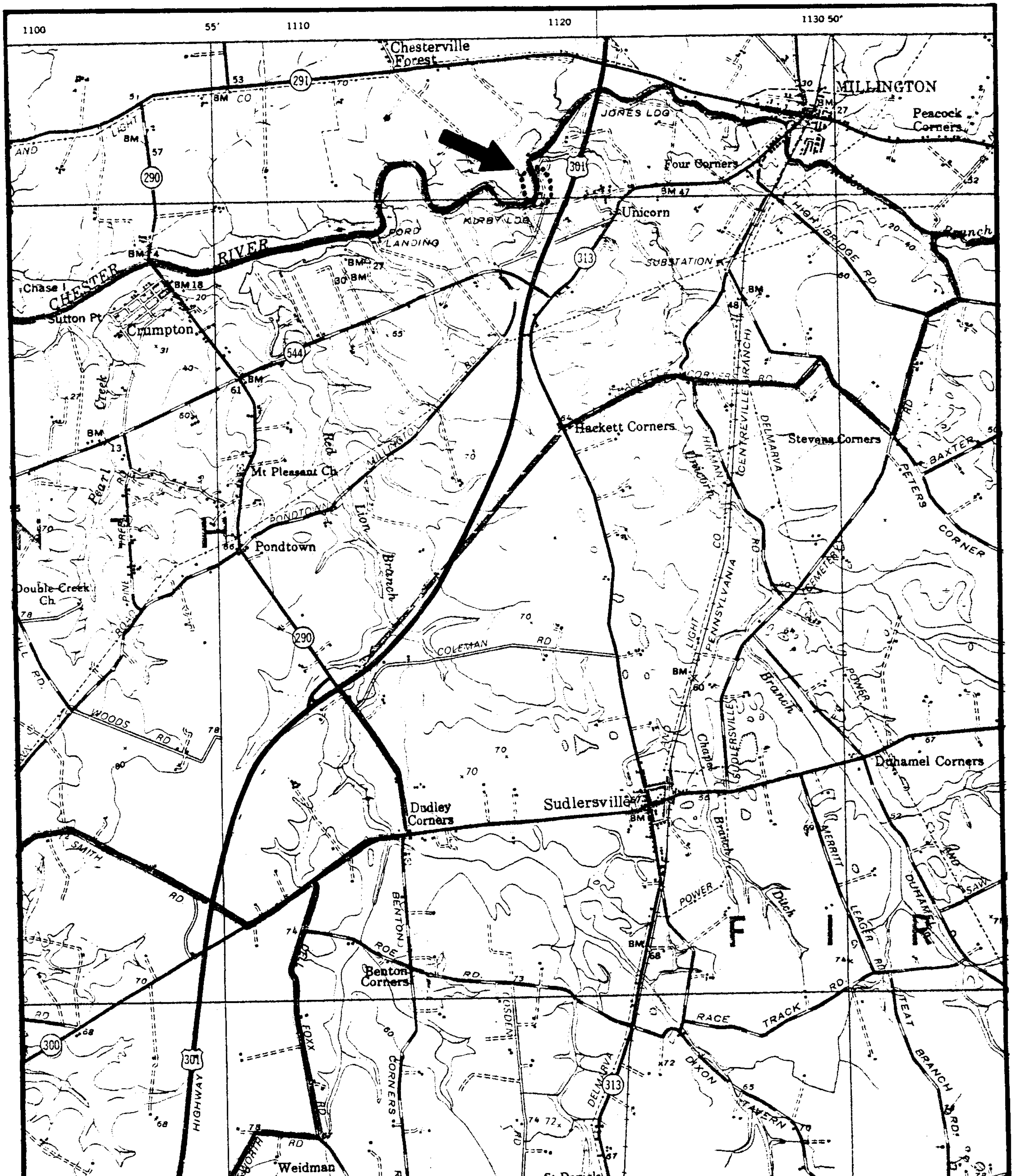

Figure 40. Sampling location (indicated by arrow) for sweetflag (Type 33) along the Chester River east of Crumpton in Queen Anne's County.

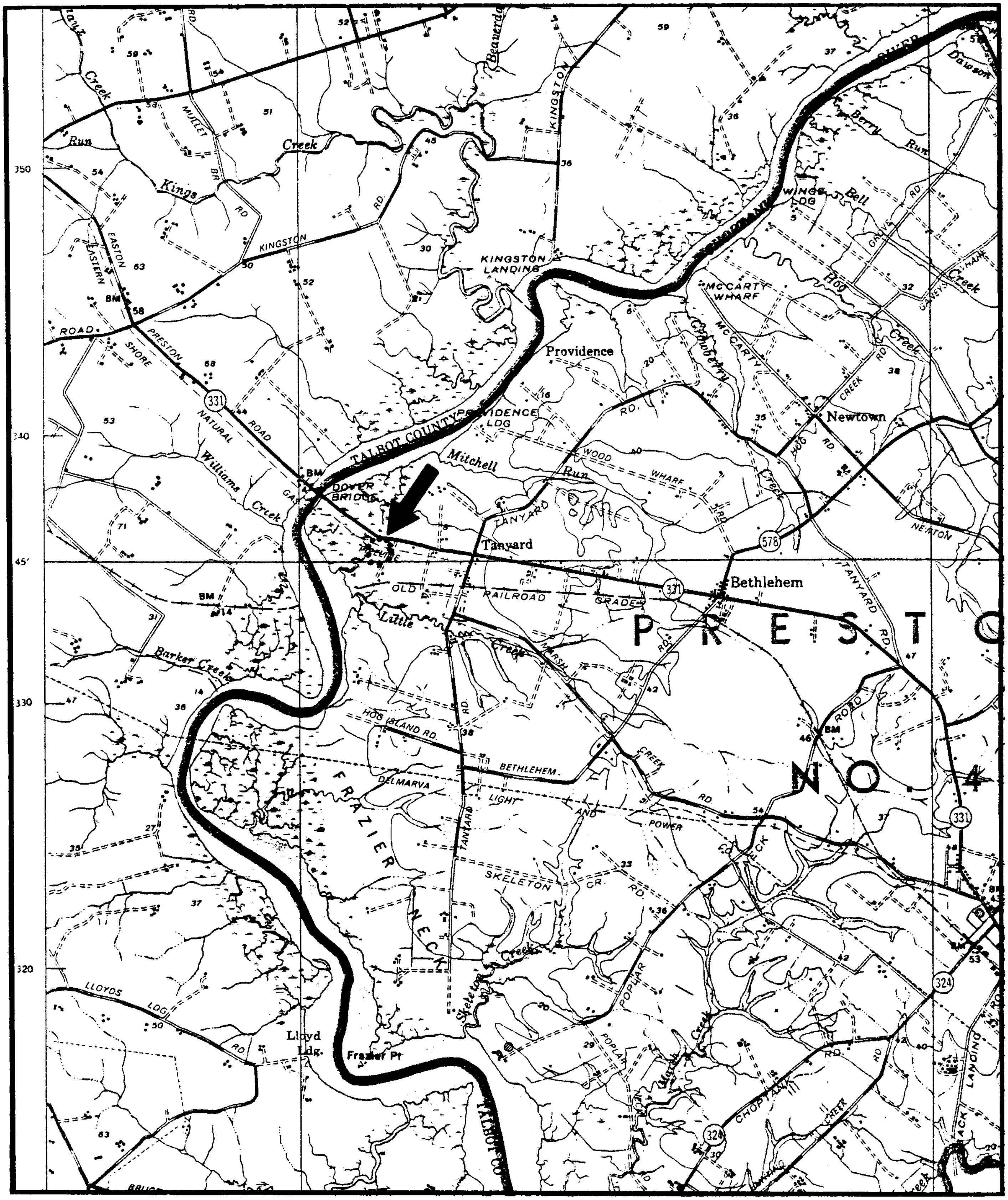

Figure 41. Sampling location (indicated by arrow) for common reed (Type 39) along the Choptank River west of Tanyard in Caroline County.

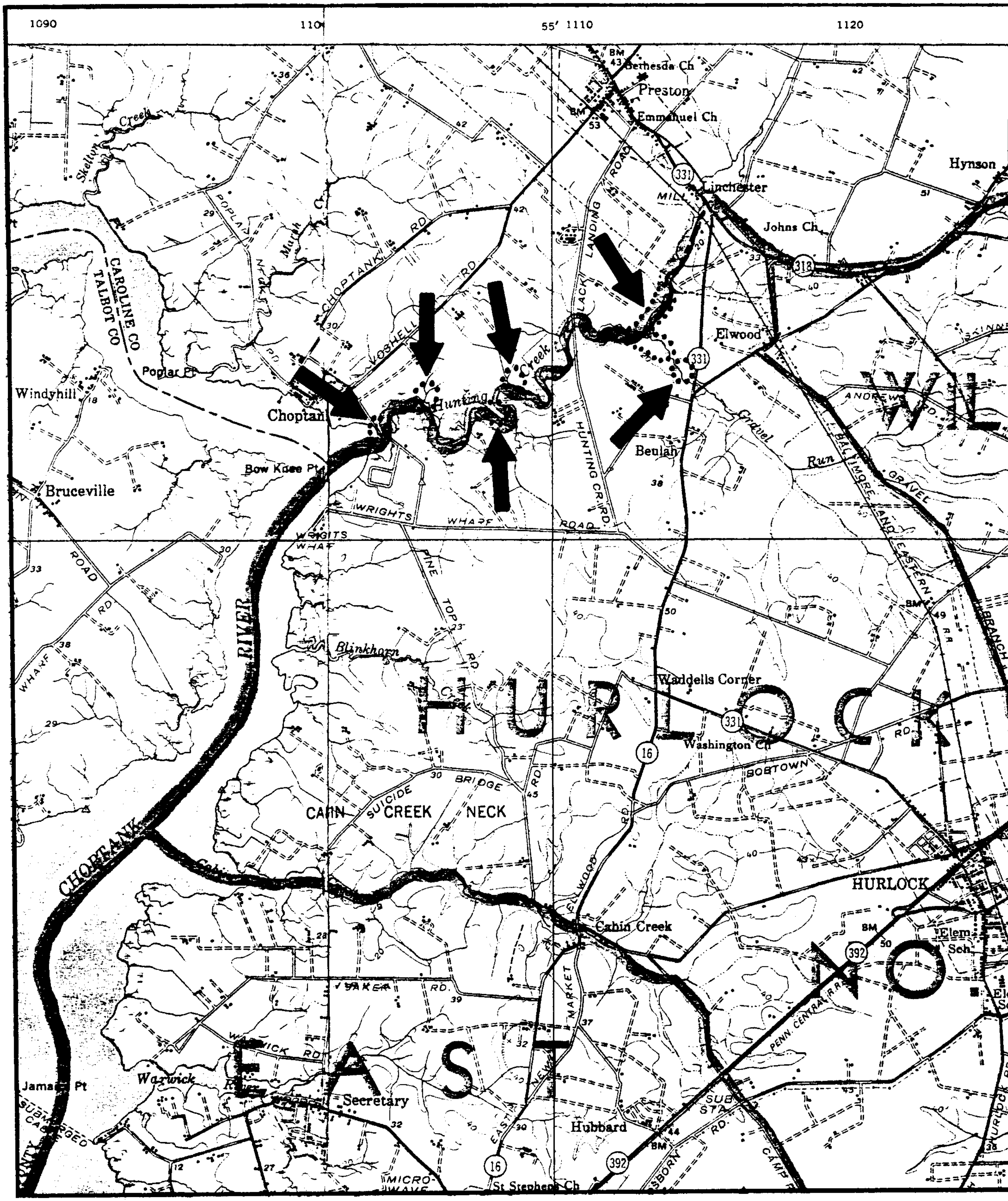

Figure 42. Sampling locations (indicated by arrows) for swamp rose (Type 11), smooth alder/black willow (Type 12), red maple/ash (Type 22), smartweed/rice cutgrass (Type 30), spatterdock (Type 31), pickerelweed/arrowarum (Type 32), rosemallow (Type 35), wildrice (Type 36), big cordgrass (Type 38), meadow cordgrass/spikegrass (Type 41), common reed (Type 49), and smooth cordgrass (Type 51) along Hunting Creek, a tributary to the Choptank River, in Caroline and Dorchester Counties.

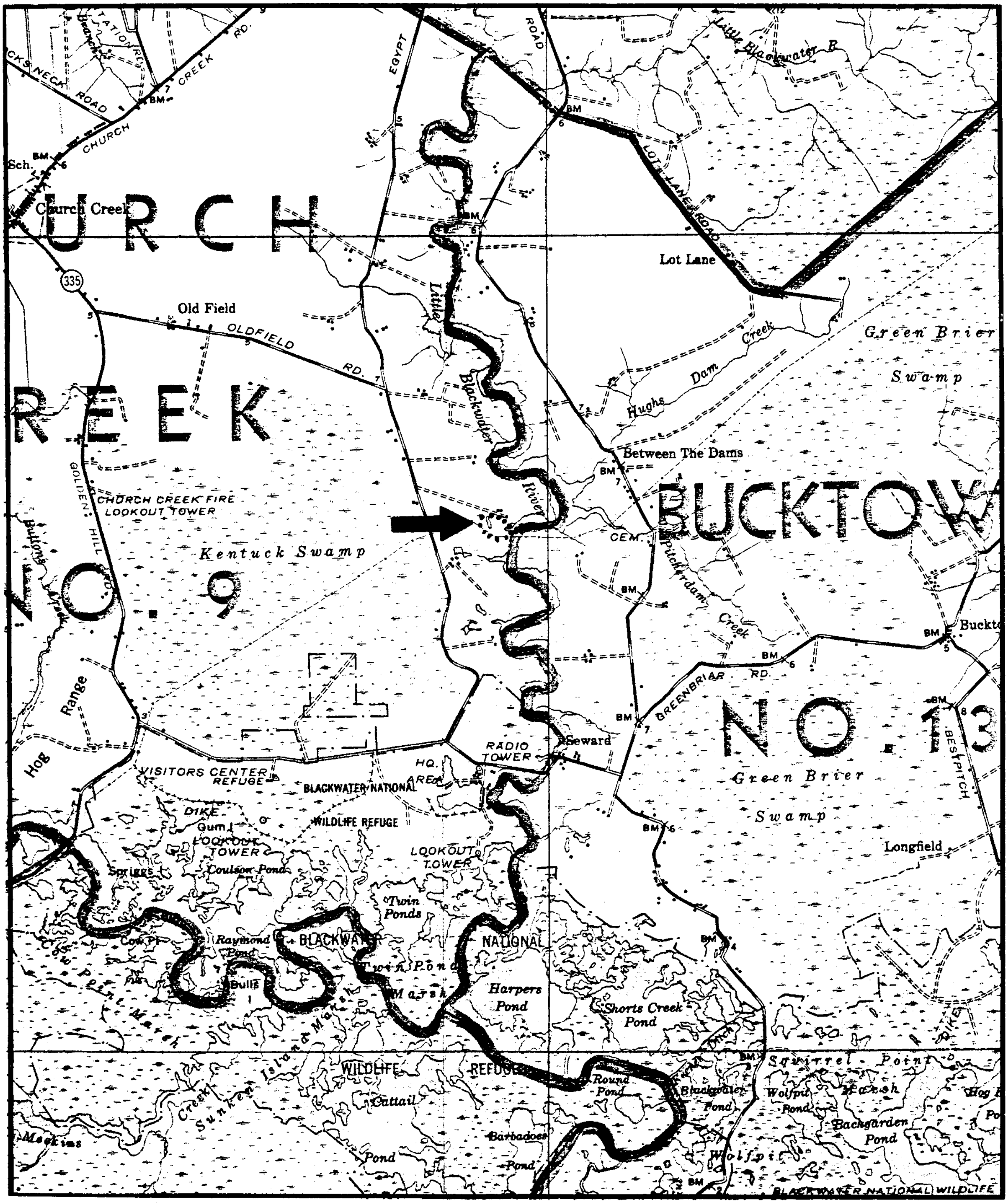

Figure 43. Sampling location (indicated by arrow) for rosemallow (Type 45) and switchgrass (Type 46) along the Little Blackwater River north of Seward in Dorchester County.

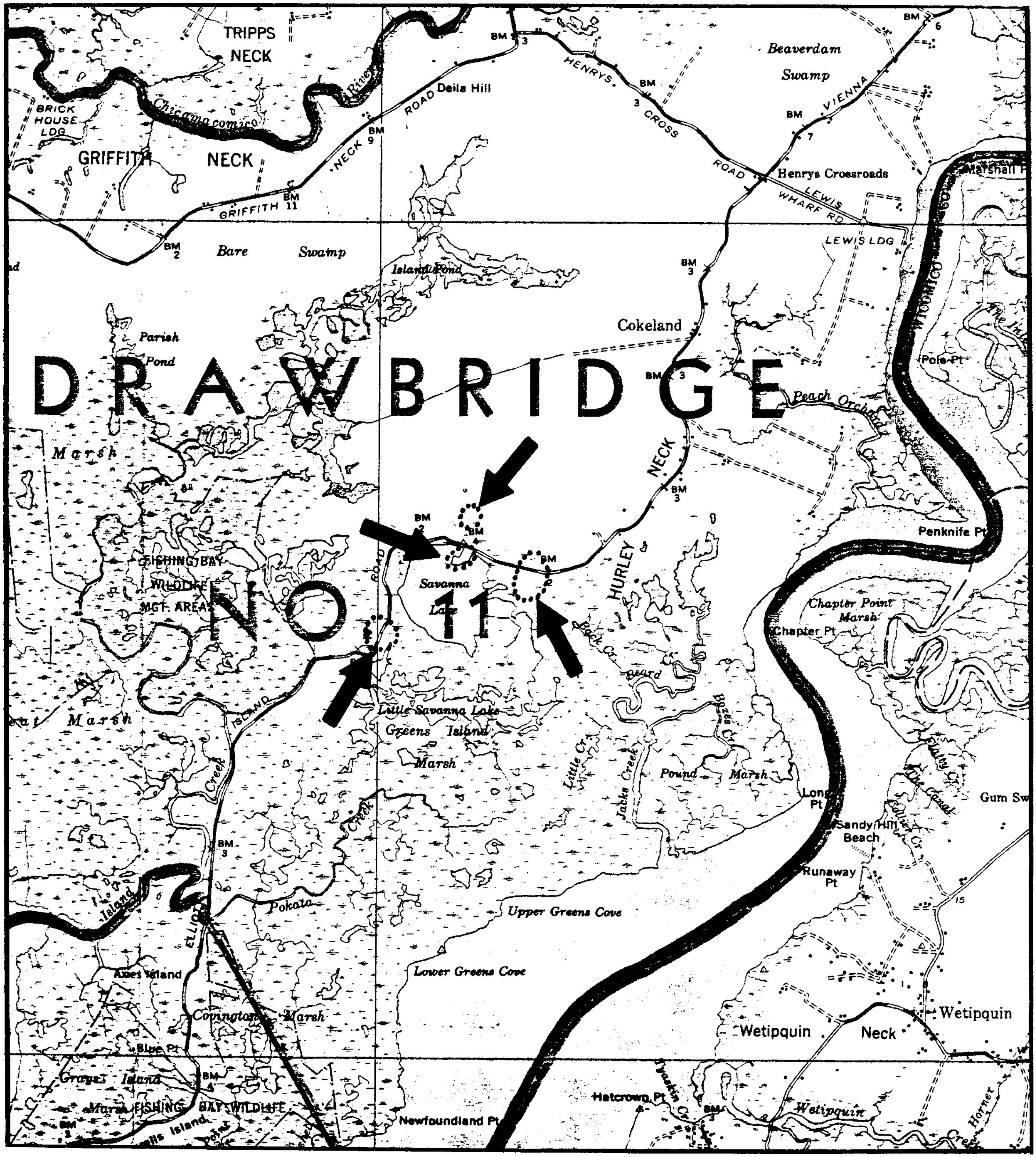

Figure 44. Sampling locations (indicated by arrows) for loblolly pine (Type 23), meadow cordgrass/spikegrass (Type 41), marshelder/groundselbush (Type 42), needlerush (Type 43), cattail (Type 44), and threesquare (Type 47) along Elliott Island Road near Savannah Lake in Dorchester County.

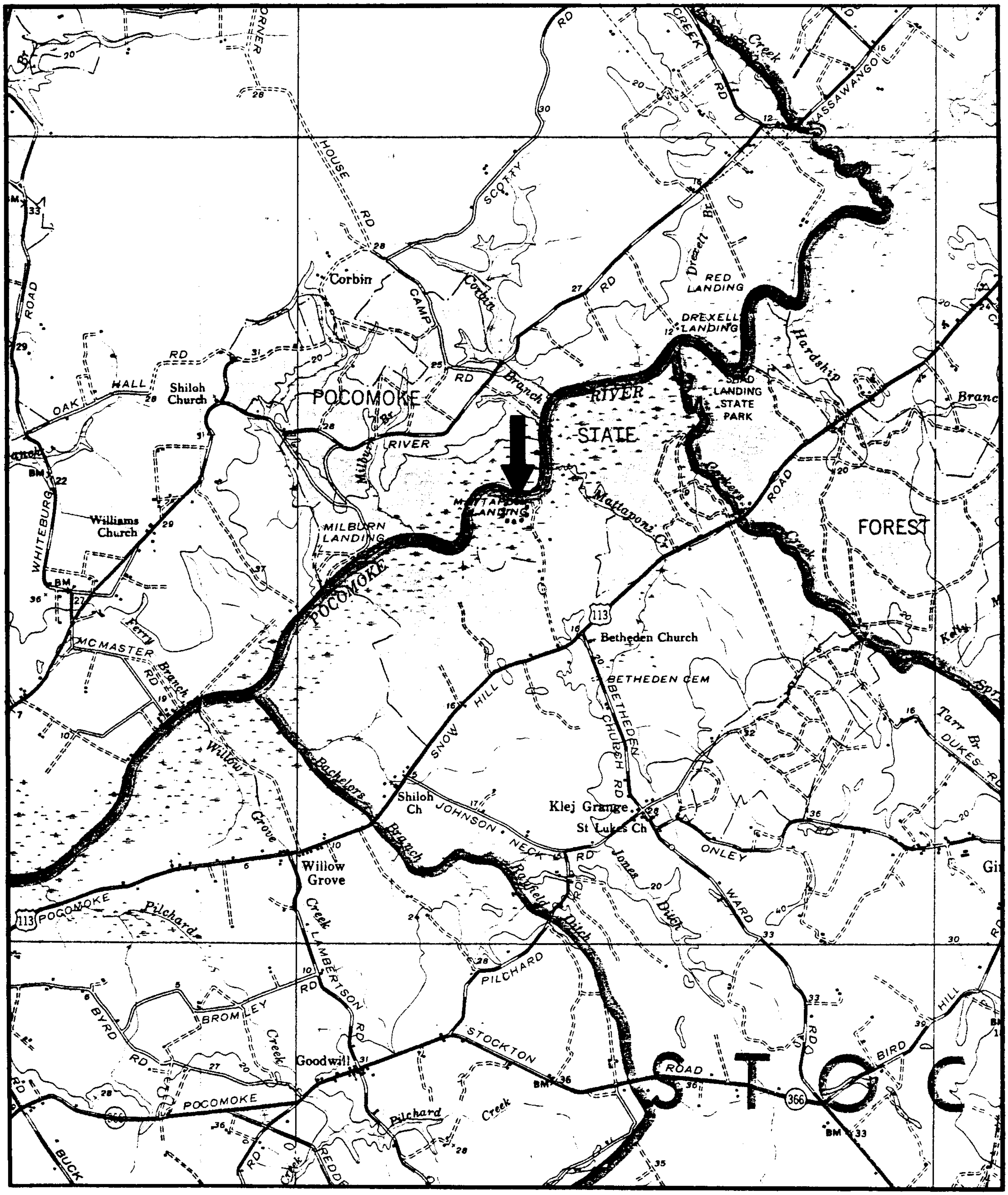

Figure 45. Sampling location (indicatd by arrow) for baldcypress (Type 21) along the Pocomoke River near Mattaponi Landing in Worcester County.

Table 83. Standing crop of swamp rose shrub swamp, Type 11.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
Herbaceous							
1	A	19 Aug.	20 Aug.-14 Oct.	31.7			
2				29.1			
3				35.1			
					511	2.3	5110
4	B	24 Aug.	25 Aug.-14 Oct.	54.5			
5				— [a]			
6				55.1			
					585	2.6	5850
Litter							
1	A	19 Aug.	18 Nov.-5 Jan.	12.2			
2		to		12.7			
3		16 Nov.		5.0			
					104	0.5	1040
4	B	24 Aug.	18 Nov.-5 Jan.	14.2			
5		to		14.5			
6		16 Nov.		11.2			
					138	0.6	1380

[a]No herbaceous materials occurred within the sampling plot.

Table 84. Standing crop of red maple/ash shrub swamp, Type 13.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
Herbaceous							
1	A	24 Aug.	25 Aug.-14 Oct.	25.2			
2				— [a]			
3				—			
					134	0.6	1340
4	B			7.1			
5				8.4			
6				81.1			
					515	2.3	5150
Litter							
1	A	24 Aug.	18 Nov.-5 Jan.	21.7			
2		to		15.6			
3		16 Nov.		29.1			
					230	1.0	2300
4	B			18.1			
5				32.5			
6				18.2			
					238	1.1	2380

[a]No herbaceous materials occurred within the sampling plot.

Table 85. Standing crop of baldcypress swamp forest, Type 21.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
Herbaceous							
1	A	30 Aug.	1 Sept.-14 Oct.	4.6			
2				— [a]			
3				—			
					25	0.1	250
4	B			2.9			
5				—			
6				6.3			
					49	0.2	490
Litter							
1	A	30 Aug.	18 Nov.-5 Jan.	27.1			
2		to		34.6			
3		18 Nov.		33.8			
					331	1.5	3310
4	B			28.4			
5				25.4			
6				28.1			
					284	1.3	2840

[a]No herbaceous materials occurred within the sampling plot.

Table 86. Standing crop of red maple/ash swamp forest, Type 22.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
Herbaceous							
1	A	24 Aug.	25 Aug.-14 Oct.	— [a]			
2				44.9			
3				—			
					239	1.1	2390
4	B			—			
5				—			
6				29.3			
					156	0.7	1560
Litter							
1	A	24 Aug.	18 Nov.-5 Jan.	34.1			
2		to		24.3			
3		16 Nov.		24.1			
					286	1.3	2860
4	B			26.1			
5				26.4			
6				30.7			
					288	1.3	2880

[a]No herbaceous materials occurred within the sampling plot.

Table 87. Standing crop of loblolly pine swamp forest, Type 23.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
Herbaceous							
1	A	31 Aug.	1 Sept.-14 Oct.	21.8			
2				29.6			
3				50.6			
					544	2.4	5440
4	B			25.6			
5				30.1			
6				19.3			
					400	1.8	4000
Litter							
1	A	31 Aug.	18 Nov.-5 Jan.	1.7			
2		to		4.9			
3		16 Nov.		2.7			
					32	0.1	320
4	B	31 Aug.	18 Nov.-5 Jan.	2.2			
5		to		3.9			
6		17 Nov.		4.0			
					35	0.2	350

Table 88. Herbaceous standing crop of smartweed/rice cutgrass fresh marsh, Type 30.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	20 Aug.-14 Oct.	150.2			
2				99.1			
3				135.4			
					2052	9.2	20520
4	B			114.1			
5				156.1			
6				148.4			
					2233	10.0	22330

Table 89. Herbaceous standing crop of spatterdock fresh marsh, Type 31.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	30 Aug.-14 Oct.	45.2			
2				20.0			
3				43.6			
					580	2.6	5800
4	B			20.2			
5				23.2			
6				40.4			
					447	2.0	4470

Table 90. Herbaceous standing crop of pickerelweed/arrowarum fresh marsh, Type 32.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	20 Aug.-14 Oct.	61.2			
2				36.4			
3				30.2			
					682	3.0	6820
4	B			31.9			
5				34.8			
6				48.3			
					613	2.7	6130

Table 91. Herbaceous standing crop of sweetflag fresh marsh, Type 33.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	17 Aug.	20 Aug.-14 Oct.	58.1			
2				71.3			
3				66.5			
					1045	4.7	10450
4	B			76.6			
5				79.3			
6				88.5			
					1303	5.8	13030

Table 92. Herbaceous standing crop of rosemallow fresh marsh, Type 35.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	20 Aug.-14 Oct.	99.1			
2				94.7			
3				90.6			
					1517	6.8	15170
4	B			88.7			
5				133.1			
6				136.4			
					1910	8.5	19100

Table 93. Herbaceous standing crop of wildrice fresh marsh, Type 36.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	20 Aug.-14 Oct.	156.7			
2				159.9			
3				172.2			
					2607	11.6	26070
4	B			137.3			
5				106.7			
6				51.1			
					1574	7.0	15740

Table 94. Herbaceous standing crop of big cordgrass fresh marsh, Type 38.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	20 Aug.-14 Oct.	326.5			
2				404.3			
3				370.8			
					5875	26.2	58750
4	B			299.4			
5				215.1			
6				500.9			
					5415	24.2	54150

Table 95. Herbaceous standing crop of common reed fresh marsh, Type 39.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	23 Aug.	25 Aug.-14 Oct.	124.7			
2				246.9			
3				272.9			
					3437	15.3	34370
4	B			273.8			
5				317.3			
6				264.1			
					4561	20.3	45610

Table 96. Herbaceous standing crop of meadow cordgrass/spikegrass brackish high marsh, Type 41.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	24 Aug.	25 Aug.-14 Oct.	50.6			
2				53.4			
3				35.9			
					746	3.3	7460
4	B			39.6			
5				62.8			
6				37.1			
					744	3.3	7440
7	C	31 Aug.	1 Sept.-14 Oct.	98.5			
8				100.0			
9				153.9			
					1879	8.4	18790

Table 97. Standing crop of marshelder/groundselbush brackish high marsh, Type 42.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
Herbaceous							
1	A	31 Aug.	1 Sept.-14 Oct.	27.2			
2				90.2			
3				121.6			
					1275	5.7	12750
4	B			39.1			
5				54.5			
6				35.2			
					687	3.1	6870
Litter							
1	A	31 Aug.	18 Nov.-5 Jan.	10.3			
2		to		8.8			
3		15 Nov.		13.1			
					112	0.5	1120
4	B			5.5			
5				9.8			
6				7.4			
					79	0.4	790

Table 98. Herbaceous standing crop of needlerush brackish high marsh, Type 43.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	31 Aug.	1 Sept.-14 Oct.	47.8			
2				215.0			
3				85.1			
					1855	8.3	18550
4	B			73.3			
5				127.2			
6				52.4			
					1349	6.0	13490

Table 99. Herbaceous standing crop of cattail brackish high marsh, Type 44.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	31 Aug.	1 Sept.-14 Oct.	104.0			
2				112.6			
3				112.9			
					1757	7.8	17580
4	B			37.6			
5				84.7			
6				93.0			
					1148	5.1	11480

Table 100. Herbaceous standing crop of rosemallow brackish high marsh, Type 45.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	23 Aug.	25 Aug.-14 Oct.	86.6			
2				127.4			
3				68.6			
					1507	6.7	15070
4	B			75.8			
5				82.7			
6				66.5			
					1199	5.3	11990

Table 101. Herbaceous standing crop of switchgrass brackish high marsh, Type 46.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	23 Aug.	25 Aug.-14 Oct.	381.4			
2				144.1			
3				277.3			
					4282	19.1	42820
4	B			350.3			
5				209.6			
6				147.9			
					3775	16.8	37750

Table 102. Herbaceous standing crop of threesquare brackish high marsh, Type 47.

Sample	Stand	Schedule: Sampling	Schedule: Drying	Dry Weight (g/.0625m²)	Mean Standing Crop: g/m²	tons/acre	kg/ha
1	A	31 Aug.	1 Sept.-14 Oct.	46.5			
2				16.9			
3				49.1			
					600	2.7	6000
4	B			79.4			
5				70.7			
6				37.9			
					1003	4.5	10030

Table 103. Herbaceous standing crop of common reed brackish high marsh, Type 49.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	19 Aug.	20 Aug.-14 Oct.	185.2			
2				301.9			
3				225.7			
					3802	17.0	38020
4	B			212.0			
5				240.3			
6				184.9			
					3398	15.2	33980

Table 104. Herbaceous standing crop of smooth cordgrass brackish low marsh, Type 51.

Sample	Stand	Schedule		Dry Weight	Mean Standing Crop		
		Sampling	Drying	(g/.0625m²)	g/m²	tons/acre	kg/ha
1	A	24 Aug.	25 Aug.-14 Oct.	47.4			
2				41.3			
3				45.8			
					717	3.2	7170
4	B			75.7			
5				80.4			
6				85.4			
					1288	5.7	12880

Table 105. Plant diversity in swamp types. Type species, •; associated species, ★ .

SPECIES (TYPE / STAND)	11 A	11 B	13 A	13 B	21 A	21 B	22 A	22 B	23 A	23 B
Acer rubrum			•	•	★	★	•	•		
Acnida cannabina		★	★				★			
Alnus serrulata		★			★	★	★	★		
Bidens sp.	★	★					★			
Cephalanthus occidentalis		★								
Clethra alnifolia					★	★	★	★		
Cornus amomum			★				★	★		
Cuscuta sp.	★	★								
Decodon verticillatus						★				
Diospyros virginiana										★
Fraxinus sp.					★	★	•	•		
Graminae Fam.						★				
Hibiscus palustris	★		★				★			
Impatiens capensis	★	★	★	★	★	★	★	★		
Leersia oryzoides	★									
Lindera benzoin						★				
Liquidambar styraciflua					★					★
Liriodendron tulipifera					★					
Magnolia virginiana		★			★		★	★		
Myrica sp.									★	★
Nuphar advena	★	★			★		★			
Nyssa sylvatica		★		★	★		★	★		
Osmunda cinnamomea							★	★		
Osmunda regalis	★		★	★			★	★		
Panicum virgatum									★	★
Peltandra virginica	★	★	★		★	★				
Phoradendron flavescens					★					
Pinus taeda					★				•	•
Polygonum sp.	★	★	★		★	★	★	★		
Pontedaria cordata		★								
Quercus phellos					★					
Rhododendron viscosum						★		★		
Rhus radicans			★	★		★	★	★		
Rosa palustris	•	•	★	★						
Rubus sp.				★						
Rumex sp.	★									
Smilax sp.					★	★	★	★	★	
Solidago sempervirens									★	
Solidago sp.										★
Spartina patens									★	
Taxodium distichum					•	•				
Thalictrum sp.						★	★			
Typha angustifolia		★								
Vaccinium corymbosum							★	★		
Vaccinium sp.						★				
Viburnum sp.					★	★				
Mosses						★				
Lichens						★				

Table 106. Plant diversity in fresh marsh types. Type species, •; associated species, ★.

SPECIES \ TYPE STAND	30 A	30 B	31 A	31 B	32 A	32 B	33 A	33 B	35 A	35 B	36 A	36 B	38 A	38 B	39 A	39 B
Acnida cannabina	★	★					★	★				★				
Acorus calamus							•	•								
Bidens sp.	★	★			★	★			★	★						
Convolvulus sp.															★	★
Cuscata sp.	★						★									
Hibiscus palustris	★								•	•			★	★	★	★
Impatiens capensis	★	★					★	★	★	★					★	★
Kosteletzkya virginica															★	★
Leersia oryzoides													★	★		
Nuphar advena			•	•					★	★						
Parthenocissus quinquefolia															★	★
Peltandra virginica	★			★	•	•	★	★	★	★	★	★			★	★
Phragmites communis															•	•
Polygonum arifolium							★	★								
Polygonum sp.	•	•			★	★	★	★	★	★	★	★	★	★		
Pontedaria cordata					★	★					★	★				
Rumex sp.													★	★		
Sagittaria sp.							★	★								
Spartina cynosuroides													•	•		
Typha angustifolia							★			★						
Zizania aquatica							★	★			•	•				

Table 107. Plant diversity in brackish marsh types. Type species, •; associated species, ★.

SPECIES \ TYPE STAND	41 A	41 B	41 C	42 A	42 B	43 A	43 B	44 A	44 B	45 A	45 B	46 A	46 B	47 A	47 B	49 A	49 B	51 A	51 B
Acnida cannabina																	★		★
Apocynum sp.				★															
Baccharis halimifolia	★			•	•														
Cassia fasciculata				★															
Cyperaceae Fam.								★	★							★			
Diospyros virginiana				★															
Distichlis spicata			★			★	★	★	★						★				
Echinochloa walteri	★								★										★
Erianthus strictus														★					
Gramineae Fam.																	★		
Hibiscus palustris					★			★	★	•	•			★	★	★			
Impatiens capensis																			
Iva frutescens	★	★		•	•											★	★		
Juncaceae Fam.										★	★						★		
Juncus roemerianus						•	•								★				
Kosteletzkya virginica								★	★							★	★		
Myrica sp.				★	★														
Panicum virgatum	★			★						★	★	•	•	★				★	
Phragmites communis		★														•	•		
Pluchea purpurascens			★					★	★								★		
Polygonum sp.										★	★						★		★
Pontedaria cordata																		★	
Prunus serotina				★															
Rhus radicans				★															
Rubus sp.				★															
Rumex sp.																★			
Scirpus olneyi	★				★					★	★			•	•				
Spartina alterniflora		★														★	★	•	•
Spartina cynosuroides																★			★
Spartina patens	•	•	•	★	★	★	★	★	★					★	★	★			
Typha angustifolia								•	•	★	★								
Zizania aquatica																		★	★
Ferns				★															

APPENDIX 3.
OUTLINE DESCRIPTION OF METHODS USED TO MEASURE THE ACREAGES OF WETLAND VEGETATION TYPES

- Tape the mylar grid sheet to a light table.
- Align the photomap over grid sheet so that the outer line on the grid sheet corresponds to the outer line on the photomap. (The legend block at the bottom of the map, consequently, will overlay part of the grid).
- If the outer lines of the two mylar sheets do not coincide exactly, align the bottom left and bottom right corners of the photomap with the corresponding corners of the grid sheet.
- The grid consists of lines spaced 1.04 inches apart. This produces squares of 1 acre at a scale of 1 inch equals 200 feet.
- To use the grid, only the intersections of the lines are considered in the tabulations. Start at the top, left of the grid and scan to the right, across the first line that includes any wetlands. Then, drop to the next lower line and scan across that line from the right to the left, and then from the left to the right. Continue this sequence, scanning alternately from the right to the left, and then from the left to the right. This will minimize the chance that lines will be double counted or skipped.
- To tabulate the areas of the various types of wetlands, each intersection of vertical and horizontal lines is counted as 1 acre. The location of one intersection point within an area of any type of wetland is counted as 1 acre of that type.
- When intersection points are exactly on the lines between two types of vegetation, or between a wetland area and an upland area, alternately attribute the intersections to the type on the right hand side and, next, to the type on the left hand side.
- When an intersection falls in a mixed vegetation type, only the type that is predominant in the mix is regarded. Thus, a 34/32 mix will be counted in the acreage tally as Type 34 and a 41/51/47 mixed type will be recorded as Type 41.
- Tabulations of counts were recorded on a commercially available lab counter with eight separate tally banks and one sum total bank.
- On numerous photomaps, one or more types were present that, owing to the small sizes of their stands or their locations, were not sampled by the grid intersections. When this occurred, the tally sheet was marked with a 0 to indicate that the type was present, but was not counted in the tally.
- Type 101 was the most difficult type to grid. It also will be underestimated because large areas of open water were not included in the photographs of the wetlands.

APPENDIX 4.
WETLAND EVALUATION SHEETS FOR OLDMANS CREEK MARSH, SALISBURY MARSH, AND TINICUM MARSH IN THE DELAWARE RIVER ESTUARY

Table 108. Wetland evaluation sheet for Oldmans Creek Marsh in Salem and Gloucester Counties, New Jersey (Data source for vegetation types and acreages: McCormick and Ashbaugh, 1972). Type values are from Table 45 and wildlife food values are from Table 51.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	0		—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42				—	—	51		80	
62				—	—	9		5	
	SF	—	—	1.9	20	—	—	—	—
21				—	—	65		70	
22		16	1.9	—	—	94	1.79	15	0.29
23				—	—	99		15	
	SM	—	—	7.8	20	—	—	—	—
35		65	7.8	—	—	74	5.77	5	0.39
45				—	—	59		5	
	FM	—	—	64.4	10	—	—	—	—
30				—	—	62		100	
31		126	15.0	—	—	27	4.05	30	4.50
32		301	35.9	—	—	30	10.77	90	32.31
3A*		39	4.7	—	—	20	0.94	30	1.41
3B*		74	8.8	—	—	22	1.94	45	3.96
	GM	—	—	25.9	20	—	—	—	—
33		16	1.9	—	—	37	0.70	35	0.67
34		46	5.5	—	—	49	2.70	50	2.75
36		144	17.2	—	—	53	9.12	45	7.74
37				—	—	[26]		40	
38				—	—	100		40	
39		11	1.3	—	—	80	1.04	35	0.46
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		838(a)	100.0	100.0	70		38.82 (b)		54.48 (i)

Acreage		Veg/Water Interspersion		Vegetation Form	
Vegetation (a)	838	Water as %	12.4	Sum	70
Water	119	Interspersion:		Number of forms	4
Total	957	Throughout	____	Product	280
		Intermediate	x	Number of Vegetation Types	10
		Single Body	____		

Parameter	Value
Wetland Production Variable	38.82 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	58.23 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	35 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	58.45 (h)
Wildlife Food Score	54.48 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	81.72 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	56.72 (k)
Total Resource Score = (d + k)	114.95 (1)

*Types not officially recognized in Maryland Typing Scheme: 3A (waterhemp), 3B (burmarigold) (see Tables 21 and 22).

Table 109. Wetland evaluation sheet for Salisbury Marsh in Gloucester County, New Jersey (Data source for vegetation types and acreages: McCormick and Ashbaugh, 1972). Type values are from Table 45 and wildlife food values are from Table 51.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	0		—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42				—	—	51		80	
62				—	—	9		5	
	SF	—	—	0		—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—	0		—	—	—	
35				—	—	74		5	
45				—	—	59		5	
	FM	—	—	64.8	10	—	—	—	—
30				—	—	62		100	
31		7.0	18.9	—	—	27	5.10	30	5.67
32		10.0	27.0	—	—	30	8.10	90	24.30
3B*		6.0	16.2	—	—	22	3.56	45	7.29
3S*		1.0	2.7			19	0.51	45	1.22
	GM	—	—	35.4	20	—	—	—	—
33		3.0	8.1	—	—	37	3.00	35	2.84
34		8.0	21.6	—	—	49	10.58	50	10.80
36		2.0	5.4	—	—	53	2.86	45	2.43
37		0.1	0.3	—	—	[26]	0.08	40	0.12
38				—	—	100		40	
39				—	—	80		35	
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		37.1(a)	100.2	100.2	30		33.79 (b)		54.67 (i)

Acreage

Vegetation (a)	37.1
Water	5.0
Total	42.1

Veg/Water Interspersion

Water as %	11.9
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form

Sum	30
Number of forms	2
Product	60
Number of Vegetation Types	8

Parameter	Value
Wetland Production Variable	33.79 (b)
Vegetation Richness Factor	1.38 (c)
Vegetation Resource Group Score = (b × c)	46.63 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	15 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	25.05 (h)
Wildlife Food Score	54.67 (i)
Vegetation Richness Factor	1.38 (c)
Adjusted Wildlife Food Score = (i × c)	75.44 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	43.50 (k)
Total Resource Score = (d + k)	90.13 (1)

*Types not officially recognized in Maryland Typing Scheme: 3B (burmarigold), 3S (duckpotato) (See Tables 21 and 22).

Table 110. Wetland evaluation sheet for Tinicum Marsh on Darby Creek in Delaware and Philadelphia Counties, southeastern Pennsylvania (Data source for vegetation types and acreages: McCormick, 1970). Type values are from Table 45 and wildlife food values are from Table 51.

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	0		—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42				—	—	51		80	
62				—	—	9		5	
	SF	—	—	0		—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—	0		—	—	—	—
35				—	—	74		5	
45				—	—	59		5	
	FM	—	—	59.99	10	—	—	—	—
30		130.84	22.65	—	—	62	14.04	100	22.65
31		131.33	22.73	—	—	27	6.14	30	6.82
32				—	—	30		90	
3R*		84.38	14.61	—	—	26	3.80	5	0.73
	GM	—	—	40.00	20	—	—	—	—
33				—	—	37		35	
34		79.96	13.84	—	—	49	6.78	50	6.92
36		138.09	23.90	—	—	53	12.67	45	10.76
37				—	—	[26]		40	
38				—	—	100		40	
39		13.08	2.26	—	—	80	1.81	35	0.79
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		577.68(a)	99.99	99.99	30		45.24 (b)		48.67 (i)

Acreage		Veg/Water Interspersion		Vegetation Form	
Vegetation (a)	577.68	Water as %	10.11	Sum	30
Water	65.00	Interspersion:		Number of forms	2
Total	642.68	Throughout	___	Product	60
		Intermediate	x	Number of Vegetation Types	6
		Single Body	___		

Parameter	Value
Wetland Production Variable	45.24 (b)
Vegetation Richness Factor	1.38 (c)
Vegetation Resource Group Score = (b × c)	62.43 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	15 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	25.05 (h)
Wildlife Food Score	48.67 (i)
Vegetation Richness Factor	1.38 (c)
Adjusted Wildlife Food Score = (i × c)	67.16 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	40.74 (k)
Total Resource Score = (d + k)	103.17 (l)

*Type not officially recognized in Maryland Typing Scheme: 3R (giant ragweed) (See Tables 21 and 22).

APPENDIX 5.
WETLAND EVALUATION SHEETS FOR THE MAJOR COASTAL WATERSHEDS AND TIDEWATER COUNTIES

Lower Susquehanna River
02-12-02

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	12.5	20	—	—	—	—
11				—	—	39		5	
12		4	10.0	—	—	[52]	5.2	5	0.50
13		1	2.5	—	—	64	1.6	15	0.38
42				—	—	51		80	
62				—	—	9		5	
	SF	—	—	10.0	20	—	—	—	—
21				—	—	65		70	
22		4	10.0	—	—	94	9.4	15	1.50
23				—	—	99		15	
	SM	—	—		0	—	—	—	—
35				—	—	74		5	
45				—	—	59		5	
	FM	—	—	37.5	15	—	—	—	—
30		9	22.5	—	—	62	13.95	100	22.50
31				—	—	27		30	
32		6	15.0	—	—	30	4.50	90	13.50
	GM	—	—	40.0	20	—	—	—	—
33		2	5.0	—	—	37	1.85	35	1.75
34		13	32.5	—	—	49	15.93	50	16.25
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39		1	2.5	—	—	80	2.00	35	0.88
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		40.00(a)	100.00	100.00	75		54.43 (b)		57.26 (i)

Acreage	
Vegetation (a)	40
Water	0
Total	40

Veg/Water Interspersion	
Water as %	0
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	75
Number of forms	4
Product	300
Number of Vegetation Types	8

Parameter	Value
Wetland Production Variable	54.43 (b)
Vegetation Richness Factor	1.38 (c)
Vegetation Resource Group Score = (b × c)	75.11 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	35 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	70 (h)
Wildlife Food Score	57.26 (i)
Vegetation Richness Factor	1.38 (c)
Adjusted Wildlife Food Score = (i × c)	79.02 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	59.67 (k)
Total Resource Score = (d + k)	134.78 (1)

Coastal Area
02-13-01

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	12.94	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		29	0.20	—	—	64	0.13	15	0.03
42		50	0.35	—	—	51	0.18	80	0.28
62		1,780	12.39	—	—	9	1.12	5	0.62
	SF	—	—	0.28	20	—	—	—	—
21		2	0.01	—	—	65	0.01	70	0.01
22		35	0.24	—	—	94	0.23	15	0.04
23		4	0.03	—	—	99	0.03	15	0.004
	SM	—	—	0.01	20	—	—	—	—
35				—	—	74		5	
45		2	0.01	—	—	59	0.01	5	0.001
	FM	—	—	0.03	20	—	—	—	—
30		4	0.03	—	—	62	0.02	100	0.03
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—	86.72	20	—	—	—	—
33				—	—	37		35	
34				—	—	49		50	
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39				—	—	80		35	
41		18	0.13	—	—	39	0.05	60	0.08
43				—	—	56		15	
44		46	0.32	—	—	59	0.19	40	0.13
46		23	0.16	—	—	98	0.16	20	0.03
47		348	2.42	—	—	26	0.63	55	1.33
48				—	—	47		10	
49		26	0.18	—	—	93	0.17	5	0.01
51		26	0.18	—	—	41	0.07	50	0.09
61		2,304	16.04	—	—	20	3.21	20	3.21
63		121	0.84	—	—	50	0.42	5	0.04
71		95	0.66	—	—	50	0.33	15	0.10
72		9,449	65.79	—	—	20	13.16	15	9.87
Total:		14,362(a)	99.98	99.98	100		20.12 (b)		15.91(i)

Acreage

Vegetation (a)	14,362
Water	638
Total	15,000

Veg/Water Interspersion

Water as %	4.25
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	18

Parameter	Value
Wetland Production Variable	20.12 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	30.18 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	15.91 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	23.87 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	31.29 (k)
Total Resource Score = (d + k)	61.47 (1)

Pocomoke River
02-13-02

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	5.94	20	—	—	—	—
11				—	—	39		5	
12		1	0.002	—	—	[52]	0.001	5	0.0001
13		75	0.18	—	—	64	0.12	15	0.03
42		2,441	5.76	—	—	51	2.94	80	4.61
62				—	—	9		5	
	SF	—	—	16.96	20	—	—	—	—
21		4,152	9.79	—	—	65	6.36	70	6.85
22		2,884	6.80	—	—	94	6.39	15	1.02
23		159	0.37	—	—	99	0.37	15	0.06
	SM	—	—	0.26	20	—	—	—	—
35		105	0.25	—	—	74	0.19	5	0.01
45		4	0.01	—	—	59	0.006	5	0.001
	FM	—	—	1.59	20	—	—	—	—
30		454	1.07	—	—	62	0.66	100	1.07
31		143	0.34	—	—	27	0.09	30	0.10
32		77	0.18	—	—	30	0.05	90	0.16
	GM	—	—	75.26	20	—	—	—	—
33				—	—	37		35	
34		166	0.39	—	—	49	0.19	50	0.20
36		3	0.01	—	—	53	0.005	45	0.005
37				—	—	[26]		40	
38		348	0.82	—	—	100	0.82	40	0.33
39				—	—	80		35	
41		10,716	25.27	—	—	39	9.86	60	15.16
43		13,177	31.07	—	—	56	17.40	15	4.66
44		186	0.44	—	—	59	0.26	40	0.18
46		251	0.59	—	—	98	0.58	20	0.12
47		1,102	2.60	—	—	26	0.68	55	1.43
48		868	2.05	—	—	47	0.96	10	0.21
49		34	0.08	—	—	93	0.07	5	0.004
51		5,066	11.94	—	—	41	4.90	50	5.97
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72			—	—		20		15	
Total:		42,412(a)	100.01	100.01	100		52.90 (b)		42.18(i)

Acreage		Veg/Water Interspersion		Vegetation Form	
Vegetation (a)	42,412	Water as %	3.83	Sum	100
Water	1,689	Interspersion:		Number of forms	5
Total	44,101	Throughout	____	Product	500
		Intermediate	x	Number of Vegetation Types	22
		Single Body	____		

Parameter	Value
Wetland Production Variable	52.90 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	79.35 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	42.18 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	63.27 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	44.42 (k)
Total Resource Score = (d + k)	123.77 (1)

Nanticoke River
02-13-03

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	3.10	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		897	1.12	—	—	64	0.72	15	0.17
42		1,582	1.98	—	—	51	1.01	80	1.58
62				—	—	9		5	
	SF	—	—	9.87	20	—	—	—	—
21				—	—	65		70	
22		7,024	8.79	—	—	94	8.26	15	1.32
23		866	1.08	—	—	99	1.07	15	0.16
	SM	—	—	0.13	20	—	—	—	—
35		44	0.06	—	—	74	0.04	5	0.003
45		52	0.07	—	—	59	0.04	5	0.004
	FM	—	—	2.98	20	—	—	—	—
30		360	0.45	—	—	62	0.28	100	0.45
31		769	0.96	—	—	27	0.26	30	0.29
32		1,254	1.57	—	—	30	0.47	90	1.41
	GM	—	—	83.92	20	—	—	—	—
33		169	0.21	—	—	37	0.08	35	0.07
34		1,394	1.74	—	—	49	0.85	50	0.87
36		196	0.25	—	—	53	0.13	45	0.11
37		1,041	1.30	—	—	[26]	0.34	40	0.52
38		386	0.48	—	—	100	0.48	40	0.19
39		32	0.04	—	—	80	0.03	35	0.01
41		9,775	12.23	—	—	39	4.77	60	7.34
43		15,156	18.96	—	—	56	10.62	15	2.84
44		2,212	2.77	—	—	59	1.63	40	1.11
46		1,144	1.43	—	—	98	1.40	20	0.29
47		15,078	18.86	—	—	26	4.90	55	10.37
48		4,295	5.37	—	—	47	2.52	10	0.54
49		481	0.60	—	—	93	0.56	5	0.03
51		15,731	19.68	—	—	41	8.07	50	9.84
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		79,938(a)	100.00	100.00	100		48.53 (b)		39.52(i)

Acreage	
Vegetation (a)	79,938
Water	2,080
Total	82,018

Veg/Water Interspersion	
Water as %	2.54
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	23

Parameter	Value
Wetland Production Variable	48.53 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	72.80 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	39.52 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	59.28 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	43.09 (k)
Total Resource Score = (d + k)	115.89 (l)

Choptank River
02-13-04

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	11.88	20	—	—	—	—
11		8	0.03	—	—	39	0.01	5	0.002
12				—	—	[52]		5	
13		150	0.57	—	—	64	0.36	15	0.09
42		2,965	11.28	—	—	51	5.75	80	9.02
62				—	—	9		5	
	SF	—	—	4.57	20	—	—	—	—
21				—	—	65		70	
22		1,066	4.06	—	—	94	3.82	15	0.61
23		133	0.51	—	—	99	0.50	15	0.08
	SM	—	—	0.30	20	—	—	—	—
35		52	0.20	—	—	74	0.15	5	0.01
45		26	0.10	—	—	59	0.06	5	0.005
	FM	—	—	6.78	20	—	—	—	—
30		241	0.92	—	—	62	0.57	100	0.92
31		597	2.27	—	—	27	0.61	30	0.68
32		945	3.59	—	—	30	1.08	90	3.23
	GM	—	—	76.47	20	—	—	—	—
33		7	0.03	—	—	37	0.01	35	0.01
34		1,035	3.94	—	—	49	1.93	50	1.97
36		26	0.10	—	—	53	0.05	45	0.05
37		145	0.55	—	—	[26]	0.14	40	0.22
38		186	0.71	—	—	100	0.71	40	0.28
39		3	0.01	—	—	80	0.01	35	0.004
41		5,630	21.42	—	—	39	8.35	60	12.85
43		8,909	33.89	—	—	56	18.98	15	5.08
44		674	2.56	—	—	59	1.51	40	1.02
46		474	1.80	—	—	98	1.76	20	0.36
47		812	3.09	—	—	26	0.80	55	1.70
48		621	2.36	—	—	47	1.11	10	0.24
49		92	0.35	—	—	93	0.33	5	0.02
51		1,490	5.66	—	—	41	2.32	50	2.83
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		26,287(a)	100.00	100.00	100		50.92 (b)		41.28(i)

Acreage	
Vegetation (a)	26,287
Water	344
Total	26,631

Veg/Water Interspersion	
Water as %	1.29
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	24

Parameter	Value
Wetland Production Variable	50.92 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	76.38 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	41.28 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	61.92 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	43.97 (k)
Total Resource Score = (d + k)	120.35 (1)

Chester River
02-13-05

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	25.20	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		34	0.50	—	—	64	0.32	15	0.08
42		1,694	24.70	—	—	51	12.60	80	19.76
62				—	—	9		5	
	SF	—	—	0.28	20	—	—	—	—
21				—	—	65		70	
22		19	0.28	—	—	94	0.26	15	0.04
23				—	—	99		15	
	SM	—	—	0.43	20	—	—	—	—
35		10	0.15	—	—	74	0.11	5	0.01
45		19	0.28	—	—	59	0.17	5	0.01
	FM	—	—	3.84	20	—	—	—	—
30		19	0.28	—	—	62	0.17	100	0.28
31		6	0.09	—	—	27	0.02	30	0.03
32		238	3.47	—	—	30	1.04	90	3.12
	GM	—	—	70.26	20	—	—	—	—
33		5	0.07	—	—	37	0.03	35	0.02
34		473	6.90	—	—	49	3.38	50	3.45
36				—	—	53		45	
37		23	0.34	—	—	[26]	0.09	40	0.14
38		246	3.59	—	—	100	3.59	40	1.44
39		20	0.29	—	—	80	0.23	35	0.10
41		1,759	25.65	—	—	39	10.00	60	15.39
43		296	4.32	—	—	56	2.42	15	0.65
44		685	9.99	—	—	59	5.89	40	4.00
46		72	1.05	—	—	98	1.03	20	0.21
47		338	4.93	—	—	26	1.28	55	2.71
48		227	3.31	—	—	47	1.56	10	0.33
49		169	2.46	—	—	93	2.29	5	0.12
51		505	7.36	—	—	41	3.02	50	3.68
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		6,857(a)	100.01	100.01	100		49.50 (b)		55.57(i)

Acreage	
Vegetation (a)	6,857
Water	213
Total	7,070

Veg/Water Interspersion	
Water as %	3.01
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	20

Parameter	Value
Wetland Production Variable	49.50 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	74.25 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	55.57 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	83.36 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	60.05 (k)
Total Resource Score = (d + k)	134.30 (l)

Elk River
02-13-06

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	17.68	20	—	—	—	—
11				—	—	39		5	
12		120	3.50	—	—	[52]	1.82	5	0.18
13		482	14.06	—	—	64	9.00	15	2.11
42		4	0.12	—	—	51	0.06	80	0.10
62			—	—		9		5	
	SF	—	—	4.20	20	—	—	—	—
21				—	—	65		70	
22		144	4.20	—	—	94	3.95	15	0.63
23				—	—	99		15	
	SM	—	—	4.29	20	—	—	—	—
35		113	3.30	—	—	74	2.44	5	0.17
45		34	0.99	—	—	59	0.58	5	0.05
	FM	—	—	24.20	20	—	—	—	—
30		312	9.10	—	—	62	5.64	100	9.10
31		21	0.61	—	—	27	0.16	30	0.18
32		497	14.49	—	—	30	4.35	90	13.04
	GM	—	—	49.63	20	—	—	—	—
33		61	1.78	—	—	37	0.66	35	0.62
34		1,248	36.40	—	—	49	17.84	50	18.20
36		112	3.26	—	—	53	1.73	45	1.47
37		25	0.73	—	—	[26]	0.19	40	0.29
38				—	—	100		40	
39		104	3.03	—	—	80	2.42	35	1.06
41		7	0.20	—	—	39	0.08	60	0.12
43				—	—	56		15	
44		97	2.83	—	—	59	1.67	40	1.13
46				—	—	98		20	
47		26	0.76	—	—	26	0.20	55	0.42
48				—	—	47		10	
49		11	0.32	—	—	93	0.30	5	0.02
51		11	0.32	—	—	41	0.13	50	0.16
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		3,429(a)	100.00	100.00	100		53.22 (b)		49.05(i)

Acreage

Vegetation (a)	3,429
Water	100
Total	3,529

Veg/Water Interspersion

Water as %	2.83
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	19

Parameter	Value
Wetland Production Variable	53.22 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	79.83 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	80.00 (h)
Wildlife Food Score	49.05 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	73.58 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	61.19 (k)
Total Resource Score = (d + k)	141.02 (1)

Bush River
02-13-07

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	1.18	20	—	—	—	—
11		1	0.02	—	—	39	0.01	5	0.001
12		11	0.20	—	—	[52]	0.10	5	0.01
13		52	0.92	—	—	64	0.59	15	0.14
42		2	0.04	—	—	51	0.02	80	0.03
62			—	—		9		5	
	SF	—	—	3.13	20	—	—	—	—
21				—	—	65		70	
22		103	1.83	—	—	94	1.72	15	0.27
23		73	1.30	—	—	99	1.28	15	0.19
	SM	—	—	11.66	20	—	—	—	—
35		657	11.66	—	—	74	8.63	5	0.58
45				—	—	59		5	
	FM	—	—	10.13	20	—	—	—	—
30		95	1.69	—	—	62	1.05	100	1.69
31		17	0.30	—	—	27	0.08	30	0.09
32		459	8.14	—	—	30	2.44	90	7.33
	GM	—	—	73.93	20	—	—	—	—
33		145	2.57	—	—	37	0.95	35	0.90
34		2,442	43.33	—	—	49	21.23	50	21.67
36		154	2.73	—	—	53	1.45	45	1.23
37		906	16.08	—	—	[26]	4.18	40	6.43
38		239	4.24	—	—	100	4.24	40	1.70
39		139	2.47	—	—	80	1.97	35	0.86
41		2	0.04	—	—	39	0.01	60	0.02
43				—	—	56		15	
44				—	—	59		40	
46		139	2.47	—	—	98	2.42	20	0.49
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		5,636(a)	100.03	100.03	100		52.37 (b)		43.63(i)

Acreage	
Vegetation (a)	5,636
Water	13
Total	5,649

Veg/Water Interspersion	
Water as %	0.23
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	18

Parameter	Value
Wetland Production Variable	52.37 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	78.56 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	43.63 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	65.45 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	54.08 (k)
Total Resource Score = (d + k)	132.64 (1)

Gunpowder River
02-13-08

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	1.14	20	—	—	—	—
11				—	—	39		5	
12		11	0.50	—	—	[52]	0.26	5	0.03
13		13	0.59	—	—	64	0.38	15	0.09
42		1	0.05	—	—	51	0.03	80	0.04
62			—	—		9		5	
	SF	—	—	0.18	20	—	—	—	—
21				—	—	65		70	
22		4	0.18	—	—	94	0.17	15	0.03
23				—	—	99		15	
	SM	—	—	9.54	20	—	—	—	—
35		212	9.54	—	—	74	7.06	5	0.48
45				—	—	59		5	
	FM	—	—	11.17	20	—	—	—	—
30		99	4.46	—	—	62	2.77	100	4.46
31		5	0.23	—	—	27	0.06	30	0.07
32		144	6.48	—	—	30	1.94	90	5.83
	GM	—	—	78.02	20	—	—	—	—
33		25	1.13	—	—	37	0.42	35	0.40
34		1,064	47.88	—	—	49	23.46	50	23.94
36		39	1.76	—	—	53	0.93	45	0.79
37		393	17.69	—	—	[26]	4.60	40	7.08
38		63	2.84	—	—	100	2.84	40	1.14
39		71	3.20	—	—	80	2.56	35	1.12
41				—	—	39		60	
43				—	—	56		15	
44		22	0.99	—	—	59	0.58	40	0.40
46		23	1.04	—	—	98	1.02	20	0.21
47		18	0.81	—	—	26	0.21	55	0.45
48				—	—	47		10	
49		1	0.05	—	—	93	0.047	5	0.003
51		14	0.63	—	—	41	0.26	50	0.32
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,222(a)	100.05	100.05	100		49.60 (b)		46.88(i)

Acreage	
Vegetation (a)	2,222
Water	17
Total	2,239

Veg/Water Interspersion	
Water as %	0.76
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	19

Parameter	Value
Wetland Production Variable	49.60 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	74.40 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	46.88 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	70.32 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	46.77 (k)
Total Resource Score = (d + k)	121.17 (1)

Patapsco River
02-13-09

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	2.58	20	—	—	—	—
11				—	—	39		5	
12		1	0.14	—	—	[52]	0.07	5	0.01
13		1	0.14	—	—	64	0.09	15	0.02
42		17	2.30	—	—	51	1.17	80	1.84
62			—	—		9		5	
	SF	—	—		0	—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—	1.76	20	—	—	—	—
35		12	1.62	—	—	74	1.20	5	0.08
45		1	0.14	—	—	59	0.08	5	0.01
	FM	—	—	14.87	20	—	—	—	—
30		89	12.03	—	—	62	7.46	100	12.03
31				—	—	27		30	
32		21	2.84	—	—	30	0.85	90	2.56
	GM	—	—	80.80	20	—	—	—	—
33				—	—	37		35	
34		256	34.59	—	—	49	16.95	50	17.30
36				—	—	53		45	
37		89	12.03	—	—	[26]	3.13	40	4.81
38		4	0.54	—	—	100	0.54	40	0.22
39		94	12.70	—	—	80	10.16	35	4.45
41		18	2.43	—	—	39	0.95	60	1.46
43				—	—	56		15	
44		34	4.59	—	—	59	2.71	40	1.84
46		5	0.68	—	—	98	0.67	20	0.14
47		6	0.81	—	—	26	0.21	55	0.45
48		2	0.27	—	—	47	0.13	10	0.03
49		29	3.92	—	—	93	3.65	5	0.20
51		61	8.24	—	—	41	3.38	50	4.12
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		740(a)	100.01	100.01	80		53.40 (b)		51.57(i)

Acreage	
Vegetation (a)	740
Water	16
Total	756

Veg/Water Interspersion	
Water as %	2.12
Interspersion:	
Throughout	___
Intermediate	x
Single Body	___

Vegetation Form	
Sum	80
Number of forms	4
Product	320
Number of Vegetation Types	18

Parameter	Value
Wetland Production Variable	53.40 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	80.10 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	51.57 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	77.36 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	49.12 (k)
Total Resource Score = (d + k)	129.22 (1)

West Chesapeake Bay
02-13-10

Type	Form	Acres	% of Area: Type	% of Area: Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food: Value	Wildlife Food: Score
	SS	—	—	18.42	20	—	—	—	—
11		10	0.48	—	—	39	0.19	5	0.02
12				—	—	[52]		5	
13		22	1.06	—	—	64	0.68	15	0.16
42		350	16.88	—	—	51	8.61	80	13.50
62			—	—		9		5	
	SF	—	—	0.15	20	—	—	—	—
21				—	—	65		70	-
22		2	0.10	—	—	94	0.09	15	0.02
23		1	0.05	—	—	99	0.05	15	0.01
	SM	—	—	0.58	20	—	—	—	—
35				—	—	74		5	
45		12	0.58	—	—	59	0.34	5	0.03
	FM	—	—	0.34	20	—	—	—	—
30		7	0.34	—	—	62	0.21	100	0.34
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—	80.52	20	—	—	—	—
33		1	0.05	—	—	37	0.02	35	0.02
34		14	0.68	—	—	49	0.33	50	0.34
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39				—	—	80		35	
41		442	21.31	—	—	39	8.31	60	12.79
43				—	—	56		15	
44		615	29.65	—	—	59	17.49	40	11.86
46		15	0.72	—	—	98	0.71	20	0.14
47		60	2.89	—	—	26	0.75	55	1.59
48		19	0.92	—	—	47	0.43	10	0.09
49		80	3.86	—	—	93	3.59	5	0.19
51		424	20.44	—	—	41	8.38	50	10.22
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,074(a)	100.01	100.01	100		50.18 (b)		51.32(i)

Acreage	
Vegetation (a)	2,074
Water	55
Total	2,129

Veg/Water Interspersion	
Water as %	2.58
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	16

Parameter	Value
Wetland Production Variable	50.18 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	75.27 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	51.32 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	76.98 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	48.99 (k)
Total Resource Score = (d + k)	124.26 (1)

Patuxent River
02-13-11

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	12.47	20	—	—	—	—
11		25	0.39	—	—	39	0.15	5	0.02
12		339	5.30	—	—	[52]	2.76	5	0.27
13		97	1.52	—	—	64	0.97	15	0.23
42		337	5.26	—	—	51	2.68	80	4.21
62			—	—		9		5	
	SF	—	—	0.31	20	—	—	—	—
21				—	—	65		70	
22		14	0.22	—	—	94	0.21	15	0.03
23		6	0.09	—	—	99	0.09	15	0.01
	SM	—	—	1.05	20	—	—	—	—
35		25	0.39	—	—	74	0.29	5	0.02
45		42	0.66	—	—	59	0.39	5	0.03
	FM	—	—	17.95	20	—	—	—	—
30		889	13.89	—	—	62	8.61	100	13.89
31		132	2.06	—	—	27	0.56	30	0.62
32		128	2.00	—	—	30	0.60	90	1.80
	GM	—	—	68.21	20	—	—	—	—
33		15	0.23	—	—	37	0.09	35	0.08
34		714	11.15	—	—	49	5.46	50	5.58
36		237	3.70	—	—	53	1.96	45	1.67
37		73	1.14	—	—	[26]	0.30	40	0.46
38		122	1.91	—	—	100	1.91	40	0.76
39		270	4.22	—	—	80	3.38	35	1.48
41		384	6.00	—	—	39	2.34	60	3.60
43		2	0.03	—	—	56	0.02	15	0.005
44		838	13.09	—	—	59	7.72	40	5.24
46		11	0.17	—	—	98	0.17	20	0.03
47		362	5.66	—	—	26	1.47	55	3.11
48		865	13.51	—	—	47	6.35	10	1.35
49		25	0.39	—	—	93	0.36	5	0.02
51		449	7.01	—	—	41	2.87	50	3.51
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		6,401(a)	99.99	99.99	100		51.71 (b)		48.03(i)

Acreage

Vegetation (a)	6,401
Water	177
Total	6,578

Veg/Water Interspersion

Water as %	2.69
Interspersion:	
Throughout	___
Intermediate	x
Single Body	___

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	25

Parameter	Value
Wetland Production Variable	51.71 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	77.57 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	48.03 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	72.05 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	56.28 (k)
Total Resource Score = (d + k)	133.85 (1)

Chesapeake Bay
02-13-99

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	2.83	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13				—	—	64		15	
42		383	2.83	—	—	51	1.44	80	2.26
62			—	—		9		5	
	SF	—	—		0	—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—	0.05	20	—	—	—	—
35				—	—	74		5	
45		7	0.05	—	—	59	0.03	5	0.003
	FM	—	—		0	—	—	—	—
30				—	—	62		100	
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—	97.12	5	—	—	—	—
33				—	—	37		35	
34		2	0.01	—	—	49	0.005	50	0.005
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39		13	0.10	—	—	80	0.08	35	0.04
41		1,557	11.49	—	—	39	4.48	60	6.89
43		11,036	81.47	—	—	56	45.62	15	12.22
44				—	—	59		40	
46		3	0.02	—	—	98	0.02	20	0.004
47		15	0.11	—	—	26	0.03	55	0.06
48		1	0.01	—	—	47	0.005	10	0.001
49		1	0.01	—	—	93	0.009	5	0.0005
51		528	3.90	—	—	41	1.60	50	1.95
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		13,546(a)	100.00	100.00	45		53.32 (b)		23.43(i)

Acreage	
Vegetation (a)	13,546
Water	178
Total	13,724

Veg/Water Interspersion	
Water as %	1.30
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	45
Number of forms	3
Product	135
Number of Vegetation Types	11

Parameter	Value
Wetland Production Variable	53.32 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	79.98 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	20 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	20 (h)
Wildlife Food Score	23.43 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	35.15 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	28.38 (k)
Total Resource Score = (d + k)	108.36 (1)

Lower Potomac River
02-14-01

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	14.93	20	—	—	—	—
11		7	0.11	—	—	39	0.04	5	0.01
12		7	0.11	—	—	[52]	0.06	5	0.01
13		167	2.73	—	—	64	1.75	15	0.41
42		733	11.98	—	—	51	6.11	80	9.58
62			—	—		9		5	
	SF	—	—	0.38	20	—	—	—	—
21				—	—	65		70	
22		12	0.20	—	—	94	0.19	15	0.03
23		11	0.18	—	—	99	0.18	15	0.03
	SM	—	—	1.77	20	—	—	—	—
35		26	0.43	—	—	74	0.32	5	0.02
45		82	1.34	—	—	59	0.79	5	0.07
	FM	—	—	7.08	20	—	—	—	—
30		252	4.12	—	—	62	2.55	100	4.12
31		26	0.43	—	—	27	0.12	30	0.13
32		155	2.53	—	—	30	0.76	90	2.28
	GM	—	—	75.83	20	—	—	—	—
33				—	—	37		35	
34		186	3.04	—	—	49	1.49	50	1.52
36				—	—	53		45	
37		104	1.70	—	—	[26]	0.44	40	0.68
38		310	5.07	—	—	100	5.07	40	2.03
39				—	—	80		35	
41		764	12.49	—	—	39	4.87	60	7.49
43		109	1.78	—	—	56	1.00	15	0.27
44		282	4.61	—	—	59	2.72	40	1.84
46		5	0.08	—	—	98	0.08	20	0.02
47		800	13.08	—	—	26	3.40	55	7.19
48		1,298	21.22	—	—	47	9.97	10	2.12
49		6	0.10	—	—	93	0.09	5	0.005
51		774	12.66	—	—	41	5.19	50	6.33
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		6,116(a)	99.99	99.99	100		47.19 (b)		46.19(i)

Acreage	
Vegetation (a)	6,116
Water	36
Total	6,152

Veg/Water Interspersion	
Water as %	0.59
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	22

Parameter	Value
Wetland Production Variable	47.19 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	70.79 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	46.19 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	69.29 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	46.43 (k)
Total Resource Score = (d + k)	117.22 (1)

Washington Metropolitan Area
02-14-02

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	11.75	20	—	—	—	—
11				—	—	39		5	
12		30	10.07	—	—	[52]	5.24	5	0.50
13		5	1.68	—	—	64	1.08	15	0.25
42				—	—	51		80	
62			—	—		9		5	
	SF	—	—	26.84	20	—	—	—	—
21				—	—	65		70	
22		80	26.84	—	—	94	25.23	15	4.03
23				—	—	99		15	
	SM	—	—		0	—	—	—	—
35				—	—	74		5	
45				—	—	59		5	
	FM	—	—	51.34	10	—	—	—	—
30		94	31.54	—	—	62	19.55	100	31.54
31		58	19.46	—	—	27	5.25	30	5.84
32		1	0.34	—	—	30	0.10	90	0.31
	GM	—	—	10.07	20	—	—	—	—
33		1	0.34	—	—	37	0.13	35	0.12
34		11	3.69	—	—	49	1.81	50	1.85
36		9	3.02	—	—	53	1.60	45	1.36
37		9	3.02	—	—	[26]	0.79	40	1.21
38				—	—	100		40	
39				—	—	80		35	
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		298(a)	100.00	100.00	70		60.78 (b)		47.01(i)

Acreage	
Vegetation (a)	298
Water	0
Total	298

Veg/Water Interspersion	
Water as %	0
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	70
Number of forms	4
Product	280
Number of Vegetation Types	10

Parameter	Value
Wetland Production Variable	60.78 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	91.17 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	35 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	70 (h)
Wildlife Food Score	47.01 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	70.52 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	56.84 (k)
Total Resource Score = (d + k)	148.01 (1)

Anne Arundel County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	20.17	20	—	—	—	—
11		35	1.52	—	—	39	0.59	5	0.08
12		84	3.65	—	—	[52]	1.90	5	0.18
13		32	1.39	—	—	64	0.89	15	0.21
42		313	13.61	—	—	51	6.94	80	10.89
62			—	—		9		5	
	SF	—	—	0.74	20	—	—	—	—
21				—	—	65		70	
22		16	0.70	—	—	94	0.66	15	0.11
23		1	0.04	—	—	99	0.04	15	0.01
	SM	—	—	0.78	20	—	—	—	—
35		6	0.26	—	—	74	0.19	5	0.01
45		12	0.52	—	—	59	0.31	5	0.03
	FM	—	—	13.14	20	—	—	—	—
30		228	9.92	—	—	62	6.15	100	9.92
31		43	1.87	—	—	27	0.50	30	0.56
32		31	1.35	—	—	30	0.41	90	1.22
	GM	—	—	65.16	20	—	—	—	—
33		14	0.61	—	—	37	0.23	35	0.21
34		151	6.57	—	—	49	3.22	50	3.29
36		113	4.92	—	—	53	2.61	45	2.21
37				—	—	[26]		40	
38				—	—	100		40	
39		23	1.00	—	—	80	0.80	35	0.35
41		315	13.70	—	—	39	5.34	60	8.22
43				—	—	56		15	
44		369	16.05	—	—	59	9.47	40	6.42
46		9	0.39	—	—	98	0.38	20	0.08
47		21	0.91	—	—	26	0.24	55	0.50
48		21	0.91	—	—	47	0.43	10	0.09
49		82	3.57	—	—	93	3.32	5	0.18
51		380	16.53	—	—	41	6.78	50	8.27
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,299(a)	99.99	99.99	100		51.40 (b)		53.04(i)

Acreage	
Vegetation (a)	2,299
Water	55
Total	2,354

Veg/Water Interspersion	
Water as %	2.34
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	22

Parameter	Value
Wetland Production Variable	51.40 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	77.10 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	53.04 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	79.56 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	58.79 (k)
Total Resource Score = (d + k)	135.89 (1)

Baltimore County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	1.72	20	—	—	—	—
11				—	—	39		5	
12		10	0.48	—	—	[52]	0.25	5	0.02
13		6	0.29	—	—	64	0.18	15	0.04
42		20	0.95	—	—	51	0.49	80	0.76
62			—	—		9		5	
	SF	—	—	0.14	20	—	—	—	—
21				—	—	65		70	
22		3	0.14	—	—	94	0.13	15	0.02
23				—	—	99		15	
	SM	—	—	4.23	20	—	—	—	—
35		81	3.85	—	—	74	2.85	5	0.19
45		8	0.38	—	—	59	0.22	5	0.02
	FM	—	—	13.26	20	—	—	—	—
30		147	6.99	—	—	62	4.33	100	6.99
31		3	0.14	—	—	27	0.04	30	0.04
32		129	6.13	—	—	30	1.84	90	5.52
	GM	—	—	80.64	20	—	—	—	—
33		25	1.19	—	—	37	0.44	35	0.42
34		835	39.71	—	—	49	19.46	50	19.85
36		35	1.66	—	—	53	0.88	45	0.75
37		431	20.49	—	—	[26]	5.33	40	8.20
38		59	2.81	—	—	100	2.81	40	1.12
39		140	6.66	—	—	80	5.33	35	2.33
41		47	2.23	—	—	39	0.87	60	1.34
43				—	—	56		15	
44		30	1.43	—	—	59	0.84	40	0.57
46		20	0.95	—	—	98	0.93	20	0.19
47		39	1.85	—	—	26	0.48	55	1.02
48				—	—	47		10	
49		4	0.19	—	—	93	0.18	5	0.01
51		31	1.47	—	—	41	0.60	50	0.74
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,103(a)	99.99	99.99	100		48.48 (b)		50.14(i)

Acreage	
Vegetation (a)	2,103
Water	10
Total	2,113

Veg/Water Interspersion	
Water as %	0.47
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	21

Parameter	Value
Wetland Production Variable	48.48 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	72.72 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	50.14 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	75.21 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	48.40 (k)
Total Resource Score = (d + k)	121.12 (l)

Calvert County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	8.05	20	—	—	—	—
11				—	—	39		5	
12		6	0.23	—	—	[52]	0.12	5	0.01
13		18	0.68	—	—	64	0.44	15	0.10
42		190	7.14	—	—	51	3.64	80	5.71
62			—	—		9		5	
	SF	—	—		0	—	—	—	—
21				—	—	65		70	
22				—	—	94		15	
23				—	—	99		15	
	SM	—	—	0.67	20	—	—	—	—
35		11	0.41	—	—	74	0.30	5	0.02
45		7	0.26	—	—	59	0.15	5	0.01
	FM	—	—	4.14	20	—	—	—	—
30		25	0.94	—	—	62	0.58	100	0.94
31		6	0.23	—	—	27	0.06	30	0.07
32		79	2.97	—	—	30	0.89	90	2.67
	GM	—	—	87.15	20	—	—	—	—
33				—	—	37		35	
34		195	7.33	—	—	49	3.59	50	3.67
36		28	1.05	—	—	53	0.56	45	0.47
37		4	0.15	—	—	[26]	0.04	40	0.06
38		14	0.53	—	—	100	0.53	40	0.21
39		66	2.48	—	—	80	1.98	35	0.87
41		303	11.38	—	—	39	4.44	60	6.83
43		2	0.08	—	—	56	0.04	15	0.01
44		664	24.94	—	—	59	14.71	40	9.98
46		10	0.38	—	—	98	0.37	20	0.08
47		220	8.26	—	—	26	2.15	55	4.54
48		447	16.79	—	—	47	7.89	10	1.68
49		36	1.35	—	—	93	1.26	5	0.07
51		331	12.43	—	—	41	5.10	50	6.22
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,662(a)	100.01	100.01	80		48.84 (b)		44.22(i)

Acreage	
Vegetation (a)	2,662
Water	16
Total	2,678

Veg/Water Interspersion	
Water as %	0.60
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	80
Number of forms	4
Product	320
Number of Vegetation Types	21

Parameter	Value
Wetland Production Variable	48.84 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	73.26 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	44.22 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	66.33 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	45.44 (k)
Total Resource Score = (d + k)	118.70 (1)

Caroline County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	0.54	20	—	—	—	—
11		3	0.09	—	—	39	0.04	5	0.005
12				—	—	[52]		5	
13		2	0.06	—	—	64	0.04	15	0.01
42		13	0.39	—	—	51	0.20	80	0.31
62			—	—		9		5	
	SF	—	—	25.87	20	—	—	—	—
21				—	—	65		70	
22		871	25.87	—	—	94	24.32	15	3.88
23				—	—	99		15	
	SM	—	—	0.24	20	—	—	—	—
35		7	0.21	—	—	74	0.16	5	0.01
45		1	0.03	—	—	59	0.02	5	0.002
	FM	—	—	36.65	15	—	—	—	—
30		196	5.82	—	—	62	3.61	100	5.82
31		466	13.84	—	—	27	3.74	30	4.15
32		572	16.99	—	—	30	5.10	90	15.29
	GM	—	—	36.71	20	—	—	—	—
33		2	0.06	—	—	37	0.02	35	0.02
34		393	11.67	—	—	49	5.72	50	5.84
36		6	0.18	—	—	53	0.10	45	0.08
37		35	1.04	—	—	[26]	0.27	40	0.42
38		12	0.36	—	—	100	0.36	40	0.14
39		1	0.03	—	—	80	0.02	35	0.01
41		1	0.03	—	—	39	0.01	60	0.02
43				—	—	56		15	
44		196	5.82	—	—	59	3.43	40	2.33
46		120	3.56	—	—	98	3.49	20	0.71
47		203	6.03	—	—	26	1.57	55	3.32
48		232	6.89	—	—	47	3.24	10	0.69
49				—	—	93		5	
51		35	1.04	—	—	41	0.43	50	0.52
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		3,367(a)	100.01	100.01	95		55.89 (b)		43.58(i)

Acreage	
Vegetation (a)	3,367
Water	22
Total	3,389

Veg/Water Interspersion	
Water as %	0.65
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	95
Number of forms	5
Product	475
Number of Vegetation Types	21

Parameter	Value
Wetland Production Variable	55.89 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	83.84 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	80 (h)
Wildlife Food Score	43.58 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	65.37 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	58.46 (k)
Total Resource Score = (d + k)	142.30 (l)

Cecil County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	11.98	20	—	—	—	—
11				—	—	39		5	
12		124	5.29	—	—	[52]	2.75	5	0.26
13		157	6.69	—	—	64	4.28	15	1.00
42				—	—	51		80	
62			—	—		9		5	
	SF	—	—	3.28	20	—	—	—	—
21				—	—	65		70	
22		77	3.28	—	—	94	3.08	15	0.49
23				—	—	99		15	
	SM	—	—	2.56	20	—	—	—	—
35		60	2.56	—	—	74	1.89	5	0.13
45				—	—	59		5	
	FM	—	—	31.03	15	—	—	—	—
30		305	13.00	—	—	62	8.06	100	13.00
31		10	0.43	—	—	27	0.12	30	0.13
32		413	17.60	—	—	30	5.28	90	15.84
	GM	—	—	51.15	20	—	—	—	—
33		61	2.60	—	—	37	0.96	35	0.91
34		904	38.53	—	—	49	18.88	50	19.27
36		112	4.77	—	—	53	2.53	45	2.15
37		25	1.07	—	—	[26]	0.28	40	0.43
38				—	—	100		40	
39		98	4.18	—	—	80	3.34	35	1.46
41				—	—	39		60	
43				—	—	56		15	
44				—	—	59		40	
46				—	—	98		20	
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,346(a)	100.00	100.00	95		51.45 (b)		55.07(i)

Acreage	
Vegetation (a)	2,346
Water	0
Total	2,346

Veg/Water Interspersion	
Water as %	0
Interspersion:	
Throughout	___
Intermediate	x
Single Body	___

Vegetation Form	
Sum	95
Number of forms	5
Product	475
Number of Vegetation Types	12

Parameter	Value
Wetland Production Variable	51.45 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	77.18 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	80 (h)
Wildlife Food Score	55.07 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	82.61 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	64.20 (k)
Total Resource Score = (d + k)	141.38 (1)

Charles County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	10.93	20	—	—	—	—
11		7	0.17	—	—	39	0.07	5	0.01
12		1	0.02	—	—	[52]	0.01	5	0.001
13		165	4.02	—	—	64	2.57	15	0.60
42		276	6.72	—	—	51	3.43	80	5.38
62			—	—		9		5	
	SF	—	—	0.34	20	—	—	—	—
21				—	—	65		70	
22		11	0.27	—	—	94	0.25	15	0.04
23		3	0.07	—	—	99	0.07	15	0.01
	SM	—	—	1.49	20	—	—	—	—
35		18	0.44	—	—	74	0.33	5	0.02
45		43	1.05	—	—	59	0.62	5	0.05
	FM	—	—	10.44	20	—	—	—	—
30		248	6.04	—	—	62	3.74	100	6.04
31		26	0.63	—	—	27	0.17	30	0.19
32		155	3.77	—	—	30	1.13	90	3.39
	GM	—	—	76.81	20	—	—	—	—
33				—	—	37		35	
34		186	4.53	—	—	49	2.22	50	2.27
36				—	—	53		45	
37		104	2.53	—	—	[26]	0.66	40	1.01
38		310	7.55	—	—	100	7.55	40	3.02
39				—	—	80		35	
41		349	8.50	—	—	39	3.32	60	5.10
43		7	0.17	—	—	56	0.10	15	0.03
44		237	5.77	—	—	59	3.40	40	2.31
46				—	—	98		20	
47		669	16.29	—	—	26	4.24	55	8.96
48		970	23.61	—	—	47	11.10	10	2.36
49		3	0.07	—	—	93	0.07	5	0.004
51		320	7.79	—	—	41	3.19	50	3.90
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		4,108(a)	100.01	100.01	100		48.24 (b)		44.70(i)

Acreage	
Vegetation (a)	4,108
Water	16
Total	4,124

Veg/Water Interspersion	
Water as %	0.39
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	21

Parameter	Value
Wetland Production Variable	48.24 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	72.36 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	44.70 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	67.05 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	45.68 (k)
Total Resource Score = (d + k)	118.04 (1)

Dorchester County

Type	Form	Acres	% of Area: Type	% of Area: Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food: Value	Wildlife Food: Score
	SS	—	—	5.13	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		906	1.09	—	—	64	0.70	15	0.16
42		3,361	4.04	—	—	51	2.06	80	3.23
62			—	—		9		5	
	SF	—	—	7.85	20	—	—	—	—
21				—	—	65		70	
22		5,727	6.88	—	—	94	6.47	15	1.03
23		806	0.97	—	—	99	0.96	15	0.15
	SM	—	—	0.04	20	—	—	—	—
35		11	0.01	—	—	74	0.007	5	0.001
45		26	0.03	—	—	59	0.02	5	0.002
	FM	—	—	1.07	20	—	—	—	—
30		173	0.21	—	—	62	0.13	100	0.21
31		430	0.52	—	—	27	0.14	30	0.16
32		283	0.34	—	—	30	0.10	90	0.31
	GM	—	—	85.92	20	—	—	—	—
33		12	0.01	—	—	37	0.004	35	0.004
34		934	1.12	—	—	49	0.55	50	0.56
36		132	0.16	—	—	53	0.08	45	0.07
37		1,038	1.25	—	—	[26]	0.33	40	0.50
38		85	0.10	—	—	100	0.10	40	0.04
39		7	0.01	—	—	80	0.008	35	0.004
41		12,728	15.29	—	—	39	5.96	60	9.17
43		23,131	27.79	—	—	56	15.56	15	4.17
44		2,330	2.80	—	—	59	1.65	40	1.12
46		1,301	1.56	—	—	98	1.53	20	0.31
47		14,891	17.89	—	—	26	4.65	55	9.84
48		2,167	2.60	—	—	47	1.22	10	0.26
49		488	0.59	—	—	93	0.55	5	0.03
51		12,280	14.75	—	—	41	6.05	50	7.38
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		83,247(a)	100.01	100.01	100		48.83 (b)		38.71(i)

Acreage	
Vegetation (a)	83,247
Water	2,271
Total	85,518

Veg/Water Interspersion	
Water as %	2.66
Interspersion:	
Throughout	___
Intermediate	x
Single Body	___

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	23

Parameter	Value
Wetland Production Variable	48.83 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	73.25 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	38.71 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	58.07 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	42.69 (k)
Total Resource Score = (d + k)	115.94 (1)

Harford County

Type	Form	Acres	% of Area: Type	% of Area: Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food: Value	Wildlife Food: Score
	SS	—	—	1.17	20	—	—	—	—
11		1	0.02	—	—	39	0.01	5	0.001
12		13	0.20	—	—	[52]	0.10	5	0.01
13		59	0.92	—	—	64	0.59	15	0.14
42		2	0.03	—	—	51	0.02	80	0.02
62			—	—		9		5	
	SF	—	—	2.75	20	—	—	—	—
21				—	—	65		70	
22		104	1.62	—	—	94	1.52	15	0.24
23		73	1.13	—	—	99	1.12	15	0.17
	SM	—	—	12.42	20	—	—	—	—
35		800	12.42	—	—	74	9.19	5	0.62
45				—	—	59		5	
	FM	—	—	9.97	20	—	—	—	—
30		127	1.97	—	—	62	1.22	100	1.97
31		19	0.30	—	—	27	0.08	30	0.09
32		496	7.70	—	—	30	2.31	90	6.93
	GM	—	—	73.69	20	—	—	—	—
33		146	2.27	—	—	37	0.84	35	0.79
34		2,909	45.18	—	—	49	22.14	50	22.59
36		158	2.45	—	—	53	1.30	45	1.10
37		957	14.86	—	—	[26]	3.86	40	5.94
38		247	3.84	—	—	100	3.84	40	1.54
39		176	2.73	—	—	80	2.18	35	0.96
41		2	0.03	—	—	39	0.01	60	0.02
43				—	—	56		15	
44				—	—	59		40	
46		150	2.33	—	—	98	2.28	20	0.47
47				—	—	26		55	
48				—	—	47		10	
49				—	—	93		5	
51				—	—	41		50	
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		6,439(a)	100.00	100.00	100		52.61 (b)		43.60(i)

Acreage

Vegetation (a)	6,439
Water	37
Total	6,476

Veg/Water Interspersion

Water as %	0.57
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	18

Parameter	Value
Wetland Production Variable	52.61 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	78.91 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	43.60 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	65.40 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	54.07 (k)
Total Resource Score = (d + k)	132.98 (1)

Kent County

Type	Form	Acres	% of Area: Type	% of Area: Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food: Value	Wildlife Food: Score
	SS	—	—	22.23	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		354	8.96	—	—	64	5.73	15	1.34
42		524	13.27	—	—	51	6.77	80	10.62
62			—	—		9		5	
	SF	—	—	2.10	20	—	—	—	—
21				—	—	65		70	
22		83	2.10	—	—	94	1.97	15	0.32
23				—	—	99		15	
	SM	—	—	2.23	20	—	—	—	—
35		54	1.37	—	—	74	1.01	5	0.07
45		34	0.86	—	—	59	0.51	5	0.04
	FM	—	—	6.89	20	—	—	—	—
30		26	0.66	—	—	62	0.41	100	0.66
31		17	0.43	—	—	27	0.12	30	0.13
32		229	5.80	—	—	30	1.74	90	5.22
	GM	—	—	66.56	20	—	—	—	—
33		5	0.13	—	—	37	0.05	35	0.05
34		636	16.10	—	—	49	7.89	50	8.05
36				—	—	53		45	
37		23	0.58	—	—	[26]	0.15	40	0.23
38		223	5.65	—	—	100	5.65	40	2.26
39		17	0.43	—	—	80	0.34	35	0.15
41		706	17.87	—	—	39	6.97	60	10.72
43		7	0.18	—	—	56	0.10	15	0.03
44		192	4.86	—	—	59	2.87	40	1.94
46		52	1.32	—	—	98	1.29	20	0.26
47		296	7.49	—	—	26	1.95	55	4.12
48		13	0.33	—	—	47	0.16	10	0.03
49		61	1.54	—	—	93	1.43	5	0.08
51		398	10.08	—	—	41	4.13	50	5.04
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		3,950(a)	100.01	100.01	100		51.24 (b)		51.36(i)

Acreage	
Vegetation (a)	3,950
Water	140
Total	4,090

Veg/Water Interspersion	
Water as %	3.42
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	21

Parameter	Value
Wetland Production Variable	51.24 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	76.86 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	51.36 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	77.04 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	57.95 (k)
Total Resource Score = (d + k)	134.81 (1)

Prince George's County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	10.89	20	—	—	—	—
11				—	—	39		5	
12		263	9.39	—	—	[52]	4.88	5	0.47
13		40	1.43	—	—	64	0.92	15	0.21
42		2	0.07	—	—	51	0.04	80	0.06
62			—	—		9		5	
	SF	—	—	2.86	20	—	—	—	—
21				—	—	65		70	
22		80	2.86	—	—	94	2.69	15	0.43
23				—	—	99		15	
	SM	—	—	0.29	20	—	—	—	—
35		8	0.29	—	—	74	0.21	5	0.01
45				—	—	59		5	
	FM	—	—	32.16	15	—	—	—	—
30		740	26.42	—	—	62	16.38	100	26.42
31		141	5.03	—	—	27	1.36	30	1.51
32		20	0.71	—	—	30	0.21	90	0.64
	GM	—	—	53.81	20	—	—	—	—
33		3	0.11	—	—	37	0.04	35	0.04
34		421	15.03	—	—	49	7.36	50	7.52
36		105	3.75	—	—	53	1.99	45	1.69
37		78	2.78	—	—	[26]	0.72	40	1.11
38		108	3.86	—	—	100	3.86	40	1.54
39		183	6.53	—	—	80	5.22	35	2.29
41		22	0.79	—	—	39	0.31	60	0.47
43				—	—	56		15	
44		171	6.10	—	—	59	3.60	40	2.44
46				—	—	98		20	
47		126	4.50	—	—	26	1.17	55	2.48
48		274	9.78	—	—	47	4.60	10	0.98
49		8	0.29	—	—	93	0.27	5	0.01
51		8	0.29	—	—	41	0.12	50	0.15
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		2,801(a)	100.01	100.01	95		55.95 (b)		50.47(i)

Acreage		Veg/Water Interspersion		Vegetation Form	
Vegetation (a)	2,801	Water as %	0	Sum	95
Water	0	Interspersion:		Number of forms	5
Total	2,801	Throughout	____	Product	475
		Intermediate	x	Number of Vegetation Types	20
		Single Body	____		

Parameter	Value
Wetland Production Variable	55.95 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	83.93 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	80 (h)
Wildlife Food Score	50.47 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	75.71 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	61.90 (k)
Total Resource Score = (d + k)	145.83 (l)

Queen Anne's County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	26.33	15	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		4	0.12	—	—	64	0.08	15	0.02
42		897	26.21	—	—	51	13.37	80	20.97
62			—	—		9		5	
	SF	—	—	0.20	20	—	—	—	—
21				—	—	65		70	
22		7	0.20	—	—	94	0.19	15	0.03
23				—	—	99		15	
	SM	—	—	0.70	20	—	—	—	—
35		9	0.26	—	—	74	0.19	5	0.01
45		15	0.44	—	—	59	0.26	5	0.02
	FM	—	—	2.71	20	—	—	—	—
30		7	0.20	—	—	62	0.12	100	0.20
31				—	—	27		30	
32		86	2.51	—	—	30	0.75	90	2.26
	GM	—	—	70.05	20	—	—	—	—
33				—	—	37		35	
34		152	4.44	—	—	49	2.18	50	2.22
36				—	—	53		45	
37				—	—	[26]		40	
38		23	0.67	—	—	100	0.67	40	0.27
39		9	0.26	—	—	80	0.21	35	0.09
41		935	27.32	—	—	39	10.65	60	16.39
43		281	8.21	—	—	56	4.60	15	1.23
44		493	14.41	—	—	59	8.50	40	5.76
46		18	0.53	—	—	98	0.52	20	0.11
47		65	1.90	—	—	26	0.49	55	1.05
48		212	6.20	—	—	47	2.91	10	0.62
49		105	3.07	—	—	93	2.86	5	0.15
51		104	3.04	—	—	41	1.25	50	1.52
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		3,422(a)	99.99	99.99	95		49.80 (b)		52.92(i)

Acreage	
Vegetation (a)	3,422
Water	134
Total	3,556

Veg/Water Interspersion	
Water as %	3.77
Interspersion:	
Throughout	____
Intermediate	x
Single Body	____

Vegetation Form	
Sum	95
Number of forms	5
Product	475
Number of Vegetation Types	18

Parameter	Value
Wetland Production Variable	49.80 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	74.70 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	52.92 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	79.38 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	58.73 (k)
Total Resource Score = (d + k)	133.43 (1)

Somerset County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	6.15	20	—	—	—	—
11				—	—	39		5	
12		1	0.002	—	—	[52]	0.001	5	0.0001
13		67	0.13	—	—	64	0.08	15	0.02
42		3,057	6.02	—	—	51	3.07	80	4.82
62			—	—		9		5	
	SF	—	—	2.48	20	—	—	—	—
21		559	1.10	—	—	65	0.72	70	0.77
22		519	1.02	—	—	94	0.96	15	0.15
23		181	0.36	—	—	99	0.36	15	0.05
	SM	—	—	0.06	20	—	—	—	—
35		26	0.05	—	—	74	0.04	5	0.003
45		4	0.01	—	—	59	0.006	5	0.0005
	FM	—	—	0.24	20	—	—	—	—
30		63	0.12	—	—	62	0.07	100	0.12
31				—	—	27		30	
32		61	0.12	—	—	30	0.04	90	0.11
	GM	—	—	91.06	20	—	—	—	—
33		11	0.02	—	—	37	0.007	35	0.007
34		132	0.26	—	—	49	0.13	50	0.13
36				—	—	53		45	
37				—	—	[26]		40	
38		190	0.37	—	—	100	0.37	40	0.15
39		1	0.002	—	—	80	0.002	35	0.0007
41		13,236	26.06	—	—	39	10.16	60	15.64
43		22,543	44.39	—	—	56	24.86	15	6.66
44		197	0.39	—	—	59	0.23	40	0.16
46		253	0.50	—	—	98	0.49	20	0.10
47		1,656	3.26	—	—	26	0.85	55	1.79
48		1,093	2.15	—	—	47	1.01	10	0.22
49		38	0.07	—	—	93	0.07	5	0.004
51		6,901	13.59	—	—	41	5.57	50	6.80
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		50,789(a)	99.99	99.99	100		49.10 (b)		37.71 (i)

Acreage	
Vegetation (a)	50,789
Water	1,829
Total	52,618

Veg/Water Interspersion	
Water as %	3.48
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	22

Parameter	Value
Wetland Production Variable	49.10 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	73.65 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	37.71 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	56.56 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	42.19 (k)
Total Resource Score = (d + k)	115.84 (1)

St. Mary's County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	22.07	20	—	—	—	—
11				—	—	39		5	
12		22	0.69	—	—	[52]	0.36	5	0.03
13		37	1.17	—	—	64	0.75	15	0.18
42		640	20.21	—	—	51	10.31	80	16.17
62			—	—		9		5	
	SF	—	—	0.47	20	—	—	—	—
21				—	—	65		70	
22		1	0.03	—	—	94	0.03	15	0.005
23		14	0.44	—	—	99	0.44	15	0.07
	SM	—	—	2.59	20	—	—	—	—
35		8	0.25	—	—	74	0.19	5	0.01
45		74	2.34	—	—	59	1.38	5	0.12
	FM	—	—	0.38	20	—	—	—	—
30		12	0.38	—	—	62	0.24	100	0.38
31				—	—	27		30	
32				—	—	30		90	
	GM	—	—	74.47	20	—	—	—	—
33				—	—	37		35	
34				—	—	49		50	
36				—	—	53		45	
37				—	—	[26]		40	
38				—	—	100		40	
39				—	—	80		35	
41		605	19.10	—	—	39	7.45	60	11.46
43		102	3.22	—	—	56	1.80	15	0.48
44		320	10.10	—	—	59	5.96	40	4.04
46		12	0.38	—	—	98	0.37	20	0.08
47		186	5.87	—	—	26	1.53	55	3.23
48		472	14.90	—	—	47	7.00	10	1.49
49		9	0.28	—	—	93	0.26	5	0.01
51		653	20.62	—	—	41	8.45	50	10.31
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		3,167(a)	99.98	99.98	100		46.52 (b)		48.07 (i)

Acreage	
Vegetation (a)	3,167
Water	189
Total	3,356

Veg/Water Interspersion	
Water as %	5.63
Interspersion:	
Throughout	
Intermediate	x
Single Body	

Vegetation Form	
Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	16

Parameter	Value
Wetland Production Variable	46.52 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	69.78 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.67 (g)
Adjusted Vegetation Form Variable = (f × g)	66.80 (h)
Wildlife Food Score	48.07 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	72.11 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	56.30 (k)
Total Resource Score = (d + k)	126.08 (1)

Talbot County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	23.17	20	—	—	—	—
11		5	0.10	—	—	39	0.04	5	0.01
12				—	—	[52]		5	
13		27	0.56	—	—	64	0.36	15	0.08
42		1,076	22.51	—	—	51	11.48	80	18.01
62			—	—		9		5	
	SF	—	—	3.93	20	—	—	—	—
21				—	—	65		70	
22		188	3.93	—	—	94	3.69	15	0.59
23				—	—	99		15	
	SM	—	—	1.48	20	—	—	—	—
35		44	0.92	—	—	74	0.68	5	0.05
45		27	0.56	—	—	59	0.33	5	0.03
	FM	—	—	11.28	20	—	—	—	—
30		40	0.84	—	—	62	0.52	100	0.84
31		118	2.47	—	—	27	0.67	30	0.74
32		381	7.97	—	—	30	2.39	90	7.17
	GM	—	—	60.13	20	—	—	—	—
33		6	0.13	—	—	37	0.05	35	0.05
34		667	13.95	—	—	49	6.84	50	6.98
36		5	0.10	—	—	53	0.05	45	0.05
37		110	2.30	—	—	[26]	0.60	40	0.92
38		172	3.60	—	—	100	3.60	40	1.44
39		2	0.04	—	—	80	0.03	35	0.01
41		552	11.55	—	—	39	4.50	60	6.93
43		122	2.55	—	—	56	1.43	15	0.38
44		380	7.95	—	—	59	4.69	40	3.18
46		80	1.67	—	—	98	1.64	20	0.33
47		46	0.96	—	—	26	0.25	55	0.53
48		314	6.57	—	—	47	3.09	10	0.66
49		78	1.63	—	—	93	1.52	5	0.08
51		341	7.13	—	—	41	2.92	50	3.57
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		4,781(a)	99.99	99.99	100		51.37 (b)		52.63(i)

Acreage		Veg/Water Interspersion		Vegetation Form	
Vegetation (a)	4,781	Water as %	2.67	Sum	100
Water	131	Interspersion:		Number of forms	5
Total	4,912	Throughout	____	Product	500
		Intermediate	x	Number of Vegetation Types	23
		Single Body	____		

Parameter	Value
Wetland Production Variable	51.37 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	77.06 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	80 (h)
Wildlife Food Score	52.63 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	78.95 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	62.98 (k)
Total Resource Score = (d + k)	140.04 (1)

Wicomico County

Type	Form	Acres	% of Area Type	% of Area Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food Value	Wildlife Food Score
	SS	—	—	1.79	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		110	0.81	—	—	64	0.52	15	0.12
42		133	0.98	—	—	51	0.50	80	0.78
62			—	—		9		5	
	SF	—	—	10.86	20	—	—	—	—
21				—	—	65		70	
22		1,304	9.60	—	—	94	9.02	15	1.44
23		171	1.26	—	—	99	1.25	15	0.19
	SM	—	—	0.45	20	—	—	—	—
35		33	0.24	—	—	74	0.18	5	0.01
45		28	0.21	—	—	59	0.12	5	0.01
	FM	—	—	10.92	20	—	—	—	—
30		180	1.32	—	—	62	0.82	100	1.32
31		352	2.59	—	—	27	0.70	30	0.78
32		952	7.01	—	—	30	2.10	90	6.31
	GM	—	—	75.97	20	—	—	—	—
33		146	1.07	—	—	37	0.40	35	0.37
34		400	2.94	—	—	49	1.44	50	1.47
36		79	0.58	—	—	53	0.31	45	0.26
37		3	0.02	—	—	[26]	0.01	40	0.01
38		284	2.09	—	—	100	2.09	40	0.84
39		24	0.18	—	—	80	0.14	35	0.06
41		1,253	9.22	—	—	39	3.60	60	5.53
43		2,490	18.32	—	—	56	10.26	15	2.75
44		66	0.49	—	—	59	0.29	40	0.20
46		112	0.82	—	—	98	0.80	20	0.16
47		199	1.46	—	—	26	0.38	55	0.80
48		1,981	14.58	—	—	47	6.85	10	1.46
49		17	0.13	—	—	93	0.12	5	0.01
51		3,271	24.07	—	—	41	9.87	50	12.04
61				—	—	20		20	
63				—	—	50		5	
71				—	—	50		15	
72				—	—	20		15	
Total:		13,588(a)	99.99	99.99	100		51.77 (b)		36.92(i)

Acreage

Vegetation (a)	13,588
Water	68
Total	13,656

Veg/Water Interspersion

Water as %	0.50
Interspersion:	
Throughout	___
Intermediate	x
Single Body	___

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	23

Parameter	Value
Wetland Production Variable	51.77 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	77.66 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	1.00 (g)
Adjusted Vegetation Form Variable = (f × g)	40 (h)
Wildlife Food Score	36.92 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	55.38 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	41.79 (k)
Total Resource Score = (d + k)	119.45 (1)

Worcester County

Type	Form	Acres	% of Area: Type	% of Area: Form	Form Value	Type Value	Wetland Production Variable	Wildlife Food: Value	Wildlife Food: Score
	SS	—	—	8.81	20	—	—	—	—
11				—	—	39		5	
12				—	—	[52]		5	
13		41	0.19	—	—	64	0.12	15	0.03
42		55	0.26	—	—	51	0.13	80	0.21
62		1,780	8.36	—	—	9	0.75	5	0.42
	SF	—	—	28.18	20	—	—	—	—
21		3,595	16.89	—	—	65	10.98	70	11.82
22		2,400	11.27	—	—	94	10.59	15	1.69
23		4	0.02	—	—	99	0.02	15	0.003
	SM	—	—	0.39	20	—	—	—	—
35		80	0.38	—	—	74	0.28	5	0.02
45		2	0.01	—	—	59	0.006	5	0.0005
	FM	—	—	2.76	20	—	—	—	—
30		407	1.91	—	—	62	1.18	100	1.91
31		143	0.67	—	—	27	0.18	30	0.20
32		38	0.18	—	—	30	0.05	90	0.16
	GM	—	—	59.84	20	—	—	—	—
33				—	—	37		35	
34		103	0.48	—	—	49	0.24	50	0.24
36		3	0.01	—	—	53	0.005	45	0.005
37				—	—	[26]		40	
38		177	0.83	—	—	100	0.83	40	0.33
39				—	—	80		35	
41		18	0.08	—	—	39	0.03	60	0.05
43				—	—	56		15	
44		46	0.22	—	—	59	0.13	40	0.09
46		28	0.13	—	—	98	0.13	20	0.03
47		348	1.63	—	—	26	0.42	55	0.90
48				—	—	47		10	
49		26	0.12	—	—	93	0.11	5	0.01
51		26	0.12	—	—	41	0.05	50	0.06
61		2,304	10.82	—	—	20	2.16	20	2.16
63		121	0.57	—	—	50	0.29	5	0.03
71		95	0.45	—	—	50	0.23	15	0.07
72		9,449	44.38	—	—	20	8.88	15	6.66
Total:		21,289(a)	99.98	99.98	100		37.79(b)		27.10 (i)

Acreage

Vegetation (a)	21,289
Water	638
Total	21,927

Veg/Water Interspersion

Water as %	2.91
Interspersion:	
Throughout	___
Intermediate	x
Single Body	___

Vegetation Form

Sum	100
Number of forms	5
Product	500
Number of Vegetation Types	24

Parameter	Value
Wetland Production Variable	37.79 (b)
Vegetation Richness Factor	1.50 (c)
Vegetation Resource Group Score = (b × c)	56.69 (d)
Vegetation/Water Interspersion Variable	30 (e)
Vegetation Form Variable	40 (f)
Vegetation Interspersion Factor	2.00 (g)
Adjusted Vegetation Form Variable = (f × g)	80 (h)
Wildlife Food Score	27.10 (i)
Vegetation Richness Factor	1.50 (c)
Adjusted Wildlife Food Score = (i × c)	40.65 (j)
Wildlife Resource Group Score = $\frac{(e) + (h) + (j)}{3}$	50.22 (k)
Total Resource Score = (d + k)	106.91 (1)

APPENDIX 6.
CONSULTANT RECOMMENDATIONS

A variety of recommendations were developed during the course of the wetlands management study. The following is a summary listing of all significant recommendations. The recommendations are divided into two major categories: management and technical. Management recommendations relate to general policies and regulatory strategies for wetlands management by DNR. Technical recommendations concern specific details of the administration of the wetlands program, and include comments on the wetland typing, aerial photography, and mapping. The arrangement of the recommendations does not reflect any order of priority.

MANAGEMENT RECOMMENDATIONS

Update Aerial Imagery

The 1970-1972 aerial photography is now seven to nine years old. During the field surveys a number of areas were observed where natural changes have occurred in the wetlands since the photography was flown. Much of this was due to shoreline erosion and subsidence, although several wetland coves along the main body of the Chesapeake Bay had either become tidal or non-tidal depending upon berm elimination or deposition. Also, the boundaries of some stands had changed considerably, for reasons which can only be speculated. These changes indicate the dynamic nature of the Maryland wetlands, and appropriate considerations should be made when using the mapping, which reflects only the condition of the wetlands at a single point in time. Consequently, the wetland maps will become increasingly outdated as time passes, due to changes in the shoreline, wetland types, and the upper inland boundary. At some time in the future (possibly ten years after the original aerial photograph) it will be advisable to rephotograph the wetlands and update the wetlands maps. This will not only provide a current data base for the management program, but also provide an invaluable overview of changes in wetland conditions. This overview will provide insight into shoreline and wetland changes in relation to erosion and sedimentation, land subsidence, and human activities.

Submerged Aquatic Vegetation

The delineation of submerged aquatics (Type 101) on the wetland maps should be considered as a conservative representation of their actual extent. Additional beds are believed to exist, but they were masked in the imagery by siltation, water depth, background color of bottom sediments, waves, and sun glare. In addition, the occurrence of submerged aquatics varies greatly from year to year and the Type 101 mapping is far less reflective of current conditions than the mapping of emergent vegetated wetlands. Type 101 also is a catch-all for a variety of aquatic plants. This type includes submerged rooted aquatics (e.g., wild celery, eelgrass, wigeongrass), floating rooted (pond lily) and non-rooted (duckweed) plants, and the alga called sea lettuce (*Ulva* spp.). These subtypes span a wide variety of salinities, water depth, bottom conditions, species composition, and growth form.

Although the available aerial imagery and the underwater situation limited detailed mapping and evaluation, the submerged aquatic vegetation warrants further study because of its importance both to marine life and to waterfowl. The immediate need is for a refinement of the mapping into more specific types. Subsequent studies should be directed towards a determination of environmental factors that affect the occurrence and distribution of submerged aquatics, particularly in regard to water quality and bottom conditions as affected by human activities.

Marsh Burning

Winter burning of brackish marshes is conducted extensively in Dorchester and Somerset Counties. Negligible published information was located regarding marsh burning. It would be useful to study this activity to define more clearly the purposes, to determine whether the intended goals are achieved, and to evaluate the impact upon the wetlands (e.g., species selection, productivity, substrate conditions). The proportion of fires that are set by arsonists should be determined, and the effects of such fires should be evaluated.

Upper Inland Boundary

A systematic on-going procedure should be established to revise the wetland maps to indicate alterations of the upper inland wetlands boundary that result from permitted activities and natural factors. A program of surveillance to detect unauthorized activities in the coastal wetlands also should be developed.

Wetland Studies

The wetland value assessment and environmental evaluation have indicated a number of data deficiencies concerning our knowledge of the wetland ecosystem. DNR should encourage researchers to direct their wetland studies toward rectifying major data deficiencies. More importantly, researchers should be strongly urged to use the DNR wetland classification system as a standard for wetlands type descriptions. This would establish a basis for direct comparisons of data from independent research studies.

Computerize Data

DNR should establish a land-oriented computer program for the storage and retrieval of wetland information. The program could utilize the wetland photomaps as the basic template for data storage, and employ an overlay coordinate grid to identify specific locations within the photomaps. Initial data storage could encompass the areal measurements of wetland types that were conducted during the wetlands management study. Future programming could be expanded to differentiate State and private wetlands, wildlife and fisheries observations, water quality information, management programs, and permit activities.

TECHNICAL RECOMMENDATIONS

Wetland Typing

Shrub Swamp Types. Only a few, small stands of the smooth alder/black willow shrub type (12) on the

Patuxent River in Charles County and Anne Arundel County were mapped in the sixteen-county study area. In addition, the swamp rose shrub type (11) and red maple/ash type (13) are very similar in appearance from the air, and could not be distinguished on the existing aerial photographs. Stands of swamp rose were delineated only where observed during field surveys. Consequently, the occurrence of shrub swamps is biased in favor of Type 13, red maple/ash. Detailed surveys related to specific permit applications and research studies, however, will be able to evaluate Types 11 and 12 more adequately on a site by site basis.

Loblolly Pine Wooded Swamp. An additional swamp type—loblolly pine, Type 23—was added to the wetlands typing system after the mapping had been initiated. This type typically consists of closed-canopy or scattered loblolly pine, with an undergrowth of switchgrass and/or common reed. Subtyping of undergrowth types was not performed, and probably would require low-altitude true color photography and intensive field checks. However, in several areas in Dorchester County, clearly definable stands of common reed were observed growing under the pine. It would be interesting to investigate some of these common reed stands, and determine whether they reflect pioneer wetland vegetation that is being favored by increased tidal incursions.

Spatterdock. Delineation of spatterdock (Type 31) is limited in late-season photography after mid-October due to the deterioration of plant materials. Particular difficulty occurs in delineating isolated clones in open water because of the absence of indications of stand boundaries. This problem is aggravated when silty water obscured plant remnants and bottom features at the time of the original aerial photography.

Rosemallow. The identification of rosemallow (Types 35 and 45) is limited by the nature of the plant and by the scale of the current mapping effort. Prior to September, true color imagery does not differentiate the marsh types well. During September, however, rosemallow drops its leaves very rapidly, and its occurrence is generally screened by other plants. Low-altitude true color photography during the period of flowering should make it possible to differentiate the rosemallow types from other scrub types.

Wild Rice. Consideration should be given to establishing two growth forms for wild rice: a tall form (possibly above 6 feet) in pure freshwater areas; and a low form (6 feet or less) in slightly-brackish freshwater marshes. Productivity probably varies considerably between the two forms and the marsh associations also are different. The tall form occurs usually in pure stands, and occasionally has an undergrowth of *Peltandra, Juncus, Scirpus, Polygonum, S. alterniflora, Echinochloa,* and various forbs (e.g., cardinal flower, asters, composites, mallow).

Smooth Cordgrass, Tall Growth Form. The delineation of the tall growth form of smooth cordgrass (Type 71) is limited due to the narrow width of most stands. Many of the current photographs were taken during periods of high tide. General glare and reflections of the sun on these photographs made it impossible to distinguish differences in height.

Additional Wetland Types. Several minor wetland types could be added to the DNR classification system. These generally occur in association with the existing major wetland types; they may warrant individual consideration, however, in site-specific studies.

- Fresh Marsh Category
  - Rush *(Juncus effusus)*
  - Switchgrass *(Panicum virgatum)*
  - Waterhemp *(Acnida cannabina)*
- Saline High Marsh Category
  - Switchgrass *(Panicum virgatum)*

Marsh Burning. Marsh burning in Dorchester and Somerset Counties complicated the classifications of brackish marshes because recent burns in which the vegetation had been destroyed appeared on some imagery, and previous burns had altered the signature of wetland types by removing dead plant materials from the stands prior to each new growing season. The prefix "B" was used to classify burned areas, and type classifications are based upon adjoining unburned areas, field checks, and the position of the area within the marsh. Future photographs should be taken before 1 November, before marsh burning becomes widespread.

Aerial Photography

1970-1972 Imagery. The current photography is difficult to use because it contains a variety of seasonal imagery in three different years: September, 1970; September through December, 1971; and July through September 1972. Consequently, several signature forms exist for most wetland types and reflect seasonal changes in plant form and condition, and annual variation in overall growth conditions. Additional differences exist due to exposure and processing variations at the times of the different flights. Any major reflights should be planned to provide maximum coverage during as short a schedule as possible. This will simplify signature interpretation considerably.

The variation in the season of the photography also can introduce bias as to apparent species dominance. For example, *Peltandra* and *Acorus* are dominant early growth species in some marshes, and early photography will exaggerate the extent of their occurrence because other plant species have not yet developed. *Polygonum,* however, becomes more abundant as the growing season progresses, and consequently is favored by late photography.

Color Infra-red Photography. Based primarily upon experience in Calvert, Charles, and Somerset Counties, color infra-red imagery was found to be too sensitive for use in regional mapping of wetlands. Infra-red signatures vary greatly and reflect wetness, depth of water, heat absorption, and physiological conditions in addition to vegetation types. The detail of the imagery may be useful for intensive site-specific studies. However, natural color imagery is preferable for extensive, more general, studies because fewer variables are involved in interpreting the signatures.

The following are examples of signature variations that were encountered in the infra-red imagery in Somerset County. This is not intended to be a complete key to infra-red signatures, but it provides examples of the complexity of this imagery.

1. Type 41: white, tan, gray, brown, pink, light blue.
2. Type 43: dark or light gray, greenish gray, silver, bluish gray, reddish brown.
3. Type 47: gray, brown, green, greenish gray, bluish green; easily confused with Type 43.
4. Mixture of Types 42, 51, and 48 adjoining water edges often cannot be differentiated due to signature similarity.
5. The extent of Types 51 and 42 is exaggerated when adjacent to Type 43.
6. Mixed Type 41-51 may appear bluish-green and be confused with Type 47.
7. Pink: Types 41, 44, 46, 49, and 51.
8. White: Types 41, 44, and 48.
9. Some distinctive green, yellow, and white areas have no relation to vegetation types.

Aerial Flights. The following are guidelines for the planning of flights to secure aerial photography.

1. Flight lines should be delineated very liberally to insure that all wetland areas are imaged during the initial flight. This will avoid the need for additional reflights to photograph missed parcels. Liberal flight lines will require that a greater number of frames be exposed. However, the extra cost of film for the initial exposures will probably always be less than the added costs of a reflight and of the subsequent complications in obtaining photography that contains signature variations due to growth and seasonal changes in vegetation condition.
2. The best time of the year for true-color photography of wetland vegetation for the purpose of type mapping is about 1 October. The period from about 15 September to 15 October should be considered for future statewide photography. This avoids the poor distinctions in the homogeneous green summer imagery in all of the wetland types; it avoids much of the autumnal deterioration of plant materials; and it takes advantage of the differential browning and drying of marsh plants. Brackish and saline marsh types deteriorate slower than fresh types, and can be flown into late October. Late brackish photography in Dorchester and Somerset Counties, however, risks encountering marsh burning and also would not be optimum for freshwater marshes in these counties.
3. Imagery of extensive wetlands can contain considerable glare distortion due to high tide, adjoining waters, or wet mud surface. Glare can distort signatures and mask wetlands, particularly in submerged aquatics or low-density vegetation. Glare can be minimized by controlling flight time to avoid the mid-day period. Although this would increase shadow length, the shadows would aid classifications in large marshes by accenting height variation between types. Glare problems generally are most pronounced in the more extensive wetland areas. In small riverine marshes, however, photographs that are taken during the early morning or late afternoon should be avoided because marsh types are overshadowed by adjoining swamps and other forests.

   Contrast-control printing is used on black-white aerial photography to even the tone variation between sun-side and shade-side on individual photographs. This results in more uniform imagery, without a bleached sun side and a dark shaded side. It would be useful to determine whether a similar process could be used with true color photographs. This would further improve the quality of the imagery by reducing signature variation.
4. Flights should not be made during hazy or cloudy weather, and should avoid periods of high spring and storm tides. In particular, storm high tides on the western shore of Chesapeake Bay obscure wetland types because of the high silt content of the water.
5. Flight lines should be planned to provide front-back and side-side overlap to permit stereoscopic viewing of all areas and to provide uniform matching of adjacent maps.

Photograph Storage and Handling. Mislabeled, damaged, and lost photographs complicate the interpretation and use of the wetland photomaps. The following suggestions relate to the handling and storage of photographic materials.

1. All photographs, particularly prints on paper, should be stored in separate plastic bags to protect the imagery and prevent sticking.
2. Photograph numbers should be placed on all infrared transparencies.
3. DNR should establish a filing and check-out system to avoid the loss or misplacement of wetlands photos.
4. Replacement prints of missing photographs should be color matched to the tone of the imagery on adjacent prints from the original photography.
5. DNR must have absolute control over the original film negatives for true color and positives for color infra-red. Subcontractors and clients should be held totally responsible for any loss of irreplaceable photographic film. DNR should obtain positive color prints of all wetland infra-red imagery that currently is owned and retained by Photoscience, Inc.
6. For future mapping, heavy paper prints of the photographs, at contact scale, should be used by the delineators. Transparencies are difficult to handle in the laboratory and, more especially, in the field owing to their tendency to curl and to the need for a light table for viewing.

Mapping

Late-Season Photography. Classifications and delineations of fresh marsh types and several brackish types were limited in late-season photography due to plant deterioration. Particular difficulty was encountered with six fresh types and one brackish type: 30, smartweed/cutgrass; 32, pickerelweed/arrowarum; 33, sweetflag; 34, cattail, when mixed with other types; 35, rosemallow; 36, wild rice; and 45, rosemallow. Moderate difficulty was encountered with four fresh and two brackish types:

34, cattail, in pure stands; 37, bulrush; 38, big cordgrass; 39, common reed; 44, cattail; and 47, threesquare. Delineations in areas of photography with the above limitations required the delineation of composite mixtures of two and three types.

Trash Rafting. Considerable rafting of flotsam and trash occurs along the main shore of Chesapeake Bay, and trash often is deposited on wetlands near the Bay, temporarily destroying the vegetation. This phenomenon was particularly apparent in Kent County, where several small cove wetlands that were unobstructed at the time of the 1971 imagery were covered to a greater or lesser degree by driftwood at the times of field inspections during 1976 to 1977. The impact upon wetlands probably varies depending upon the height of storm tides and upon the direction and magnitude of accompanying winds. Prevailing northwesterly winds tend to drive driftwood into the wetlands on the western shore of Kent County from the ship channels in Chesapeake Bay and from Baltimore Harbor.

The mapping of wetlands obscured by trash was based upon the aerial photograpy, and not upon current conditions.

Map Indices. The map indices should be completed to show all wetlands maps and to indicate the accompanying photograph numbers.

Map Symbols. Line weights for the upper inland boundary, the tick mark system to denote wetlands, and the letter size for wetland/upland symbols should be standardized. Tick marks and symbols should be used very sparingly on future wetlands maps, because they interfere with type mapping lines; and should be removed when the type mapping is completed.

Somerset Photomaps. The following recommendations pertain to the wetlands maps in Somerset County.

1. Scale variation exists among some of the wetlands maps due to differential enlargements from the aerial photographs. The scale of each map should be verified, and any necessary corrections made on the legend.
2. Match lines between adjoining maps were incomplete, and sometimes involve overlaps or gaps. Manuscript corrections were made during the wetlands management study, within time and budget constraints. These corrections should be verified, all match lines checked, and revised lines inked onto the maps.
3. The press-on titles and legends on the maps are badly deteriorated, and should be replaced with ink and/or pre-printed heat-resistant adhesive title blocks.
4. All maps should be inspected to eliminate inconsistencies in the upper inland boundary on adjoining maps.
5. The upper inland boundary on the Somerset maps probably was drawn with a #1 pen point. However, the inland boundary in other counties was a thicker #3 line, and in those counties a #1 point was used for wetland type delineations so that the two types of lines would be distinguishable. For consistency, a #1 line was used for type delineations in Somerset County. DNR should widen the upper inland boundary on the Somerset maps, so that it will be clearly distinguishable from the type delineations.

Mappingof Unimaged Areas. During the wetlands management study, a number of wetland photomaps were encountered for which the corresponding aerial photography was lost or unavailable. Most of these maps were mapped on the basis of intensified observations during the helicopter surveys. The following maps, however, could not be delineated because no suitable photographic coverage was available and because of budget constraints.

—Anne Arundel 159, 160, 161, and 162
—Charles 6, 7, 8, 9, 10, 11, 26, 45, 46, 48, 49, 58, 64, 74, 77, and 78
—Somerset 42

The following additional maps were delineated on a best-effort basis, utilizing non-stereoscopic imagery from adjoining maps:

—Charles 2, 19, 24, 25, 27, 28, 30, 35, 42, 56, 68, 81, 82, and 83

The quality of these delineations is considered to be adequate, but not equal to that achieved on the other maps for which full stereoscopic photography was available.

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