FY 1992 **FINAL PRODUCT** Task 9

Permit Compliance & Inspection

Wetlands Guidelines

Prepared by

The Department of Wetlands Ecology
Virginia Institute of Marine Science
College of William and Mary

and

The Habitat Management Division
Virginia Marine Resources Commission

Developed Pursuant to Chapter 13 of Title 28.2, Code of Virginia

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Table of Contents

Section I

Introduction

Virginia's coastal zone is composed of many different but highly interrelated ecological systems. Below the low tide limits are found the vast areas of submerged bottomland which are vitally important as fish and shellfish feeding, spawning and nursery habitat. These areas not only help support Virginia's highly valuable commercial catch but also the myriad of species which the average Virginian never directly encounters but nevertheless are as important ecologically as the commercially sought organisms.

Between the high water line and the low water line are found the nonvegetated intertidal flats and beaches. These areas, though uncovered and seemingly devoid of life during a portion of each tidal cycle, provide important habitat for a host of different marine organisms, aquatic birds and many mammals.

Beginning approximately at the elevation we call mean sea level are found the various vegetated communities known as marshes. Best known for their high plant production on the order of tons per acre per year, marshes have other valuable functions. They are a buffer between the estuary and the upland; interacting with both.

With the passage of House Bill 400, which adds nonvegetated intertidal areas to the existing wetlands protection mechanism, the General Assembly has not only recognized the value of intertidal flats and beaches to the Commonwealth but also the interrelated and interdependent nature of the vegetated and nonvegetated wetlands systems. All wetland resources of the Commonwealth will now be managed under a single, unified program. Moving landward from mean low water (the Marine Resources Commission controls the bottomland seaward of mean low water) wetland jurisdiction now extends to mean high water where no emergent vegetation exists, and to 1.5 times the mean tide range where marsh is present. All intertidal areas are now called wetlands and can be managed holistically under a single permit system.

The purpose of this document is to revise the existing *Wetlands Guidelines,* which deal only with marshes, to include beaches, tidal flats and subaqueous lands as well. Although scientific research has yet to clearly define and quantify all aspects of wetlands function and importance within the estuary, there are few in the scientific community who would argue that these areas are not highly significant systems whose conservation is very important to the Commonwealth. The policy stated by the legislature when it passed the vegetated wetlands act in 1972 is as relevant today as it was then:

> "Therefore, in order to protect the public interest, promote the public health, safety and the economic and general welfare of the Commonwealth, and to protect public and private property, wildlife, marine fisheries and the natural environment, it is declared to be the public policy of this Commonwealth to preserve the wetlands, and to prevent their despoliation and destruction and to accommodate necessary economic development in a manner consistent with wetlands preservation."

In the pages that follow, the value of the wetlands to the Commonwealth and its citizens is described. This is followed by a brief description of each community type and then by an environmental value ranking system. In this section the community types are ranked relative to each other according to their environmental values. It should be noted that all wetlands are important but where management decisions must be made regarding necessary economic development in wetlands, this ranking system may help in guiding development into the lesser value wetland communities.

The ranking system is followed by the general and specific guidelines for wetland disturbing activities. These guidelines have been expanded to cover the nonvegetated area and to deal with issues that have arisen since the adoption of the original guidelines in 1974. it is intended that these guidelines aid wetland managers in preserving the wetlands while accommodating necessary economic development along Virginia's 5000 miles of shoreline.

Section II

Wetlands Types and Properties

Wetlands, as defined in Chapter 13 of Title 28.2 of the Code of Virginia, fall into two major groupings: vegetated (tidal marshes and swamps) and nonvegetated (intertidal flats, bars and beaches). Although seldom recognized by the general public except as exhibited in the desire to live on or near the water, wetlands have a variety of both tangible and intangible values which place them in a position of inestimable importance to the Commonwealth.

This section of this document first identifies the primary values of the wetlands, then describes the general wetland types found in "Tidewater" Virginia, and finally ranks these types relative to each other in terms of these primary values.

Each wetland type is evaluated in accordance with five general values.

These are:

A. **Production and detritus availability.** Marshes and tidal flats are major sites of primary production in the marine ecosystem. When this plant material dies and begins to decay (detritus) it becomes the basis of a major marine food pathway. The productivity of all the major marsh community types is well documented and ranges from one to six tons per acre per year. Generally, the lower the elevation of the marsh, the greater its contribution of detritus and the greater its value to the aquatic environment.

   Plant productivity on tidal flats is typically less than that of tidal marshes but higher than the bottom in deeper open water areas due to the greater supply of light and nutrients available. Plant productivity in intertidal areas is dominated by nonvascular plants (bottom-dwelling, one-celled micro- and macroalgae). Probably the most important function of the nonvegetated wetlands is that of mediating the breakdown of detritus produced on the vegetated marshes. Tidal flats located adjacent to extensive marsh areas may therefore be more biologically valuable than more isolated tidal flats. As mediators of detrital breakdown, nonvegetated wetlands are often the sites of large, diverse invertebrate populations and are often major feeding sites and spawning and nursery grounds for estuarine organisms of sport and commercial value to man.

B. Waterfowl and Wildlife Utilization. Long before wetlands were discovered to be detritus producers and feeding areas for marine organisms, they were known as rich habitats for various mammals, marine birds and migratory waterfowl. Some wetland types are more important than others in this regard but in many cases distinctions may not be clear-cut. A species, for example, may appear to be dependent on vegetated marsh for cover and breeding but without the adjacent tidal flats may not use a certain marsh at all. Wetlands offering a variety of habitats and plant types are generally the more valuable from a habitat perspective.

C. Erosion Buffer. Erosion is a common problem throughout coastal Virginia and is by no means limited to ocean beaches. Vegetated wetlands do erode but by virtue of their ability to establish dense root systems, trap and accumulate sediments, and baffle wave energy they are buffers against erosion and sea level rise. Among the vegetated wetlands the freshwater communities are less effective in this regard.

Nonvegetated wetlands are also effective erosion buffers although they function in a different manner from the marshes. For example, a broad, gently sloping sand beach is an excellent wave energy dissipator and large intertidal bars and flats serve to "trip" waves as they move shoreward thus reducing their energy before they strike the shoreline. The disruption of nearshore intertidal areas may increase wave energy striking the adjacent shoreline thus accelerating erosion there.

D. Water Quality Control. The dense growth of some marshes acts as a filter, trapping upland sediment before it reaches waterways and thus protecting shellfish beds and navigation channels from siltation. Marshes can also filter out sediments that are already in the water column. The ability of marshes to filter sediments and maintain water clarity is of particular importance to the maintenance of clam and oyster production. Some marshes have been shown to act as sinks or traps for other pollutants and marsh plants take up nutrients deposited in marsh soils. Excess nutrient levels in an estuary can be a problem but the exact role of marshes in nutrient removal is not yet fully understood.

Nonvegetated wetlands are also important in the cycling of nutrients in the estuary and the filter feeding organisms present, particularly on tidal flats, remove suspended solids from the water column in amounts that may significantly affect water clarity.

E. **Flood Buffer.** The peat substratum of some marshes acts as a giant sponge in receiving and releasing water. This characteristic is an effective buffer against coastal flooding, the effectiveness of which is a function of marsh type and size. The higher elevation marshes are the more effective flood buffers. Nonvegetated wetlands, because of their intertidal location have little value in this regard.

The following descriptions of wetland community types are identified and presented for management purposes. The first twelve of these are the vegetated wetlands and of these the first ten are characterized by a single dominant species of emergent vegetation. The term "dominant" is defined here to mean at least 50% of the vegetated surface of the marsh is covered by a single plant species. Types eleven and twelve are brackish and freshwater marshes which have no clearly dominant species of vegetation.

The five types of nonvegetated wetlands described here are identified mainly by physiographic position and sediment composition. No attempt is made to quantitatively separate the communities by particle size dominance since this is not necessary for value judgements on the level described in this publication.

SALTMARSH CORDGRASS
Spartina alterniflora

3 to 6
feet high

Type I. Saltmarsh Cordgrass Community

Dominant vegetation: Saltmarsh cordgrass (*Spartina alterniflora* Loisel).

Associated vegetation: Saltmeadow hay, saltgrass, black needlerush, saltwort, sea lavender, marsh elder, groundsel tree, sea oxeye.

Growth habit: Stout, erect grass; long, smooth leaves, often with attached periwinkle snails; located at the waters edge. Tall form 4 to 6 feet along the water; short form 1 to 2 feet at or slightly higher than MHW.

Physiographic position: Ranges from mean sea level to approximately mean high water.

Average density: Usually 20 plants per square foot. Can range from 10 to 50 plants.

Annual production and detritus availability: Average yield is about 4 tons per acre per annum; optimum growth up to 10 tons per acre. Daily tides flux nearly throughout this community. Available detritus to the marine environment is optimum. This type of marsh is recognized as an important spawning and nursery ground for fish.

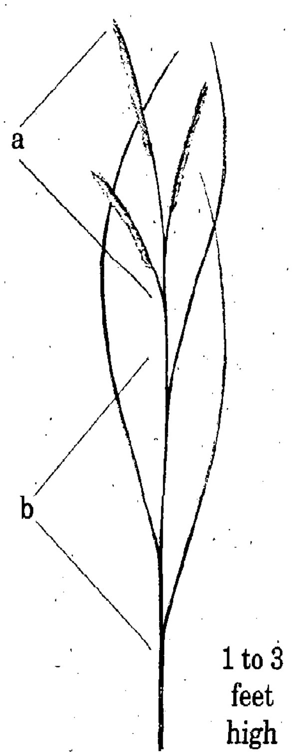
Waterfowl and wildlife utility: Roots and rhizomes eaten by waterfowl. Stems used in muskrat lodge construction. Nesting material for Forsters tern, clapper rail and willet.

Potential erosion buffer: Most salt marshes and brackish water marshes are bordered by saltmarsh cordgrass along the waters edge. A marsh/water interface of this type is highly desirable as a deterrent to shoreline erosion. Underlying peat with a vast network of rhizomes and roots is very resistant to wave energy.

Water quality control and flood buffer: Marshes of this type can also serve as traps for sediment that originate from upland runoff. This also includes large debris that may accumulate on the marsh surface.

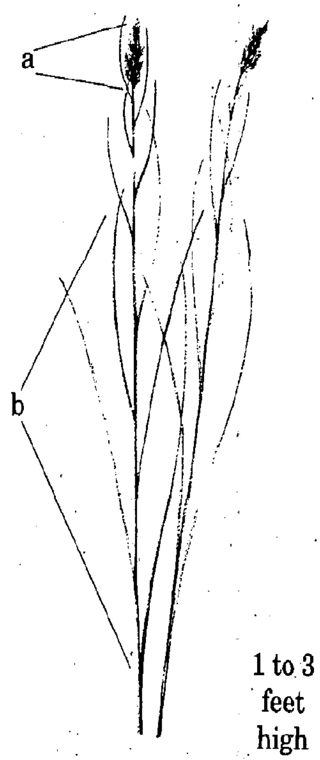
SUMMARY: Considering the many attributes of this type of marsh community, its conservation should be of highest priority.

SALTMEADOW HAY
or
SALTMEADOW CORDGRASS
Spartina patens



a. Flowering or fruiting head.
b. Leaves arranged in 3 or more planes.

SALT GRASS
Distichlis spicata



a. Flowering or fruiting head.
b. Leaves arranged in one plane.

Type II. Saltmeadow Community

Dominant vegetation: Saltmeadow hay (*Spartina patens* (L.) Greene) Saltgrass (*Distichlis spicata* (L.) Greene).

Associated vegetation: Saltmarsh cordgrass, black needlerush, marsh elder, groundsel tree, saltwort, sea oxeye.

Growth habit: Matted meadow-like stands with swirls or "cowlicks," individual plants wiry in appearance; saltgrass 1-2 feet high.

Physiographic position: About mean high tide to the limit of spring tides; saltgrass at lower elevations, saltmeadow hay predominates at the higher end of the range.

Average density: Mixed populations; 50-150 stems per square foot.

Annual production and detritus availability: Ranges from 1-3 tons per acre annum. Only small amounts of dead plant material are flushed out during storms and spring tides.

Waterfowl and wildlife utility: Seeds eaten by birds; provides nesting area. Habitat for a snail (*Melampus*) important as food for birds.

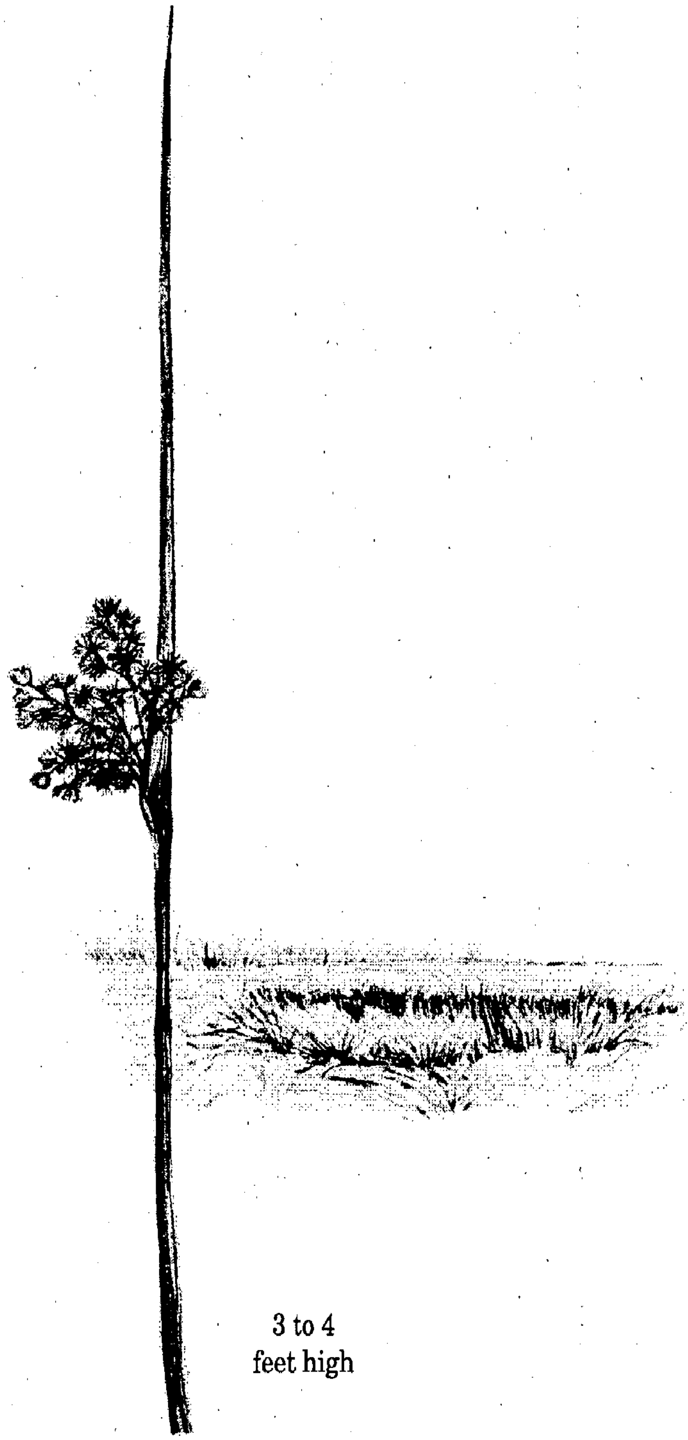
Potential erosion buffer: Effective erosion deterrent at higher elevations.

Water quality control and flood buffer: In many cases, this community represents the oldest part of a marsh system. Peat may accumulate to great depths, making this type of marsh act as a giant sponge when flood waters wash over it. Denseness of vegetation and deep peat filter sediments and waste material.

SUMMARY: This system is an excellent buffer, filtering out sediments and wastes and absorbing runoff water originating in the uplands. Production and detritus are less important to the marine environment than in Type I communities. Its contributions tend to favor the upland environment. Its values rank somewhat below Type I but, nevertheless, a Type II marsh should not be unnecessarily disturbed.

NEEDLERUSH

Juncus roemerianus



Type III. Black Needlerush Community

Dominant vegetation: Black needlerush (*Juncus roemerianus* Scheele.)

Associated vegetation: Usually pure stands with saltmarsh cordgrass, saltgrass and saltmeadow hay near the margin.

Growth habit: Dense monospecific stands; plant leafless, cylindrical hard stems tapering to a sharp pointed tip; brown to dark green in color, 3 to 5 feet high.

Physiographic position: About mean high water to somewhat below spring tide limit. Seems to prefer sandy substratum.

Average density: 30 to 50 stems per square foot.

Annual production and detritus availability: 3 to 5 tons per acre per annum, decomposes more slowly than most of the marsh grasses. Not flushed daily by tides.

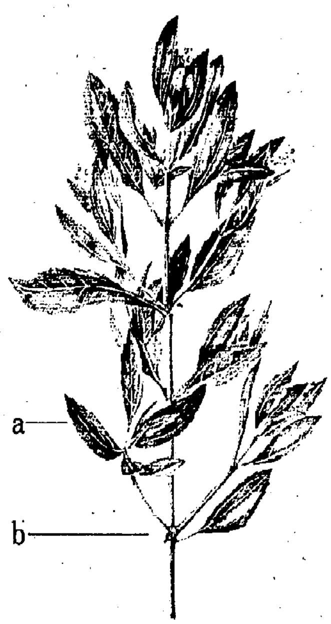
Waterfowl and wildlife utility: There is no evidence that waterfowl or wildlife utilize this type of plant directly as a food. Because of the dense, stiff stands, it has little wildlife value except for limited cover.

Potential erosion buffer: The dense system of rhizomes and roots of black needlerush are highly resistant to erosion. On sandy shores and low sand berms which support this community type, this characteristic is of high value.

Water quality control and flood buffer: An effective trap for suspended sediments, but less effective than the densely matted saltmeadow community. Provides effective absorbent areas to buffer coastal flooding.

SUMMARY: As a single monospecific community this type would support less wildlife diversity than Type I and II. It functions well as a sediment trap and erosion deterrent but ranks lower than the preceding types. The rhizomes of black needlerush are harder and tougher than the grasses that dominate Types I and II communities; therefore, needlerush is useful as an erosion deterrent. Overall, the values of this marsh type rank below Types I and II.

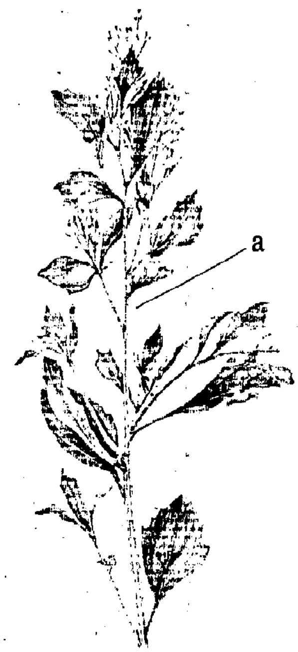
MARSH ELDER
Iva frutescens



3 to 10 feet high

a. Leaves thick and fleshy.
b. Leaves opposite each other on the stem.

GROUNSEL TREE
Baccharis hamilifolia



3 to 10 feet high

a. Leaves alternate on stem.

Type IV. Saltbush (Gallbush) Community

Dominant vegetation: Groundsel tree, highwater bush (*Baccharis halimifolia* L.), marsh elder saltwater bush (*Iva frutescens* L.)

Associated vegetation: Saltmeadow hay, saltgrass, wax myrtle, sea oxeye.

Growth habit: Shrubs 3 to 10 feet high along the margin of the marsh and upland plant communities.

Physiographic position: Lower limit is approximately the upper limit of marsh (marsh-upland ecotone).

Average density: May provide dense canopy over marsh. Individual shrub trunks usually spaced 3 to 10 feet apart.

Annual production and detritus availability: Probably less than 2 tons per acre per annum. Detritus of little value.

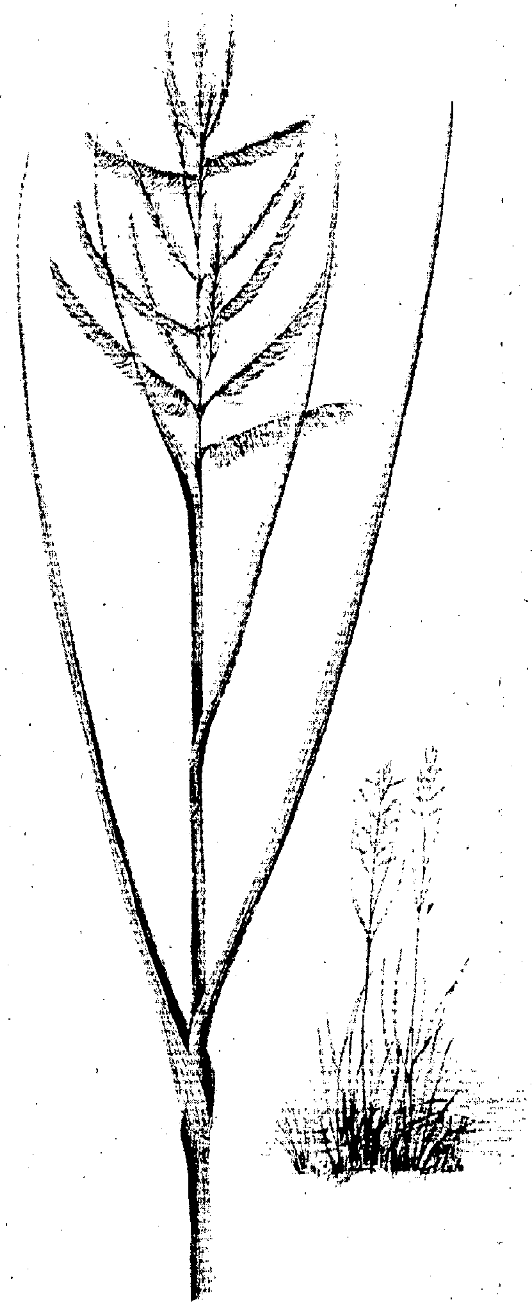
Waterfowl and wildlife utility: Provides diversity for wildlife in general and especially as a nesting area for small birds. No significant food value.

Potential erosion buffer: Although not structurally suited as an assimilator of sediment and flood waters, it serves somewhat as a buffer to erosion on sand berms that often front small pocket marshes. Also functional as a trap for larger flotsam.

Water quality control and flood buffer: Of minor consequence, but does trap larger material. (See above).

SUMMARY: Useful as an indicator of upper limits of marshes as defined in the Wetlands Act. Values of this type rank below that of the preceding types. However, this community does add diversity to the marsh ecosystem.

BIG CORDGRASS
Spartina cynosuroides



Type V. Big Cordgrass Community

Dominant vegetation: Big cordgrass (*Spartina cynosuroides* (L.) Roth.)

Associated vegetation: Usually pure stands.

Growth habit: Very tall (6-12 feet), heavily stemmed, leafy grass with distinct branched fruiting head in the fall.

Physiographic position: At or slightly above mean high water and extending to the upland margin. Most common in brackish or lower salinity marshes.

Average density: 10 to 15 stems per square foot.

Annual production and detritus availability: 3 to 6 tons per acre per annum. Detritus accessible only on spring or wind tide, however is rivaled only by saltmarsh cordgrass, which gives big cordgrass a higher value in the context of production than other grasses found above mean high tide. Decomposes more slowly than saltmarsh cordgrass.

Waterfowl and wildlife utility: Utilized as a habitat by small animals, often used for muskrat lodges. Geese often eat its rhizomes.

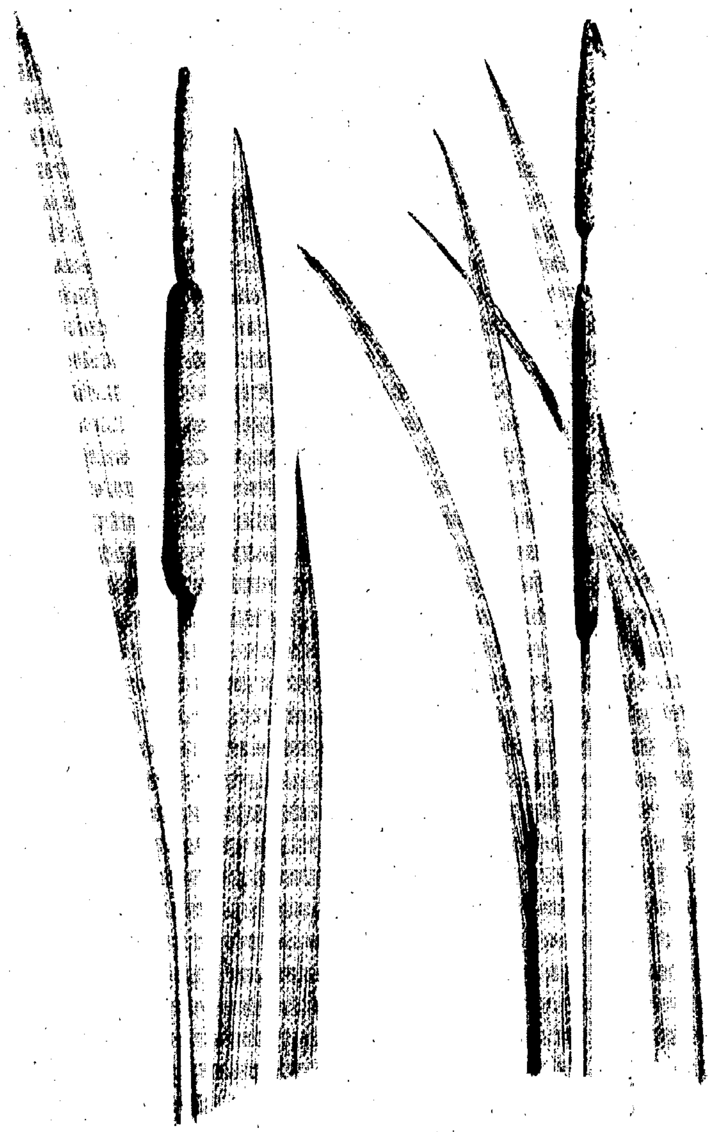
Potential erosion buffer: The large, coarse rhizomes and intertwining roots stabilize peat along marsh edges.

Water quality control and flood buffer: Usually this community type occupies the older parts of a marsh system where peat may be deeper increasing its capacity as a flood water assimilator. It is also useful in trapping flotsam.

SUMMARY: Although the elevation occupied by this community type is similar to that of the saltmeadow community, big cordgrass has a much higher yield of organic matter which likely contributes to the marine food web. It is also relatively high in value as a wildlife food as well as a buffer to erosion.

COMMON or BROAD-LEAVED CATTAIL
Typha latifolia

NARROW-LEAVED CATTAIL
Typha angustifolia



Type VI. Cattail Community

Dominant vegetation: Narrowleaf cattail (*Typha angustifolia* L.)

Associated vegetation: Broadleaf cattail (*Typha latifolia* L.), sedges, bulrushes, arrow arum, pickerel weed, smartweed, other fresh or brackish water plants.

Growth habit: Characteristic "Wiener on a stick" fruiting heads, long strap-like leaves, somewhat blunted tips. 4 to 6 feet tall.

Physiographic position: Very wet sites, sometimes in standing water, often at the margin of marsh and uplands. Does well in seepage areas resulting from upland runoff.

Average density: 2 to 6 stalks per square foot.

Annual production and detritus availability: 2 to 4 tons per acre. Detritus usually not readily accessible to the marine environment.

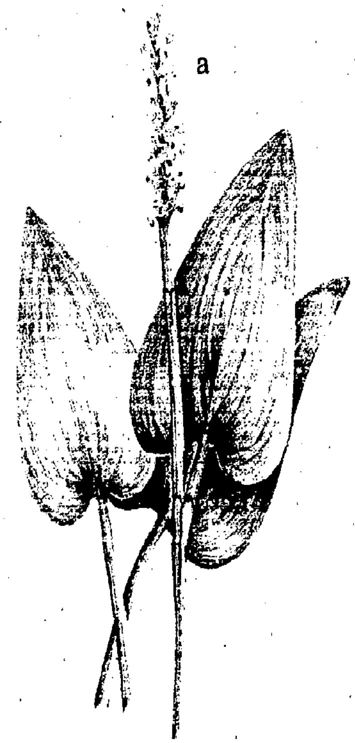
Waterfowl and wildlife utility: Provides habitat for certain birds; roots consumed by muskrats.

Potential erosion buffer: Because of its preferred habitat and its characteristic shallow root system, Type VI is only a minor buffer to erosion.

Water quality control and flood buffer: Its usual habitat along the upland margins in soft muddy areas ranks this marsh type high as a sediment trap despite its shallow rooted condition. Very few species will grow in these areas either because of the stagnant condition of the substratum or because they are inhibited by toxin release of the cattail roots or a combination of the two factors.

SUMMARY: Because of its value as a wildlife food and habitat, its function as a sediment trap, its relatively high production and the usual soft substratum, this type of marsh community should not be indiscriminately used as a development site. As far as overall value is concerned it compares with a saltmeadow marsh (Type II).

PICKEREL WEED
Pontederia cordata



a. Blue flower head.

ARROW ARUM
Peltandra virginica

a. Flower head.
b. Fruiting head.

Type VII. Arrow Arum-Pickerel Weed Community

Dominant vegetation: Arrow arum (*Peltandra virginica* (L.) Kunth.) Pickerel weed *Pontederia cordata* L.)

Associated vegetation: Sedges, smartweeds, bulrushes, ferns, cattails, pond lily.

Growth habit: Many broad leaved clumps growing from a thick, cylindrical rhizome; arrow or heart shaped leaves. Clumps 2 to 6 feet tall, average height 3 feet.

Physiographic position: On tidal mud flats from mean sea level to about mean high tide in low salinity or freshwater marshes.

Average density: 1 or 2 clumps per 10 square feet.

Annual production and detritus availability: 2 to 4 tons per acre. Detritus readily available to the marine food web because of daily tide fluxes. In the fall of the year these species decompose quite rapidly and completely except for the root stock.

Waterfowl and wildlife utility: Seeds and shoots of both species are eaten by ducks. Arrow arum seeds float after the pod decays and are readily available for wood ducks. Often associated with confirmed spawning and nursery areas for herring and shad.

Potential erosion buffer: Although this community type lacks the vast network of rhizomes, roots and peat substratum typical of a saltmarsh cordgrass community, this marsh/water interface vegetation is often the only vegetative buffer to shoreline erosion in freshwater areas. The substratum in a marsh such as this is typically often, unstable mud. After the vegetation has decayed in the winter time, the mud flats are highly susceptible to erosion due to winter rains.

Water quality control and flood buffer: Slows the flow of flood waters, causing some suspended sediment to settle out.

SUMMARY: Under natural conditions the marsh of this type is relatively stable but is highly sensitive to development and activities such as excessive boat traffic. Because of its many attributes this marsh ranks similar to that of Type 1.

REED GRASS
Phragmites australis

Type VIII. Reed Grass Community

Dominant vegetation: Reed grass (*Phragmites australis*) formerly (*Phragmites communes* Trinius)

Associated species: Switch grass, saltbushes, a few others.

Growth habit: Tall stiff grass with short, wide leaves tapering abruptly to a point; soft plume-like seed head. 6 to 10 feet high.

Physiographic position: Usually above mean high tide, drier areas on disturbed sites.

Average density: 3 to 6 stems per square foot.

Annual production and detritus availability: 4 to 6 tons per acre, detritus seldom available except in storm conditions.

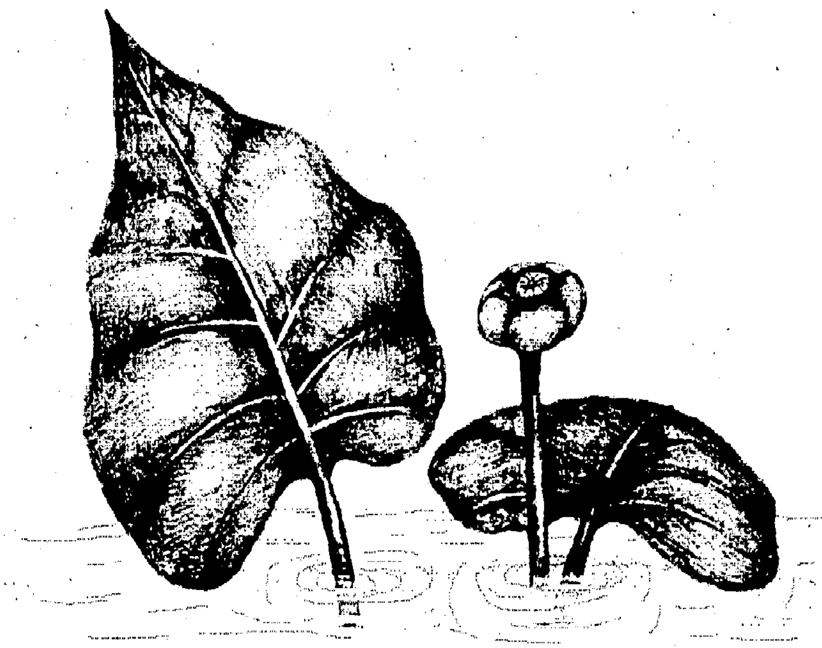
Waterfowl and wildlife utility: Little direct value to wildlife except as cover. May have a detrimental effect in that it can invade areas of a marsh and compete with desirable species. It appears to be replacing big cordgrass and other plants in freshwater marshes of the Pamunkey River.

Potential erosion buffer: Good erosion deterrent on disturbed sites, especially on spoil.

Water quality control and flood buffer: Valuable as a buffer to erosion. Potential as sediment trap and flood deterrent appears to be minimal.

SUMMARY: This plant is a relatively recent invader in Virginia but is spreading rapidly, often displacing more important marsh plants. It has little or no value to wildlife in general. Its only important value would be its function as a stabilizer on dredge spoil. This community type ranks below a Type III marsh, the black needlerush community.

YELLOW POND LILY
Naphur luteum



Type IX. Yellow Pond Lily Community

Dominant vegetation: Yellow pond lily, spatter-dock (*Nuphar luteum* (L. Sibthrop and Smith)

Associated vegetation: Pickerel weed, arrow arum.

Growth habit: Saucer shaped leaves with a narrow notch, floating on water; large, leathery yellow flower. 2 to 4 feet high from submerged root stalk.

Physiographic position: Submerged except for floating leaves at high tide. Found in freshwater areas.

Average density: One plant (cluster of leaves) for every 3 to 5 square feet.

Annual production and detritus availability: To 1 ton per acre; detritus readily available but not a significant contributor to the food chain.

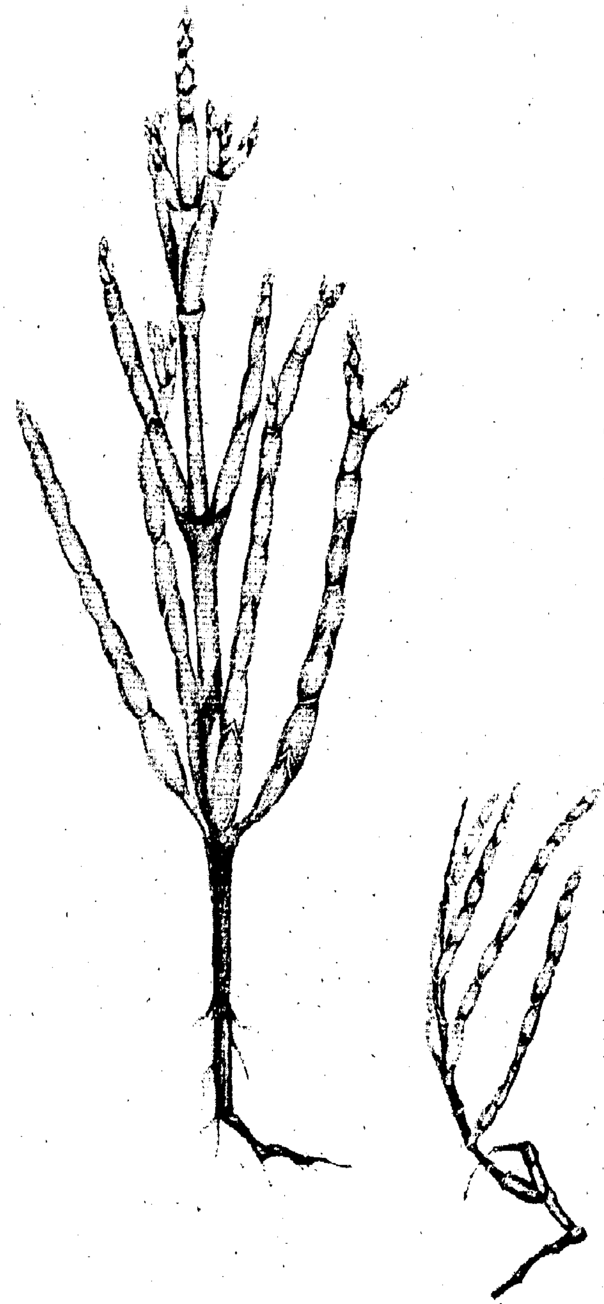
Waterfowl utility: Excellent cover and attachment site for aquatic animals and algae. Feeding territory for aquatic birds and fish.

Potential erosion buffer: While lacking the stiffness of grasses and sedges, these plants do reduce wave action from wind and boats. This has been noted in freshwater streams and boat channels.

Water quality control and flood buffer: Although not a direct assimilator of sediments and flood waters, the flow of flood water is slowed somewhat and sediments can settle out. This function is minimal because the community is submerged completely in flood conditions.

SUMMARY: Destruction of the community would result in a decrease in number and diversity of aquatic animal life in the immediate area. The greatest value the community has is its habitat for aquatic biota. This type should be ranked with or slightly higher than a Type III (black needlerush) marsh.

SALTWORT
Salicornia sp.



Type X. Saltwort Community

Dominant vegetation: Saltwort, glasswort (*Salicornia* sp.)

Associated vegetation: Saltmarsh cordgrass, saltgrass, sea lavender.

Growth habit: Leafless green fleshy-stemmed plant, red in color in fall; 8 inches to 1 feet tall.

Physiographic position: Above mean high tide in pannes or sparsely vegetated areas.

Average density: 10 to 15 stems per square foot.

Annual production and detritus availability: Less than 1/2 ton per acre. Exerts very little influence on the marine environment.

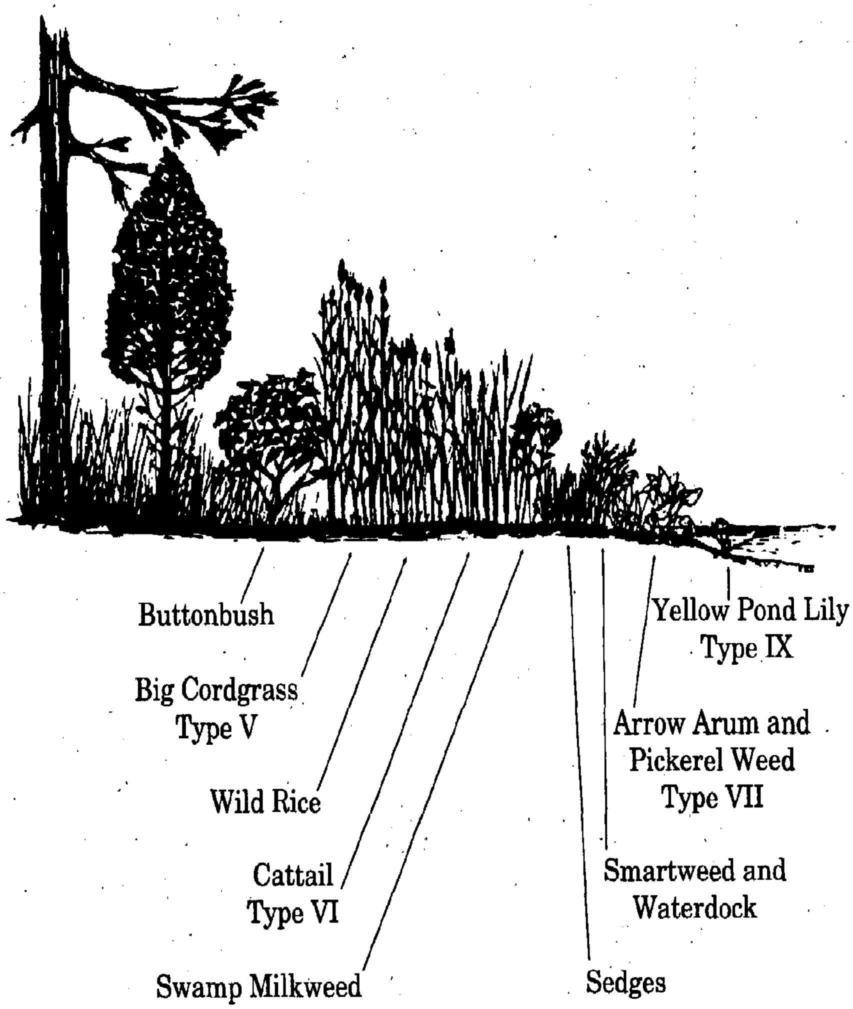
Wildlife and waterfowl utility: Some evidence that stems are eaten by ducks. May be a feeding area for other marsh birds.

Potential erosion buffer: Has very little value as an erosion deterrent.

Water quality control and flood buffer: Because of the character of the stem, a shallow root system and the usual small sizes of the populations, these community types have little or no value in this category.

SUMMARY: This community is not high in value. It usually occupies small areas within larger more productive marshes and can be used as an indicator of higher marsh elevations.

FRESHWATER MIXED COMMUNITY - TYPE XI
(excluding upland species - pines, cedars, etc.)



Type XI. Freshwater Mixed Community

Dominant vegetation: No single species covers more than 50% of the site.

Associated vegetation: Bulrushes, sedges, waterdock, smartweeds, ferns, pickerel weed, arrow arum, wildrice beggar's ticks, rice cutgrass.

Growth habit: Heterogeneous mixture of plants.

Physiographic position: From submerged to the upper limits of the wetlands.

Average density: Highly variable.

Annual production and detritus availability: 3 to 5 tons per acre. Detritus of species such as arrow arum, pickerel weed and yellow pond lily would be available in the intertidal zone.

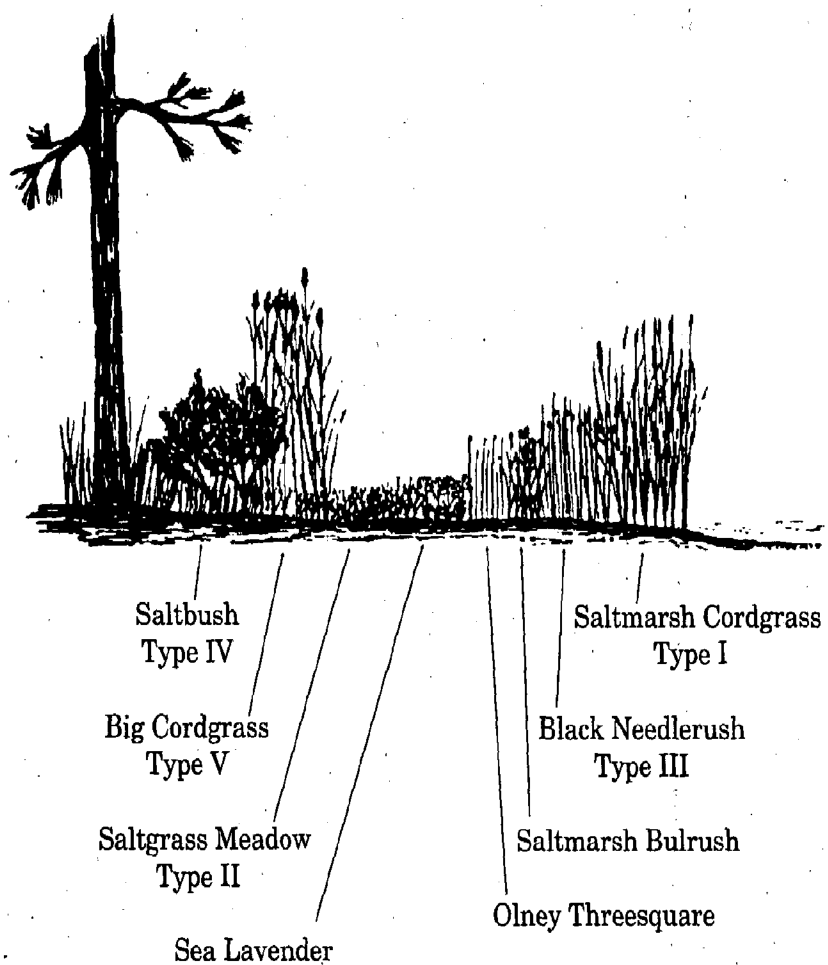
Waterfowl and wildlife utility: A highly valuable marsh for a broad diversity in wildlife species. Plant species such as smartweeds, waterdock, wildrice and others are prime waterfowl and sora rail foods. Waters adjacent to these type marshes are also known as spawning and nursery grounds for striped bass, shad and river herring.

Potential erosion buffer: Shoreline erosion protection provided by this type of marsh is equivalent to Type VII, arrow arum - pickerel weed community.

Water quality control and flood buffer: This ranks somewhat higher as a sediment trap and flood deterrent than an arrow arum - pickerel weed community. The presence of the stiffer, more resilient grasses, sedges and rushes and peaty-type substratum increases the ability of this type of community over a Type VII marsh as an assimilator of sediments and flood waters.

SUMMARY: These are very valuable marshes and the aim should be to keep them in a natural state. This type of marsh would be ranked equivalent to a saltmarsh cordgrass marsh (Type I) and an arrow arum - pickerel weed (Type VII) marsh.

BRACKISH WATER MIXED COMMUNITY - TYPE XII
(excluding upland species - pines, cedars, etc.)



Type XII. Brackish Water Mixed Community

Dominant vegetation: No single species covers more than 50% of the site.

Associated vegetation: Saltmarsh cordgrass, saltmeadow hay, saltgrass, black needlerush, saltbushes, threesquares, big cordgrass, cattails.

Growth habit: Heterogeneous mixture of plants in wet areas.

Physiographic position: Extending from about mean sea level to the upland margin.

Average density: Highly variable.

Annual productivity and detritus availability: 3 to 4 tons per acre, detritus readily available in the intertidal zone.

Waterfowl and wildlife utility: Wide diversity of vegetation provides a variety of wildlife food. Waterfowl foods are plentiful, such as the generous seed heads of saltmarsh bulrush.

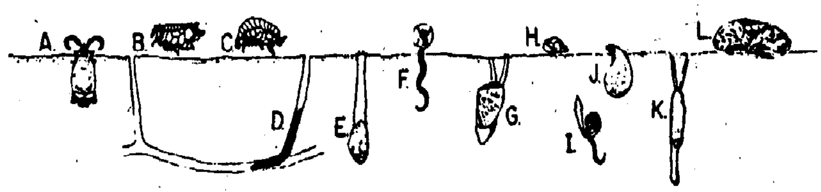
Potential erosion buffer: Shoreline erosion protection is the same as that of a Type I marsh (saltmarsh cordgrass). Most brackish water marshes are bordered by saltmarsh cordgrass.

Water quality control and flood buffer: Ranks high in this category, having similar attributes as a Type II marsh (saltmeadow).

SUMMARY: This marsh is a microcosm of all the communities found in saline waters. Brackish water marshes are known spawning and nursery grounds. This community type contains valuable food and habitat for a wide diversity of wildlife species. Ranks with a Type I (saltmarsh cordgrass) marsh.

DOMINANT BENTHIC SPECIES OF THE NON-VEGETATED WETLAND COMMUNITIES

	Intertidal Beach Community		Tidal Flat Community		Intertidal Oyster Reef Community
SEDIMENT TYPE	SAND	SAND	SAND/MUD	MUD	SHELL
DOMINANT SPECIES	Amphipods Mole crabs Donax clams	Amphipods Bloodworms Soft clams Razor clams Sandworms	Mud snails Soft clams Razor clams Spionid worms Hard clams	Mud snails Bloodworms Razor clams Spionid worms	Oysters Hard clams Curved mussels Amphipods Mud crabs



SPECIES INDEX

- A. Mole crab (*Emerita talpoida*)
- B. Haustorid amphipod (*Parahaustorius*)
- C. Haustorid amphipod (*Parahaustorius*)
- D. Sandworm (*Nereid polycheate*)
- E. Soft clam (*Mya arenaria*)
- F. Spionid worm (*Polydora ligni*)
- G. Donax clam (*Donax variabilius*)
- H. Mud snail (*Ilyanassa obsoleta*)
- I. Bloodworm (*Glycera dibranchiata*)
- J. Curved mussel (*Isochodium recurvus*)
- K. Razor clam (*Tagelus plubeus*)
- L. Oyster (*Crassostrea virginica*)

Type XIII. Intertidal Beach Community

Dominant species:

Ocean Beach - Mole crabs, Donax clam, Haustorid amphipods

Bay Beach - Haustorid amphipods, oligochaete worms, beach fleas

Associated species: Ghost crabs, polychaete worms, razor clams

Growth habit: Most organisms buried just below the sand surface. Constantly being uncovered by waves and burrowing back into sand. Most species are annuals.

Average density: Highly variable, animals move up and down beach with tide level. In warmer months densities can average 100 to 5000 individuals/m^2. Annual production is very high.

Primary production and nutrient cycling: Relatively low compared to marshes and tidal flats because of high wave energy.

Habitat value: Very important foraging area for many shorebirds areas above mean high water are used as nesting sites by terns and skimmers. Fish utilize area for feeding during high tide.

Erosion buffer: Beach is an ideal natural wave-energy dissipator. It interacts with nearshore sand bars and dunes. Its most important ecological function to man is to buffer the effects of storm waves.

SUMMARY: Beach systems deserve the highest order of protection particularly when associated with extensive dunes and nearshore sandbars.

Type XIV. Sand Flat Community

Dominant species: Sandworm, bloodworm, amphipods, soft clams, razor clams.

Associated species: Other polychaete worms, mollusks and phoronid worms.

Growth habit: Most of the inhabitants are surface and deep burrowing species; some are permanent tube builders. Most species are annuals or biannuals, several reproduce throughout the warm weather period. There is a fairly rapid turnover of individuals due to predation so the average size of organisms is small.

Average density: Highly variable with polychaete worms reaching higher densities than other groups. Densities of major invertebrate groups range from 330 to 3000 ind./m^2.

Primary production: Annual production ranges from 100 to 200 g C/m^2. This is lower than that of marshes but only slightly less than other tidal flats. The primary production of this community enters the estuarine food web directly via grazing. This is more efficient than the detrital food chain where decomposition in an intermediate step. The large particle size of sand and lower percentage of organics reduces the role of this community type in nutrient recycling.

Habitat value: Very important as nursery and feeding area for fishes and blue crabs. Important shorebird feeding area. May support high shellfish populations.

Erosion buffer: Important in reducing wave energy and thus erosion potential on adjacent shorelines.

SUMMARY: Overall, the ecological value of this community rates only slightly below beaches, oyster reefs and Group I marshes.

Type XV. Sand/Mud Mixed Flat Community

Dominant species: Hard clams, parchment worms, Spionid polychaetes, soft clams, razor clams and mud snails.

Associated species: Other polychaetes, molluscs, crustaceans, acorn worms, Phoronid worms.

Growth habit: This community is populated in general by many surface and deep burrowers, and permanent tube builders. Otherwise similar to sand flats.

Average density: Highly variable but overall higher than sand flats or mud flats. Densities range from 5300 to 8300 individuals/m^2.

Primary production and nutrient cycling: Primary production in this community is very similar to sand flats. Since the organic matter content of the sediments is higher than that of sand flats, secondary, microbial production may be higher and this augments the primary production. This community probably interacts with estuarine nutrient cycles to a greater extent than sand flats.

Habitat value: This community is a very important area for wading birds, shorebirds and other other migratory waterfowl. It is heavily used by important commercial and sports fishes for feeding and is important blue crab habitat. The habitat value may increase in importance when a marsh is adjacent due to higher organic content in the sediments and the habitat variety provided by the marsh.

Erosion buffer: Slows wave velocity and thus may reduce wave erosion impinging on adjacent shoreline.

SUMMARY: Overall this community has very high habitat values especially if associated with marshes. Ranks only slightly below beaches and intertidal oyster reefs.

Type XVI. Mud Flat Community

Dominant species: Spionid worms, mud snails, razor clams, bloodworms.

Associated species: Other polychaetes, molluscs and crustaceans.

Growth habit: Surface and shallow burrowing organisms predominate in this community type. Some permanent tube builders may be present. Problems with sediment stability limit species to mainly surface detrital feeders.

Average density: Highly variable; Generally densities are slightly lower than mixed flats but higher than sand/flats with a range of 50 to 5000 individuals/m^2.

Primary production and nutrient cycling: The areal extent of mud flats is probably equal to or greater than the total for marshes. Primary production is probably the highest of the nonvegetated communities. Mud flats interact significantly with adjacent vegetated areas in the cycling of nutrients. Where mudflats and marshes occur together they are mutually dependent. Ecologically, each is an extension of the other.

Habitat value: Highly important foraging area for waterfowl, sports and commercial fishes and many other species of food chain value in the marine ecosystem.

Erosion buffer: Since this community is generally only found in quiescent areas it has less value in this regard than sand or mixed flats.

SUMMARY: The overall ecological value of mud flats is comparable to sand flats and mixed flats. It is probably most important in nutrient cycling of the three.

Type XVII. Intertidal Oyster Reef Community

Dominant species: Oysters, hard clams, sand worms, amphipods, mud crabs.

Associated species: Other polychaetes, mud snails, curved mussels, barnacles, sponges, hydroids, razor clams, other molluscs and crustaceans.

Growth habit: Oyster shells provide increased diversity of habitats for a variety of estuarine species. This community is characterized by high diversity of attached and associated organisms.

Average density: Oysters dominate when area managed by man. Otherwise the reef is dominated by fouling organisms as listed above. Highly variable density but generally greater than other flats.

Primary productivity and nutrient cycling: Very little data are available concerning the primary production of oyster reefs. Given the high habitat and animal diversity however, it is probable that primary production is at least as high as other nonvegetated communities.

Habitat value: Very high; many important food chain organisms associated. This community is heavily utilized by blue crabs and fishes during high tides. Very high diversity and secondary productivity.

Erosion buffer: Shells cemented together may be important in dissipating waves and may resist shoreline erosive forces.

SUMMARY: Overall ecological value very high. This community is an excellent habitat with high diversity.

Section III

Evaluation of Wetlands Types

For management purposes, the twelve types of vegetated wetlands (marshes) and five types of nonvegetated wetlands (tidal flats and beaches) identified in Section II are grouped into five classifications based on the estimated total environmental value of an acre of each type. The reader is cautioned however that these groupings are based on average values and case-by-case analysis may yield differing results. One must also exercise restraint when comparing vegetated vs. non-vegetated communities.

Group One: **Vegetated communities**

Saltmarsh cordgrass (Type I)
Arrow arum-pickerel weed (Type VII)
Freshwater mixed (Type XI)
Brackish water mixed (Type XII)

Nonvegetated communities

Intertidal beaches (Type XIII)
Intertidal oyster reef (Type XVII)

The vegetated community types in Group One have the highest values in productivity and wildlife utility and are closely associated with fish spawning and nursery areas. They also have high values as erosion inhibitors, are important to shellfish populations and are important factors in nutrient cycling.

Intertidal beaches and sand bars have the highest relative values as buffers to shoreline erosion. In addition, they rank very high as marine habitat and in secondary productivity. Intertidal oyster reefs, which occur primarily on the seaside of the Eastern Shore, have their highest values in terms of productivity, habitat and commercial importance.

All of the communities in the Group One classification merit the highest order of protection.

Group Two: **Vegetated communities**

Big cordgrass (Type V)
Saltmeadow (Type II)
Cattail (Type VI)

Nonvegetated communities

Sand/flats (Type XIV)
Sand/mud mixed flats (Type XV)
Mud/flats (Type XVI)

The marshes in Group Two are only slightly less valuable than those in the Group One classification. The major differences being the reduced availability of detritus from the Group Two marshes due to physiographic factors. The detritus produced on the Group Two marshes is more likely to accumulate in the marsh and is less available to marine organisms. Group Two marshes have high values in maintaining water quality, buffering coastal flooding, and as habitat.

The Group Two nonvegetated communities have high general productivity values and play an essential role in nutrient cycling in the estuary. They are very important foraging areas for marine birds and many mobile marine organisms of commercial and recreational importance. They have less value than the Group One communities from an erosion and flood buffering standpoint.

Group Two wetlands communities rank only slightly below those of Group One in overall environmental importance. They deserve an order of protection only slightly below that of the Group One wetlands. Since there are many variables involved in any evaluation scheme, it is highly likely that some Group Two wetlands may on occasion outrank some Group One communities. This may be particularly true of the nonvegetated communities which exhibit a great deal more variability than the vegetated communities.

Group Three: Yellow pond lily (Type IX)
Black needlerush (Type III)

The two marshes in the Group Three category are quite dissimilar in properties. The yellow pond lily marsh is not a significant contributor to the food web but it does have high values to wildlife and waterfowl. Black needlerush has a high productivity factor but a low detritus availability value. Black needlerush has little wildlife value but it ranks high as an erosion and flood buffer. Group Three marshes are important, though their total values are less than Group One and Two marshes. If development in wetlands is considered necessary, it would be better to alter Group Three marshes than Group One or Two.

Group Four: Saltbush (Type IV)

The saltbush community is valued primarily for the diversity and bird nesting habitat it adds to the marsh ecosystem. To a lesser extent it also acts as an erosion buffer. Group Four marshes should not be unnecessarily disturbed but it would be better to concentrate necessary development in these marshes rather than disturb any of the marshes in the preceding groups.

Group Five: Saltwort (Type X)
Reedgrass (Type VIII)

Based on present information Group Five marshes have only a few values of significance. While Group Five marshes should not be unreasonably disturbed, it is preferable to develop in these marshes than in any of the other types.

The ranking system above is only a partial tool for use in making decisions to alter wetlands for it measures only one wetland type against another. Other factors, involving a total view of the creek or river system involved, should be considered in the decision making process.

Acreage is obviously one important factor to consider when evaluating a specific wetland. A large wetland is inherently more valuable than a smaller wetland of the same type. Many creeks and rivers in Virginia however, contain vegetated and nonvegetated wetland areas which are quite small and/or fragmented. The cumulative value of these small areas may be as great or greater than that of a single wetland of the same type and acreage.

Any marsh which is 2 feet or more in average width is considered to have significant values as an erosion deterrent and in filtering sediments coming from the uplands. It may also have other values depending upon the total acreage of the marsh parcel. 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. Depending on its location, it may also have value as an erosion buffer.

In Virginia wetlands represent a little over 1% of the total acreage in the state yet they play a vital role in sustaining the important commercial and recreational fisheries which millions of east coast citizens enjoy. Population and development pressures in the tidal portion of Virginia pose a subtle but constant threat to these marine resources. Habitat losses are generally counted in small portions rather than catastrophic leaps. It is very important to note that although the large scale projects attract greater publicity, the total resource loss due to many small projects may be of equal or greater importance from an environmental viewpoint.

Because of the essential functions performed by wetlands in the marine environment and the limited extent of this resource, it is necessary to limit the activities which adversely affect wetlands to those considered highly essential. If the activity proposed can be accommodated while preserving all or most of the wetlands involved, a proper balance has been struck. In cases where development and preservation are mutually exclusive the necessity of the activity must be weighed against the value of the resource involved and the degree of adverse impact the activity will have on the wetland.

Section IV

Criteria for Evaluating Alterations of Wetlands

The legislature established a policy "to preserve the wetlands and to prevent their despoliation and destruction and to accommodate necessary economic development in a manner consistent with wetlands preservation". This section addresses the foregoing policy. Many proposed uses of the shoreline can be accommodated with little or no loss of wetlands if the following criteria are applied. There are times, of course, when these criteria may not apply in specific cases. The conscientious application of these criteria will, however, materially reduce adverse environmental impacts of man's activities on the shoreline.

The individual criteria contained in this section are supported by brief statements explaining the basic reasons behind adoption of the particular criterion. It is emphasized that these rationale are of necessity very brief and do not encompass all aspects of the given subject. Persons desiring further details should contact either the Virginia Marine Resources Commission, Habitat Management Division or the Virginia Institute of Marine Science, Department of Wetlands Ecology.

General Criteria

A. Provided significant marine fisheries, wetlands and wildlife resources are not unreasonably detrimentally affected, alteration of the shoreline or construction of shoreline facilities may be justified in order to:

1. Gain access to navigable waters by:

   a. Commercial, industrial, and recreational interests for which it has been clearly demonstrated that waterfront facilities are required.

   b. Owners of land adjacent to waters of navigable depth or waters which can be made navigable with only minimal adverse impact on the environment.

2. Protect property from significant damage or loss due to erosion or other natural causes.

B. Alteration of the shoreline is ordinarily **not** justified:

1. For purposes or activities which can be conducted on existing fastlands and which have no inherent requirement for access to water resources.

2. For purposes of creating waterfront property from lots and subdivisions which are not naturally contiguous to waters of navigable depth or waters which can only be made navigable by substantial alteration or destruction of marine resources.

3. When damage to properties owned by others is a likely result of the proposed activity.

4. When the alteration will result in discharge of effluents which impair wetlands, water quality or other marine resources.

5. When there are viable alternatives which can achieve the given purpose without adversely affecting marshes, oyster grounds or other natural resources.

Rationale: These criteria recognize riparian rights and reserve the shoreline for those uses or activities which require water access. These criteria also point out that activities such as dredging into the fastlands for housing developments often have a significant and long term adverse impact on the marine environment through such effects as changed upland hydrology, sedimentation, changes in water current patterns near the shoreline, and the introduction of pollutant discharges which frequently lead to closure of shellfish grounds. The dredging of channels into fastlands may also lead to deterioration of ground water by salt water intrusion into aquifers.

C. Utilization of open-pile type structures for gaining access to adequate water depths is generally preferred over the construction of solid structure, dredging or filling.

Rationale: The construction of solid structures, or the conduct of dredging and filling operations, often causes irretrievable loss of wetlands through their direct displacement or by indirect effects of sedimentation or altered water currents. Open-pile type structures permit continued tidal flow over existing wetlands and subtidal areas, avoid potential sedimentation problems, future maintenance dredging, and have less effect on existing water current patterns.

D. Channels, fills and structures should be designed to withstand the maximum stresses of the marine environment and also to minimize the frequency of future maintenance activities.

Rationale: Shoreline alterations often change currents, affect shoreline stability and cause biological damage. Unsuccessful structures or channels generate demands for remedial action which can compound initial adverse effects. Designs which minimize the dredging frequency in channels are particularly important. Dredging destroys or displaces bottom-dwelling organisms of value to the aquatic food web. Organisms can be expected to recolonize a dredged area after a period of time, however, too frequent dredging can inhibit recolonization.

E. High density development in or immediately adjacent to wetlands and/or other flood plains is discouraged.

Rationale: Development in low-lying areas and on high energy coastlines has historically created costly flood control and flood relief problems including claims for indemnification. Additionally, hydrological changes in surface run-off patterns are caused by the paving over of formerly absorbent soil. The usual effect is an increase in both the amount and the rate of surface water-flow, often contributing to shoreline erosion and other problems. Finally, high-density development leads to a concentration of contaminating constituents in urban surface water runoff which can severely stress receiving waters in the adjacent marine environment. There appears to be a direct relationship between population density in a watershed and increased bacterial levels in adjacent waters. This may lead to the imposition of long term restrictions on the direct marketing of shellfish.

Specific Criteria

The following specific criteria are established for use in the design, evaluation or modification of individual projects.

A. Shoreline Protection Strategies

1. Shoreline protection structures are justified only if there is active, detrimental shoreline erosion which cannot be otherwise controlled; if there is rapid sedimentation adversely affecting marine life or impairing navigation which cannot be corrected by upland modifications; or if there is a clear and definite need to accrete beaches.

   Rationale: The design and placement of shoreline protection structures is a highly technical subject and often the precise or long-term effects of such structures on littoral processes cannot be predicted. A study of one county's shoreline shows that nearly 50% of the existing shoreline protection systems are ineffective or poor in performance. Shoreline protection structures disrupt natural forces and drive a shoreline away from a natural equilibrium state. In short, all protective structures have the potential to adversely affect marine resources directly or through indirect means. Needless shoreline modification is therefore discouraged.

2. For shorelines experiencing mild to moderate erosion, the planting of marsh grasses is a preferred means of stabilization. **Note:** The planting of marsh grasses is not appropriate on all shorelines and requires some technical expertise. Free advice is available from the Virginia Shore-

line Advisory Service and the Virginia Institute of Marine Science.

Rationale: Fringing marshes buffer erosion through their dense root systems and ability to collect sand and sediments moving along the shoreline. When a fringe marsh is established, it not only provides food and habitat for marine birds and other organisms but also minimizes the adverse effects to adjacent shoreline properties which are often associated with other types of erosion control measures.

3. When an erosion control structure, such as a bulkhead or seawall, is deemed necessary, it should ordinarily be placed landward of any existing and productive marsh vegetation. A line of saltbushes, if existing, can usually indicate the seaward limit of the vertical structure. Along shorelines where no marsh vegetation exists, the retaining structure should ordinarily be placed far enough landward of mean high water so as to minimize exposure to wave action.

   Rationale: A vertical retaining structure behind a marsh not only preserves the marsh for its biological productivity but also utilizes the marsh's capabilities of aiding water quality and deterring erosion.

   Placing a vertical retaining structure landward of mean high water minimizes its exposure to wave action and reduces erosion or scour along the toe which could jeopardize the integrity of the structure. Landward placement also preserves intertidal bottom, maintaining habitat diversity and associated functions of this area within the marine ecosystem.

4. Sloped rock or riprap revetments and gabions are generally preferred over vertical structures.

Rationale: Vertical retaining structures tend to reflect wave energy and often transfer a problem to neighboring properties. Coastal waves, whether from natural causes or from boat wakes, are better absorbed or dissipated by riprap revetments or gabions. In addition, the slope and open spaces in riprap or gabion structures may provide suitable habitat for crabs and small fish. In some cases, sediment may be trapped in riprap or gabion structures and subsequently become vegetated with marsh species.

5. The placement of offshore breakwater or submerged, nearshore sills parallel to a portion of shoreline in order to attempt to elevate the height of a beach or dampen wave energy is generally acceptable only in areas with a good sand supply in the nearshore zone or where there is active detrimental erosion. Sill structures are usually constructed of properly filled sandbags, gabions or mortar filled bags. Although not a general rule, the sill is usually most effective when placed at or near the mean low water line. Both breakwaters and sills must be specifically designed for the shoreline segment in question.

   Rationale: The placement of sill structures where there is an insufficient supply of sand to the beach may cause harmful effects to the shorelines of adjacent downdrift properties. Placing the sills at, or near the mean low water line will usually ensure sufficient backshore height. Placement of the sill structure too far offshore may result in insufficient filling and ultimately failure of the system. Sills may also not be suitable for high use beaches because of the potential hazard to swimmers.

6. The placement of a groin or series of groins on eroding shorelines in an effort to trap sand and build up a beach is justified only when there is sufficient sand in the littoral drift system or if properly functioning groins already exist in the section of shoreline in question.

Rationale: Groins are designed to trap sand and build beaches. When they function properly, they necessarily deprive downdrift shorelines of sand and thus may accelerate erosion to adjacent properties particularly if there is only a small amount of sand available in the system.

7. When groins are considered justified they should be low profile in design and only as long as is necessary to trap sand drifting in the littoral zone. Ideal groin length can be determined by examining the sand fillets in existing groins along the same shoreline reach or can be based on the width of the local beach.

   Rationale: The low profile groin is designed to resemble the natural beach slope and allow sand to by-pass and thus nourish downstream properties once the groin has filled. Groins which are too long for the existing beach may shunt sand out to deeper water thus making it unavailable to downdrift properties.

8. The use of jetties at the entrance of a channel in order to maintain navigable depths or protect the entrance from wave attack is justified only when there is a clear and demonstrated need for such a structure and adjacent properties will not be significantly adversely affected.

   Rationale: jetties attempt to prevent the littoral drift from entering the channel by trapping sediment moving along the shoreline. Sand tends to accumulate on the updrift side of a jetty and sediments are transported away from the jetty on the downdrift side. This can often result in accelerated erosion of the downdrift shoreline.

B. Filling and Dredged Material Disposal.

1. Filling in wetlands or subaqueous areas for the singular purpose of creating waterfront upland property is generally undesirable.

Rationale: Marine resources are finite, provide many valuable services and products and are delicately balanced in an intricate web of biological and physical interactions. Permanent loss of these resources and unnecessary alterations jeopardize this delicate ecological balance.

2. When filling along a shoreline is necessary, the activity should be confined to the area landward of any wetlands. If suitable non-wetland areas are not available and it is necessary to locate the fill further seaward, locations in Group 3-5 wetlands should be selected if possible (reed grass, saltwort, saltbush, black needlerush, yellow pond lily). Every reasonable effort should be made to preserve existing Group 1 and 2 wetlands communities. In nonvegetated wetlands, fill should be contained at or above the mean high water line. In cases where some encroachment beyond mean high water is justified (e.g. where an eroding bluff is being graded down to stop erosion), the encroachment channelward of mean high water should be limited to the minimum required to achieve the desired goal.

   Rationale: The values of the more important wetland communities are preserved, thus somewhat lessening the undesirable impact of destroying marshes and in the case of nonvegetated areas, minimizing encroachment conserves these shallow areas to function as described in Section II of this document.

3. Fill material, whether on wetlands or nearby fastlands, should not contain contaminants which may leach into adjacent waters. Upland source material is generally preferable to dredged material for use as fill.

   Rationale: Oil or other contaminants can leach off the surface of filled areas and travel to adjacent waters via surface runoff. In some instances, they may also leach downward into the water table. In either case, water quality is impaired. Most dredged material is composed of silts and clays which when dry and compacted do not allow the free flow of water and thus may cause hydraulic flow problems behind a bulkhead.

4. Where feasible, controlled disposal of dredged material on highland property is the preferred method.

   Rationale: There are many difficulties inherent in controlling dredged material in the marine environment. Marine resources are finite and subject to significant disruption from such activities since the water column can act as a vector carrying sediments well beyond the immediate disposal point.

5. Dredged material disposal areas should meet the following criteria:

   a. Disposal by the bucket or dragline method:

      (1) Build an earth-tight bulkhead along the perimeter of the disposal area sufficient to confine the dredge spoil. The bulkhead or dike (berm) should have a top elevation at least 3 feet above the average upper limit of spring tides.

      (2) Earthen dikes (berms) should be compacted as they are constructed, have side slopes no steeper than 1 horizontal to 3 vertical, a top width of at least 3 feet, and the toe of the slope should be at least 15 feet from existing marsh grasses. Spillway boxes or release pipes should be provided to prevent water from eroding or over-topping the dike. As soon as possible after completion of the project, the disposal area should be graded and vegetative cover established.

(3) In some projects involving small volumes of generally sandy material, a double line of staked straw bales may provide suitable containment.

b. Disposal by hydraulic methods:

(1) Earthen dikes should be constructed by dragline or land fill methods to the specifications as described in 3 (1) above. The volume of the disposal area lying below the elevation of the spillway crest should, at all times during the dredging, be sufficient to provide a retention time long enough to clarify the discharge water to meet applicable water quality standards. The spillway should be placed as far as possible from the discharge end of dredging pipes.

(2) The dredge pipeline should have tight joints to prevent leaks. Grading and vegetative cover should be accomplished as soon as possible. (It is recognized that hydraulically filled areas may take many months to dry sufficiently for people or equipment to move across them. Seeding may have to be delayed for periods possibly as long as a year. The spillway should therefore be maintained until the area is permanently seeded and vegetation is well established and providing adequate ground cover to retain the soil).

Rationale: Control of sedimentation is accomplished if the above criteria is maintained during the entire dredging period.

6. Dredged material should not ordinarily be deposited in adjacent marsh as a convenience. if it becomes necessary to place spoil on a marsh, consideration should be given to placing it on those portions of lower value or to scattering the material in a thin layer rather than containing it be-

hind a berm. Berms in marshes should be used to contain fill only when absolutely necessary and when they will not impair tidal flow to other wetlands areas.

Rationale: A continuous berm often cuts off water supply to a marsh. Selective piling allows continued water supply to uncovered portions of a marsh and may enhance habitat for wildfowl and animals. Scattering of dredged material in a thin layer can sometimes maintain basic marsh values though it may ultimately lead to changes in vegetative species if the marsh surface is significantly raised in elevation. The depth of the soil layer must be evaluated in each case.

7. Whenever feasible, displaced marsh vegetation and peat should be used to reconstitute marsh in the vicinity of the activity site and particularly along the banks of newly cut canals. The practice of compensating for marsh loss in one area by building marsh in another is theoretically viable but because of significant technical difficulties is not always recommended.

   Rationale: This procedure, when successful, aids in maintaining marsh inventory and will deter shoreline erosion and enhance water quality conditions.

8. When under specific case by case analysis it is determined that marsh creation is an acceptable means of compensating for an unavoidable marsh loss, one marine habitat (e.g. tidal flats) should ordinarily not be sacrificed to create another (marsh). Resource compensation through marsh creation is not a panacea and should be limited to cases where the loss of existing marsh is unavoidable and significant and there is a high probability of success.

   Rationale: There is at present no conclusive evidence that the trading of one marine habitat for another results in a net gain for the environment. The creation of marsh from upland or other habitat is technically feasible in many cases. It is however a complex activity that generally cannot be successfully accomplished without technical knowledge and expertise.

9. Overboard disposal of dredged material is generally undesirable unless the deposits are basically clean sand, the disposal area is devoid of commercially important bottom organisms, and the deposits will have a beneficial effect on shoreline erosion problems. There may be occasions when overboard disposal of silty spoil can be used to create marsh. This will probably also entail the planting or seeding of marsh vegetation under closely controlled conditions.

   Rationale: Silty soils tend to stay in the water column longer than the heavier sands and may therefore drift to other areas resulting in damage to bottom organisms outside the selected spoil area. Pollutants may likewise drift with the currents. In some cases, good quality sand can be beneficial in nourishing starved or eroding beaches and this possibility should be considered.

10. Whenever overboard disposal is permitted, the operation should be located and conducted so as to minimize impacts on commercially important bottom dwelling (benthic) organisms such as clams and oysters, submerged aquatic vegetation, and other unique or highly productive habitats.

    Rationale: Because water is the link which ties all different marine habitats together and can transport pollutants over large areas, care must be taken to localize the impacts of overboard disposal to the maximum extent practical.

11. The overboard disposal of good quality sand in order to replenish beaches is generally acceptable so long as the beach sand and dredged sand are size-compatible.

    Rationale: The placement of material of smaller particle size than that found on the natural beach will only serve to increase turbidity since it will be resuspended by wave action and carried away very quickly resulting in little benefit for the sand-starved beach.

C. Dredging

1. When possible, open pile piers should be lengthened to reach necessary water depths in order to minimize the amount of dredging required.

   Rationale: Open pile piers have a minimal adverse impact on the marine environment. Dredging is a significant, though temporary, disruption which must be repeated in order to maintain water depths. Every dredging project, whether new dredging or maintenance requires an approved disposal area and this can be a major problem particularly in developed areas.

2. Dredging for the singular purpose of obtaining fill is ordinarily not justified.

   Rationale: Although dredged areas are repopulated to a degree by organisms after cessation of dredging, they generally never return to their predredge productivity levels if water depths are greatly increased. The result is a chronic degradation of habitat quality and reduction in system productivity.

3. For relatively small projects (2000 c.y. or less), dredging by dragline or bucket method is generally preferred.

   Rationale: Control of sedimentation is much simpler with the bucket dredge in that there is a higher ratio of soil to water as the dredged material is transferred from the dredging area. Dredged material disposal is less complicated and more easily subject to productive use. Hydraulic dredging is preferred for large dredging projects particularly when the dredged material is to be placed in an area remote from the dredged site.

4. The practice of "double handling" dredged material in a waterway is generally undesirable.

   Rationale: This activity, which involves the interim placement of dredged material in the waterway effectively doubles the adverse effects of bottom disruption and turbidity associated with dredging activities.

5. Dredging in shellfish areas, beds of subaquatic vegetation and other areas of singularly high productivity should be avoided if possible.

   Rationale: These areas generally have very high values to both commercial and sport fisheries and to the organisms that support them. In addition their recovery period from dredging is measured in years rather than months as is the case for other bottom types. In many cases the new depth involved after dredging may preclude any recovery of these particular biotic communities.

6. In oyster and clam growing areas (brackish and saline water) dredging should be avoided during the months of July, August, September, December, January and February, whenever possible. This is particularly important when the dredging is to be performed within 500 yards of, or overboard disposal is within one mile of, productive public or privately leased oyster ground. In anadromous fish spawning and nursery areas (i.e. freshwater), dredging and overboard disposal operations should be avoided, when possible, during the period of mid-March through October. Particularly critical is the actual spawning period, mid-March through June. Concern is heightened when overboard disposal is involved.

   Rationale: The majority of oyster spawning and spatfall occurs during the months of July, August and September in most areas of Virginia. Higher than normal suspended solids levels, which can occur in proximity to large dredging and disposal activities, can interfere with the development and survival of oyster larvae. Resultant sedimentation can also adversely affect the setting of oyster larvae by covering clean hard substrates thus making them unavailable to the larvae. During the coldest months of the year, oysters are more susceptible to siltation because their pumping activity is reduced and they are less able to clear away rapidly accumulating silt. During the spring spawning run (mid-March through June) anadromous fish eggs and larvae can be adversely affected by higher than normal levels of suspended sediments. Adult migrations can be impeded especially in narrow streams and rivers where turbidity may reach from bank to bank. The period July through October is the nursery period when the larvae develop into juveniles before beginning their migration back to the ocean. **Note:** This guideline is not subject to blanket application in the salinity regimes where it is applicable. Careful case-by-case analysis is required.

7. In relatively large water bodies, overdredging to reduce the frequency of maintenance dredging, should not exceed an additional two feet and this should be based on the anticipated sedimentation rate. In narrow canals and other water bodies subject to poor flushing, the dredged depth should not exceed one foot below that of the connecting waters.

   Rationale: This guideline balances the benefits of reduced maintenance frequency and thus environmental disturbance with the creation of stagnant or "dead" water which can occur when artificially deep holes are created.

Specialized Structures and Activities

D. Channeling into Fastland or Marshes

1. Where feasible, community piers and launching facilities are preferable to channeling into fastlands or marshes for water access in conjunction with urban development.

Rationale: Studies have shown that such channeling leads to water quality problems. Poor water circulation and flushing, combined with contaminating constituents and high nutrient loads from adjacent development often leads to reduced dissolved oxygen levels, noxious odors, uncontrolled algal growth and fish kills.

2. While environmentally objectionable, there may be times when channels into marshes or uplands are permitted. When this is the case, the following criteria should be applied in order to reduce adverse effects:

   a. Channels should be short in length and preferably no longer than twice the width.

   b. Channels should not be dredged more than I foot deeper than the depth of the waterway to which they are to be connected.

   c. Channels should not be box-cut but should be dredged with slopes that approximate the natural angle of repose of soils of the area, usually on the order of 3 feet horizontal for every 1 foot vertical.

   d. The top banks of channels should be graded to a slight incline anywhere between mean sea level and mean high tide for an inland distance of at least 10 feet. This area should then be planted with marsh vegetation appropriate to the soils and the salinity of waters in the area.

   e. Channels should be significantly shallower at their heads than at their mouths in order to promote better exchange with the natural waterway.

   f. Channel curves and angles should be avoided.

   Rationale: The foregoing criteria reduce the potential adverse impacts of channelization by providing for better water circulation and bank stability. The marsh vegetation aids in preventing upland spoils and contaminants from lowering water quality.

E. Dams and Impoundments

1. Dams and impoundments should ordinarily not be located in tidal wetland areas. If some encroachment into such areas is deemed necessary every effort should be made to limit the encroachment as much as possible and restrict marsh loss to Group 3-5 marshes.

   Rationale: Impounding an upland area generally involves a tradeoff of one set of upland habitat values (e.g. hardwood forest) for another set (lake or pond). When tidal wetlands are lost to this same type of development, the loss to the marine environment can be severe and is generally irreplaceable.

2. When a dam or impoundment is constructed in, or adjacent to, a tidal stream, provisions should be incorporated into the design to maintain a flow of freshwater into the estuary.

   Rationale: Maintaining a flow will minimize the upstream movement of salt water in the stream and thus reduce large scale aquatic habitat changes due to salinity shift.

3. Dams should incorporate the use of fish ladders in order to minimize the loss of upstream spawning and nursery grounds for marine species.

   Rationale: Many commercial and sports fishes are spawned and develop to adult stages above the tidal estuary. These areas are critical to the maintenance of population levels in these species.

4. Techniques which will minimize the possibility of mudwave creation adjacent to the dam site should be implemented when wetlands are present.

   Rationale: This guideline limits wetland losses due to impoundments to that immediately in and upstream of the dam site. A mudwave effectively destroys wetlands in its path by raising the substrate elevation above the range of tide.

5. Whenever possible, impoundments should be designed to incorporate shallow water areas capable of supporting emergent vegetation and water tolerant timber.

   Rationale: Shallow water habitat within the impoundment can help offset the loss of tidal wetland habitat due to dam construction.

F. Marinas

1. Dry storage type facilities are encouraged in preference to wet slip complexes.

   Rationale: Such facilities minimize adverse impacts to the marine environment and do not occupy space in the water which could be used for recreation by all citizens of the Commonwealth.

2. When siting and designing a marina facility in a coastal waterway, the following should be considered:

   a. All structures should be open-pile or floating with any permanent loss of aquatic habitat limited to that which is absolutely necessary.

   b. If sited in a small tributary or other poorly circulating body of water, the marina should be situated near the mouth rather than the headwaters.

c. The structures should encroach no more than one third the distance across the waterway except in unusual channel configurations.

d. Marinas should be sited away from productive or actively worked oyster and clam grounds.

e. Consideration should be given to the size and depth of the existing waterway and to the number of boats already housed in the vicinity.

f. Slips for deep draft vessels should be located in the naturally deeper waters of the marina.

g. If the site involves a marsh, all structures except those needed for access (ramps, railways, etc.) should be located landward of or channelward of marsh vegetation.

h. Design of any necessary breakwaters should permit adequate water circulation within the facility to help prevent an accumulation of pollutants. Floating tire or other non-permanent type breakwaters should be considered.

Rationale: The foregoing criteria reduce the potential adverse impacts of marinas by providing for better water circulation, minimizing marine habitat loss, and reducing initial and maintenance dredging requirements.

G. Drainage and mosquito ditches

1. Drainage and mosquito ditches should be designed according to a master plan which will maximize their effectiveness while minimizing their extent as much as possible.

2. Ditches designed along conventional grid patterns are discouraged in favor of ditches which link identified mosquito

producing areas within the marsh with tidal waters. Drainage ditches should also be designed to connect to specifically identified areas of poor drainage.

3. Depths should be limited to no more than 1 foot deeper than the connecting waters.

4. Depending on the size of the ditch, dredging should be accomplished "in the dry" (landside to seaward).

5. If dredge spoil must be placed in the marsh, it should be spread or broadcast as thinly as possible over a broad area with no effective elevation change on the marsh surface. If this is not possible, the dredged material should be placed in small widely separated mounds creating plant diversity and allowing water to circulate over the remaining marsh.

6. Where maintenance dredging is to be accomplished, the dredged material should be placed, to the maximum extent possible, on the old spoil area. If this is in the form of a continuous berm paralleling the ditch, the berm should be breached periodically to promote inundation of the remaining marsh.

7. Rotary ditchers are the preferred means of constructing mosquito ditches and small drainage ditches.

Rationale: Adherence to the above procedures will maximize the effectiveness of the ditches while minimizing adverse impacts to the wetlands.

H. Submarine pipeline crossings

1. Whenever feasible, pipelines should be placed on piles or attached to existing structure.

2. When a pipeline must be buried in the river bottom, the stockpiling of excavated material adjacent to the trench should be avoided.

3. When a pipeline must be buried in a marsh, material may be temporarily placed along side the trench if upon completion all excess material is removed from the marsh, the original elevation is restored, and all denuded areas are sprigged with appropriate vegetation.

   Rationale: These guidelines minimize construction impacts to the wetlands and allow for the fastest possible recovery of the natural system after the disturbance.

Section V. Wetlands Mitigation-Compensation Policy

Definitions

The following words, when used in these guidelines, shall have the following meaning unless the context clearly indicates otherwise:

"Compensation" means actions taken which have the effect of substituting some form of wetland resource for those lost or significantly disturbed due to a permitted development activity; generally habitat creation or restoration. Compensation is a form of mitigation.

"Mitigation" means all actions, both taken and not taken, which eliminate or materially reduce the adverse effects of a proposed activity on the living and nonliving components of a wetland system or their ability to interact.

Policy

In spite of the passage of the Virginia Wetlands Act and the Federal Water Pollution Control Act in 1972, the pressures to develop lands, including wetlands along Virginia's shoreline, have continued to accelerate as evidenced by the increasing number of permit applications being submitted. At the same time scientific research has demonstrated that certain wetlands can be established or re-established in areas where wetlands are not found at present. This has led to an increasing number of proposals calling for the destruction of wetlands in one area in order to accommodate development, and the creation of wetlands in another area in order to offset the loss of the natural wetland resource.

Although compensating for the loss of a wetland by establishing another of equal or greater area sounds very attractive in theory and has been regarded as successful in a few specific cases, in general, this form of mitigation has proven difficult to successfully implement. Many questions regarding the ecological soundness and feasibility of substituting one habitat for another remain to be answered. In addition, a number of studies have demonstrated that for various reasons the created habitats either never attain the level of productivity or diversity of the natural systems they replace or simply are not capable of performing the ecological functions of the undisturbed habitat.

Although California and Oregon now require compensation for lost wetlands on all projects, states such as North Carolina and New Jersey have taken a much more limited approach to the mitigation-compensation question. In general, these latter two states rely on wetland compensation only as a last resort to replace wetlands whose loss is highly justified and unavoidable. Virginia to this point has also taken a very conservative tack with regard to the use of wetland compensation as a management tool.

The Commission, and these guidelines, do not require that all wetlands losses be compensated. They do recommend, however, that compensation be required on a limited basis to replace unavoidable wetlands losses. There are three main reasons for this recommendation.

First, a literature survey and experience with implementing compensation on a day-to-day basis reveal a number of significant problems with the concept itself that remain to be resolved.

Second, there are general philosophical and technical questions regarding compensation which have not been answered by the scientific community to this point in time.

Third, and most important, a reading of the Wetlands Act clearly indicates that the General Assembly intended for the Commonwealth's wetland resources to be preserved in their "natural state," and emphasized through its declaration of policy, the importance of an overall ecological approach to wetlands management.

> "The Commonwealth of Virginia hereby recognizes the unique character of the wetlands, an irreplaceable natural resource which, in its *natural state,* is essential to the ecological sys-

> tems of the tidal rivers, bays and estuaries of the Commonwealth." (Emphasis added)

The General Assembly also stated that where economic development in the wetlands is clearly necessary and justified it will be accommodated while preserving the wetlands resource.

> ".... it is declared to be the public policy of this Commonwealth to preserve the wetlands and to prevent their despoliation and destruction and to accommodate *necessary* economic development in a manner consistent with *wetlands preservation.*" (Originally adopted under Section 62.1-13.1 of the Code of Virginia) (Emphasis added)

In Section 28.2-1308 of the Code of Virginia the General Assembly mandated the preservation of the ecological systems within wetlands of primary ecological significance and then stated:

> "Development in Tidewater, Virginia, to the maximum extent possible, shall be concentrated in wetlands of lesser ecological significance, in wetlands which have been irreversibly disturbed before July one, nineteen hundred seventy-two, and in areas of Tidewater, Virginia, apart from the wetlands."

The General Assembly has spelled out clearly that "necessary economic development" is to be accommodated in Tidewater, Virginia, but that the emphasis is on wetlands preservation in their natural state.

General Criteria

It shall remain the policy of the Commonwealth to mitigate or minimize the loss of wetlands and the adverse ecological effects of all permitted activities through the implementation of the principles set forth in these Wetlands Guidelines which were promulgated in 1974 and revised in 1982. To determine whether compensation is warranted and permissible on a case-by-case basis, however, a two-tiered mechanism will be implemented. This dual approach will consist first of an evaluation of necessity for the proposed wetlands loss (See Specific Criteria). If the proposal passes this evaluation, compensation will be required and implemented as set forth in the second phase, the Supplemental Guidelines.

The primary thrust of combining the existing Wetlands Guidelines with the two-tiered compensation guidelines is to preserve the wetlands as much as possible in their natural state and to consider appropriate requirements for compensation only after it has been proven that the loss of the natural resource is unavoidable and that the project will have the highest public and private benefit. Commitments to preserve other existing wetlands shall not ordinarily be an acceptable form of compensation.

Specific Criteria

In order for a proposal to be authorized to destroy wetlands and compensate for same in some prescribed manner, the three criteria listed below must be met. If the proposal cannot meet one or more of these criteria, the activity shall be denied, or must occur in areas apart from the wetlands. Should it satisfy all three criteria, however, compensation for the wetlands lost is required.

1. All reasonable mitigative actions, including alternate siting, which would eliminate or minimize wetlands loss or disturbance must be incorporated in the proposal.

2. The proposal must clearly be water-dependent in nature.

3. The proposal must demonstrate clearly its need to be in the wetlands and its overwhelming public and private benefits.

Supplemental Guidelines

If compensation is required, then the following guidelines should be given due consideration and, if appropriate, may be included as conditions of the permit:

A. A detailed plan, including a scaled plan view drawing, shall be submitted describing the objectives of the wetland compensation, the type of wetland to be created, the mean tide range at the site, the proposed elevations relative to a tidal datum, the exact location, the areal extent, the method of marsh establishment and the exact time frame from initial work to completion.

B. Once the grading is completed at the planting site, it should be inspected by a competent authority to insure that the elevations are appropriate for the vegetation to be planted and that the surface drainage is effective.

C. The compensation plan and its implementation must be accomplished by experienced professionals knowledgeable of the general and site-specific requirements for wetland establishment and long-term survival.

D. A performance bond or letter of credit is required and shall remain in force until the new wetland is successfully established; a minimum of two growing seasons.

E. The compensation marsh should be designed to replace as nearly as possible, the functional values of the lost resource on an equal or greater basis. In general this means creating a marsh of similar plant structure to that being lost. This may not be the case where a lesser value marsh is involved (i.e. Group 4 or 5 wetlands). A minimum 1:1 areal exchange is required in any case.

F. The compensation should be accomplished prior to, or concurrently with, the construction of the proposed project. Before any activity under the permit may begin, the permittee must own all interests in the mitigation site which are needed to carry out the mitigation.

G. All reasonable steps must be taken to avoid or minimize any adverse environmental effects associated with the compensation activities themselves.

H. On-site compensation is the preferred location alternative with off-site in the same watershed as a consideration when on-site is not possible. Locating a compensation site outside the river basin of the project is not acceptable unless it is done as part of a state-coordinated program of ecological enhancement.

I. In selecting a compensation site, one aquatic community should not be sacrificed to "create" another. In cases where dredged material must be placed overboard, the area may be used to create marsh, oyster rock or improve the resource value of the bottom.

J. The type of plant community proposed as compensation must have a demonstrated history of successful establishment in order to be acceptable.

K. The proposed activity should stand on its own merits in the permit review. Compensation should not be used to justify permit issuance.

L. Manipulating the plant species composition of an existing marsh community, as a form of compensation, is unacceptable.

M. Nonvegetated wetlands should be treated on an equal basis with vegetated wetlands with regard to compensation and mitigation, unless site-specific information indicates one is more valuable than the other.

N. Both short- and long-term monitoring of compensation sites should be considered on a case-by-case basis. For unproven types of compensation the applicant will be responsible for funding such monitoring as is deemed necessary.

O. Where on-site replacement for noncommercial projects is not feasible, compensation for small wetland losses (less than 1,000 sq. ft.) should be avoided in favor of eliminating loss of the natural marsh to the maximum extent possible.

P. Conservation or other easements to be held in perpetuity should be required for the compensation marsh. Easements accepted by the Commission will be processed in accordance with the provisions of Section 28.2-1301 of the Code of Virginia.

Q. All commercial projects which involve unavoidable wetland losses should be compensated.

Glossary

ALGAE - Simple marine or freshwater photosynthetic plants. May be single or multicelled.

ANNUALS - Invertebrates which generally spawn once a year and live about a year.

BENTHIC - Pertaining to any plant or animal living in or on the bottom sediment of a river, ocean, lake or other aquatic system.

BERM - A wall or mound built around a low-lying area to contain a spoil material.

BIANNUALS - Invertebrates which generally spawn twice a year and live less than a year.

BRACKISH - Pertaining to the waters of bays and estuaries, salty but of lower salinity than seawater.

BULKHEAD - A structure or partition, usually running parallel to the shoreline, for the purpose of protecting fastlands from wave action or protecting channels from upland sedimentation.

COMMUNITY - Ecological term for any naturally occurring group of different organisms inhabiting a common environment, interfacing with each other relatively independent of other groups. Communities may vary in size and larger communities may contain smaller ones.

DETRITUS - Organic matter (primarily marsh plants) which while decaying in the aquatic system forms the basis of major marine food web. The organic matter and its rich growth of microbes are fed on by many estuarine species.

DOMINANT - For purposes of classifying marshes in this report, any organism which makes up at least 50% by volume of the organisms present in a given area.

DRAGLINE - The method of dredging employing a crane and large metal bucket to remove accumulated sediment.

DREDGING IN THE DRY - A technique of dredging used where new channels or canals are being cut. The canal is dredged from the landward end toward the seaward end and the last step is to open the new canal to the existing waterway.

DIKE - A wall or mound built around a low-lying area to prevent flooding.

ECOLOGY - The overall relationships between organisms and their environment.

FASTLANDS - The zone extending from the landward limits of wetlands to at least 400 feet inland.

FRESH WATER - Waters containing no appreciable salt, usually less than .5 parts per thousand.

FOOD WEB - The complex interactions of organisms in a natural community involving organisms feeding on one another to obtain energy.

GABION - A container filled with stone, brick, shells or other material to give it a heavy weight suitable for use in constructing bulkheads or groins. In the marine environment, usually made of galvanized steel wire mesh with a PVC (polyvinyl chloride) coating over the galvanizing.

GROIN - A shore protection structure built (usually perpendicular to the shoreline) to trap sand and other material moving along the shoreline and thus retard erosion of the shore.

HETEROGENEOUS - Being composed of many different forms of something. Specifically, a heterogeneous marsh is one composed of many different species without any one being dominant.

HYDROLOGICAL - Pertaining to water, its properties and distribution especially with reference to water on the surface of the land, in the soil and underlying rock.

INTERTIDAL - Area on a shoreline between mean high water and mean low water.

JETTY - On open seacoast, a structure extending into a body of water designed to prevent shoaling of a channel by sand or other materials. Usually placed along side channels at entrances.

LINE OF SALTBUSHES - Refers to the characteristic growth of salt marshes at the upper limit of the highest high tides. When present in a line along the inland side of a marsh it often indicates the upper limits of wetlands as defined in the Virginia Wetlands Act.

LITTORAL PROCESSES - Those physical features and characteristics of the intertidal area which determine the type of shoreline present.

MICROCOSM - A small community regarded as having all the characteristics of the biosphere or the world.

MONOSPECIFIC - Being composed entirely of one species or one type of organism. In this case a marsh vegetated by one type of grass.

MEAN HIGH WATER - The average height of high waters over a nineteen year period.

MEAN LOW WATER - The average height of low waters over a nineteen year period.

PERENNIAL - A plant which produces new growth year after year according to the seasons. In the case of nonwoody plants the aerial portion dies each winter and is replaced each spring.

PHYSIOGRAPHIC - A description of nature or natural phenomena in general.

POPULATION - All of the members of one species within a community.

PRIMARY PRODUCTION - Biomass produced directly from sunlight by plants.

PRODUCTIVITY - The rate of energy storage of an ecosystem or community in the form of organic substances which can be used as food materials.

RHIZOMES - Underground stems capable of producing new aerial shoots.

RIPRAP - Refers to a bulkhead or groin constructed of selected rock or concrete forms carefully placed so as to dissipate wave energy (bulkhead) or collect sand (groin) along a shoreline.

SECONDARY PRODUCTION - Biomass produced by animals grazing on plants or other organic matter.

SHORE DEFENSE STRUCTURES - A bulkhead or groin intended to deter erosion of the shoreline.

SPECIES DIVERSITY - Pertaining to the numbers of different species inhabiting a given area, i.e. high species diversity would mean many different species in one area.

SPOIL - The material removed from a channel bottom or other body of water during a dredging operation.

SPRING TIDES - Higher high tides which occur twice monthly due to astronomical conditions.

WRACK LINE - A line of debris, above the mean high tide line, which has been deposited by previous higher than normal tides.

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