Task 15

Final Product

Wetlands Educational Curriculum

Instructors' Manual

Prepared by

Wetlands Program
Virginia Institute of Marine Science
College of William and Mary

September 1991

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Table of Contents

Introduction

The Wetlands Education Curriculum consists of a lecture series addressing the tidal wetland management program in the Commonwealth of Virginia. The lectures are designed for presentation by the Wetland Program staff of the Virginia Institute of Marine Science. The lecture series provides a consistent and comprehensive curriculum for wetland board members, planning staff, coastal resource managers, applicants, agents, contractors, and interested citizen groups.

The curriculum provides technical information on basic ecological, management and procedural issues central to appropriate management of the Commonwealth's tidal wetland resources. Each unit provides a standardized set of technical information in a consistent format. The intent of the education program is to provide similar technical backgrounds for wetland managers throughout Virginia. This will assist wetland board members across coastal Virginia in providing a more consistent, technically based review of wetland activities.

The curriculum includes thirteen education units of which selected units comprise a core curriculum that address the basic needs and concerns of tidal wetland managers. These include values and functions of tidal wetlands, critical examination of coastal structures and their impacts to the marine environment, and the role of the wetland boards. The manual also includes more advanced lectures such as: marina development, wetland mitigation and compensation, and plant and animal adaptations to the marine environment.

Education seminars will be provided on a regular basis; generally the core curriculum will be presented. Periodically, and on request, the Wetland Program staff will also offer lectures covering more advanced material.

The education units easily lend themselves to field site visits for hands-on learning. Field trips will be used to reinforce lecture material. Field work will generally be held in conjunction with classroom training.

Following completion of the core curriculum, students will receive a certificate of training for completion of the VIMS Tidal Wetlands Workshop.

The instructors' manual is divided into three sections. The first includes preparation procedures for seminars, teaching tips, and speaking tips. The bulk of the manual is comprised of the education units. Each unit includes the lecture notes, handouts, slide lists, and the corresponding slides. Additional material such as sign-in sheets, evaluation forms, and registration forms are found in the back of the manual.

Maryann Wohlgemuth
Project Coordinator

Preparation for Wetland Education Seminar

Prior to Seminar

1. Choose date(s) and location convenient for chosen audience.

2. Reserve room(s) tentatively. Fill out meeting arrangement form from Director's office, if applicable.

3. Prepare and mail announcements, to include:
   a. preliminary schedule of talks, date, and location;
   b. pre-registration forms;
   c. description of certificate of completion;
   d. deadline for response;
   e. brochure of education program.

4. Include announcement in Virginia Wetlands Report (if possible).

5. Following receipt of pre-registration forms, mail:
   a. final schedule of talks and field work;
   b. parking forms (if presented at VIMS);
   c. suggestions for appropriate attire for field work sessions;
   d. map of the local area, and directions.

6. Arrange for refreshments (donuts, coffee).

7. Assemble name tags, registration forms, evaluation forms, handout materials, and pencils. Forms are in section 14.

8. Arrange for tables for refreshments and registration materials.

9. Prepare certificates of completion. The certificate is on file in the Publications Center. Provide appropriate information to fill in the blanks for printing on parchment paper.

Day of Seminar

1. Set up slide screen and projector.

2. Load slides into tray. Preview the entire tray to make sure that they are all in order and right side up.

3. Set up tables.

4. Check PA system and lights. Need operator if at VIMS.

Teaching Tips

1. Identify your audience; determine background, interests, and needs.
2. Read through the complete education unit, including the handouts.
3. Review the slides to confirm their order, and to familiarize yourself with them.
4. Glossary words and suggested reading lists are found on the handout sheets.
5. Make a copy of the education unit for your use.
6. Use the left column labeled "Notes" for notes you may need during your presentation.
7. Choose and verify field site locations.

Speaking Tips

1. Project your voice and vary your vocal pitch to add emphasis, to keep the audience interested, and to minimize sounding monotonous or flat.
2. Speak rapidly enough to avoid a boring drone and slowly enough to be understood.
3. Maintain eye contact with your audience as much as possible rather than reading from notes.
4. Minimize distracting mannerisms such as: swaying, pacing, toying with coins in pocket, and tapping fingers or feet.
5. Speak with vitality. A moderate amount of the following may help you be more expressive in your delivery: gestures, body movement, and varied facial expressions.
6. Utilize props whenever possible such as: NOAA tide book, field guides (*Common Plants of the Mid-Atlantic Coast*), VMRC code book, and VMRC guidelines.
7. Use non-technical language as much as possible. When correct technical terms are essential, pause to spell and define them for the audience. Then be sure to use them in your presentation so that the audience will become familiar with them in appropriate context.
8. Adult learners are often hesitant to admit confusion or ask questions. Check for understanding periodically by engaging the audience in discussion of the material which has been covered.
9. Use samples and specimens whenever possible. Familiarity with the relevant "real thing" is important to developing the participants' confidence in using and applying concepts learned.
10. Begin each presentation by explaining what the audience should expect to gain from the session (see objectives for individual modules). At the end of each presentation, a review of information covered is helpful.

Environmental History

Thomas A. Barnard, Jr.

Objectives

Notes

Length of Presentation: 20 min.

The purpose of this module is to expose students to an overview of American environmental history and the development of the attitudes toward wetlands and resource management which we find in the country today.

Upon completion, students should be able to:

- Examine historical wetlands losses and the development of our existing laws and statutes.
- Understand the "tragedy of the commons" and introduce the implications of population growth for the coastal plain of Virginia and the Chesapeake Bay.

Materials

1. 35 mm slide projector
2. Screen
4. Slides
5. Handouts

Instructor Preparation Tasks

1. Review outline
2. Review and choose visual aids
3. Prepare handouts
4. Review references
5. Ensure that equipment is in good working order

Procedure

1. Introduce yourself and others as required
2. Announcements
   a. Will take questions at end of talk or as we go along
   b. With limited time this can be only a limited overview
   c. Urge additional reading, especially *Quiet Crisis* and *Life and Death of the Salt Marsh*
3. Distribute handouts

Lecture Notes

I. INTRODUCTION

Slide 1

A. The New World has a relatively short chronological history compared to the older civilizations on the other side of both the Atlantic and Pacific Oceans.

B. In terms of environmental history, however, the differences are not so great for two main reasons:

Slide 2

1. Man's need, desire and ability to significantly manipulate his physical environment on a global scale has only evolved since North America was settled by the white man.

2. The eventual solidification in the Americas of the European concept of individual land ownership and the loss of the "earth is mother" and "all lands are commons" concepts of the native Americans.

II. THE AMERICAN ENVIRONMENTAL ETHIC

Slide 3

A. The early colonists were totally consumed with scratching out a living in the new world.

Slide 4

1. Once civilization was firmly established, profits and the accumulation of wealth became goals (Udall, 1963).

Slide 5

2. The concept that the earth's resources were "limitless" became well established in the minds of the pioneers. "Spoil the nest and move west".

B. The westward expansion period was one of tremendous abuse of natural resources from the slaughter of the buffalo to the destruction of soil during the gold rush and the filling of wetlands to create agricultural land.

Slide 6

1. The machines of the industrial revolution greatly expanded man's ability to harvest resources, and reclamation of wetland "waste areas" was the norm (Siry, 1984).

Slide 7

2. Government policy encouraged the "giveaway" of resources such as trees, gold and oil to the Robber Barons.

3. Even presidents such as Ulysses S. Grant condoned and encouraged the uncontrolled exploitation.

C. The assumption of the presidency in 1901 by Theodore Roosevelt saw the beginnings of a national conservation movement to address the abuses of the time.

1. T. Roosevelt started the National Park System, and under Gifford Pinchot the National Forest Service and the concept known as "conservation".

2. John Muir, a "preservationist", argued against multiple use of National Parks and Refuges and later started the Sierra Club.

3. Today the philosophical battles between preservationists and conservationists continue. Clear-cutting on National Park lands, the cutting of "old growth forests" and government subsidies of the lumber industry are all arguments based on these differing philosophies.

Slide 8

D. The post-depression era saw the development of scientific methods which gave rise to quantitative ecology and the assessment of natural environments through scientific observation (Siry, 1984).

Slide 9

E. The decades of the 60's, 70's and 80's saw not only the rise of the environmental movement but also tremendous emphasis on our estuaries in general and wetlands in particular.

Slide 10

1. Federal government studies have estimated that total wetlands losses in the continental U.S. have been greater than 100 million acres, or approximately 54% (Dahl, 1990).

Slide 11

2. During the mid-1950's to mid-1970's period total wetland losses were 458,000 acres/year (Tiner, 1984).

Slide 12

3. During the approximate same time period tidal wetlands in Virginia were being lost at a rate of 451 acres per year, with this figure projected to increase by 710 acres per year (Settle, 1969). Tidal wetlands losses being permitted today total 25 to 40 acres per year.

III. TODAY WE SEE MANY OF THE OLD ATTITUDES REGARDING WETLANDS HAVE FADED BUT NOT DISAPPEARED. MANY MORE PEOPLE NOW RECOGNIZE THE VALUES OF WETLANDS AND THEIR NATURAL FUNCTIONS.

1. The Virginia Wetlands Act became effective July 1, 1972. It has been amended numerous times, with the latest allowing the use of civil charges in the case of unpermitted activities. (Explain chronology handout.)

Slide 13

Slide 14

2. The pressures to use or develop wetlands for short-term gain are still great, however. The demand for waterfront property and population increase in the coastal zone, as well as the world in general, threaten natural resources and the systems they support. In the next 30 years the Maryland, Pennsylvania and Virginia portions of the Bay watershed are expected to grow by almost 20%, or 2.6 million people (2020 Panel, 1988).

3. With the population and economic pressures of today, the tragedy of the commons, where small individual uses or demands placed on a resource are harmless singularly, collectively result in an eventual collapse of the common resource to the detriment of all. (Use example here; pasture and sheep, ocean and pollutant dumping, fish and fishermen, etc.)

4. Even though we are dealing here with only the management of wetlands, it is important that we realize that reality dictates that we at least look at our Bay system as a complete unit or drainage basin. The procedures currently being used throughout the Bay region to address growth and development are clearly inadequate (2020 Panel, 1988).

a. As the tragedy of the commons illustrates, we cannot afford to deal with our resources in a piecemeal manner any more than we can look at a pasture commons from only one or a few perspectives.

b. Because ownership in Virginia goes to mean low water, wetlands are economically not a common. Ecologically, however, the Chesapeake Bay's health and vitality are dependent on the interactions of man and the contributions of resources such as wetlands and SAV and are truly a commons in this sense.

Slide 15

c. At the present time we do not have a management program for nontidal wetlands in Virginia, and yet many of these wetlands in the coastal plain are intimately tied to tidal marshes and our coastal waters. The Chesapeake Bay Preservation Act includes some nontidal wetlands as a management area based on their water quality enhancement functions.

Slide 16

d. As you work your way through this curriculum or program, it is important that in learning the specifics presented here, you keep an overall perspective ranging from regional in the case of Bay issues to global in the case of issues of broader significance.

References

2020 Panel. 1988. Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020. The report of the year 2020 panel to the Chesapeake Executive Council. 52 pp.

Dahl, T. E. 1990. Wetland losses in the United States 1780's to 1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 21 pp.

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Siry, Joseph V. 1984. *Marshes of the Ocean Shore, Development of an Ecological Ethic*. Texas A&M University Press. College Station, TX. 216 pp.

Teal, John M. and Mildred. 1969. *Life and Death of the Salt Marsh*. Ballantine Books. New York, New York. 274 pp.

Tiner, Ralph W., Jr. 1984. Wetlands of the United States: Current Status and Trends. U.S. Fish and Wildlife Service, National Wetlands Inventory. Washington, D.C. 46 pp.

Udall, Stuart L. 1963. *The Quiet Crisis*. Holt, Rinehart and Winston. New York, Chicago, San Francisco. 209 pp.

Udall, Stuart L. 1988. *The Quiet Crisis II*. Henry Holt and Company. New York, New York.

Wild, Peter. 1979. *Pioneer Conservationists of Western America*. Mountain Press Publishing Company. Missoula. 246 pp.

Wild, Peter. 1986. *Pioneer Conservationists of Eastern America*. Mountain Press Publishing Company. Missoula. 280 pp.

Slide List

1. Pristine swamp slide.
2. Heavy industry photo (smokestack, shipyard, bulldozer, etc.).
3. Photo of corn, tobacco, or other crop.
4. Plantation house.
5. Shot of marsh or forestland or other resource running from corner to corner of picture.
6. Abuse of resources photo.
7. Abuse of resources photo.
8. Scientific sampling apparatus.
9. Satellite photo of Chesapeake Bay.
10. Wetlands loss graphic.
11. Wetlands loss illustration.
12. Virginia wetlands loss graphic.
13. Wetlands destruction slide.
14. High density housing slide.
15. Satellite slide of Bay.
16. Global implications slide.

Environmental History Handout

Virginia Wetlands Historical Summary

Background

1966 Legislature established a special Marine Resources Study Commission.

1967 Study Commission recommended a special study on marsh and wetlands.

1968 Legislature directed VIMS to conduct the wetlands study.

1969 VIMS report (*Coastal Wetlands of Virginia, Interim Report*, Wass and Wright, Dec. 1969).

1970-72 Public hearings, drafting of Wetlands Act and research (Marcellus, Boon, Lynch) to determine wetlands definitions and upper limits of wetlands.

1972 Published *Tidal Datum Planes and Tidal Boundaries and Their Use as Legal Boundaries*, Boon and Lynch, 1972.

1972 Wetlands Act enacted, to become effective 1 July 1972. Publication of *Coastal Wetlands of Virginia, Interim Report No. 2*, Marcellus, July 1972. First local wetlands boards established and VIMS commences training workshops for boards. VIMS also commences wetlands inventory.

1973 Published management manual for wetlands boards (*Local Management of Wetlands—Environmental Considerations*, Marcellus, Dawes, Silberhorn, June, 1973). First county inventory published (*Lancaster County Tidal Marsh Inventory*, Silberhorn, December, 1973).

1974 Published wetlands guidelines (*Coastal Wetlands of Virginia, Interim Report No. 3, Guidelines for Activities Affecting Virginia Wetlands*, Silberhorn, Dawes, Barnard, June 1974). Published two county inventories (Mathews, York; both Silberhorn). Wetlands Guidelines promulgated by VMRC.

1974 Wetlands of Back Bay and the North Landing River and its Tributaries added by amendment.

1982 Nonvegetated wetlands added by amendment. Boards expanded from 5 to 7 members (optional). Grandfather Sunset Clause.

1983 Wetlands Guidelines revised to include nonvegetated areas.

1987 Wetlands Act amended to allow reporting, site inspections, notice to comply and stop work orders.

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School of Marine Science
Gloucester Point, Virginia 23062

1989 Wetlands Mitigation-Compensation Policy adopted.

1990 Wetlands Act amended to allow court ordered civil penalties not to exceed $25,000 for each day of violation. In lieu of any civil penalty, civil charges of up to $10,000 for each violation may be ordered by the Marine Resources Commission or Wetlands Board. Restoration hearings were also authorized.

1991 Tidal Marsh Inventory for City of Chesapeake completed and published (last of original series). Wetlands inventories to be maintained and updated using computer-based Geographical Information System (GIS).

1991 VIMS Wetlands Program produces "Virginia Wetlands Management Handbook" and Wetlands Educational Curriculum.

Suggested Reading List

2020 Panel. 1988. Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020. The report of the year 2020 panel to the Chesapeake Executive Council. 52 pp.

Hardin, Garrett. 1968. The tragedy of the commons. Science 162, 1243-1248.

Teal, John M. and Mildred. 1969. *Life and Death of the Salt Marsh.* Ballantine Books. New York, New York. 274 pp.

Udall, Stuart L. 1963. *The Quiet Crisis.* Holt, Rinehart and Winston. New York, Chicago, San Francisco. 209 pp.

Udall, Stuart L. 1988. *The Quiet Crisis II.* Henry Holt and Company. New York, New York.

Coastal Resources:
Definitions and Jurisdictions

Julie G. Bradshaw

Notes

Length of Presentation: 20 min.

Objective

The purpose of this unit is to review the coastal resources definitions and regulatory jurisdictions necessary for wetland board members to understand their role in the permit process and for applicants to understand the coastal resources terms used in the Joint Permit Application.

Upon completion, students should be able to:

- Define the following terms: mean low water, mean high water, mean tide range, National Geodetic Vertical Datum (NGVD), vegetated wetlands, non-vegetated wetlands, subtidal, subaqueous, coastal primary sand dune, beach, federal jurisdiction wetland.

- Explain the jurisdiction of the local wetlands boards, VMRC, and (generally) the US Army Corps of Engineers.

Materials

1. 35 mm projector
2. Screen
3. Slides
4. Handout

Instructor Preparation Tasks

1. Review lesson outline
2. Review Technical Report No. 91-2
3. Review slides
4. Practice with equipment

Procedure

1. Introduce self and other instructors
2. Announcements (explain field trip, if taking one)
3. General comments (explain objective of unit)
4. Distribute handouts

Lecture Notes

Slide 1

I. REGULATORY AUTHORITY

Slide 2

A. State/local (from Code of Virginia).

1. Tidal Wetlands Act (Title 62.1, Chap. 2.1).

2. Coastal Primary Sand Dune Protection Act (Title 62.1, Chap. 2.2).

3. Establishment of Commonwealth ownership of subaqueous land (Title 62.1, Chap. 1).

Slide 3

B. Federal (from U.S. Code).

1. Section 404 of the Clean Water Act of 1977 (33 USC 1251)—dredge and fill.

2. Section 10 of Rivers and Harbors Appropriation Act of 1899 (33 USC 403)—navigation.

Slide 4

II. TIDAL DATUMS

A. **Mean low water (MLW)**—the average elevation of low water observed over a specific 19 year period.

B. **Mean high water (MHW)**—the average elevation of high water observed over a specific 19 year period.

C. **Mean tide range**—the difference in elevation between MLW and MHW.

D. **Mean sea level**—the average of hourly water elevations observed over a specific 19 year period.

E. Note on 19 year period: The National Oceanic and Atmospheric Administration's National Ocean Service keeps tidal datum records at a network of gauge stations along the coast. The specific 19 year period used for calculating MLW and MHW, called the Metonic cycle or the National Tidal Datum Epoch, incorporates a number of the astronomical cycles which cause variations in tide levels.

F. **National Geodetic Vertical Datum** (NGVD)—a fixed reference based on the earth's shape and the distance between the earth's surface and the center of the earth. NGVD is the datum for land elevations on USGS topographic maps. NGVD was formerly known as the Sea Level Datum of 1929. The name was changed because of confusion with the tidal datum

Mean Sea Level (already defined). Relationships between NGVD and local tidal datums are variable and are published in conjunction with the tidal bench mark data by the National Ocean Service.

III. STATE/LOCAL DEFINITIONS

A. **Vegetated wetlands**—those lands which satisfy these criteria:

1. Between MLW and an elevation above MLW equal to 1.5 times the mean tide range (emphasize that this is a vertical measurement).

2. Contiguous to MLW.

3. Vegetated with any of the listed wetland plant species (included in handout).

B. **Nonvegetated wetlands**—those lands which satisfy these criteria:

1. Between MLW and MHW.

2. Contiguous to MLW.

3. Not otherwise considered vegetated wetlands.

C. **Subtidal land** or **subtidal bottom**—the area channelward or seaward of MLW, without regard to political subdivision or land ownership.

D. **Subaqueous land** or **subaqueous beds**—ungranted beds of the bays, rivers, creeks and shores of the sea which are owned by the Commonwealth. This includes the beds of tidal and nontidal water bodies. Because property ownership in Virginia extends channelward to MLW in tidal areas, subaqueous land is the land channelward of MLW, with some exceptions:

1. Potomac River—is owned by the State of Maryland and the District of Columbia. The boundary between Maryland and Virginia is generally at MLW on the Virginia side of the river, except where embayments, creeks, and inlets occur, at which the boundary line is from headland-to-headland. Therefore, VMRC often may not have jurisdiction over subtidal land on the Potomac River.

2. Manmade canals—VMRC does not currently exert jurisdiction over subtidal land in manmade canals. However, the Commonwealth's Tidal Wetlands Act does apply to vegetated and nonvegetated wetlands within manmade canals.

Slide 5

E. **Coastal primary sand dunes**—those lands which have the following characteristics:

1. Mound of unconsolidated sandy soil.

2. Contiguous to MHW.

3. Landward and lateral limits marked by a change in grade from 10% or greater to less than 10%.

4. Vegetated with any of the listed dune plant species (in handout).

5. Applies only to Counties of Accomack, Lancaster, Mathews, Northampton, Northumberland, and Cities of Hampton, Norfolk, and Virginia Beach.

F. **Beaches**—those lands which meet the following criteria:

1. The shoreline zone of unconsolidated sandy material.

2. Extends from MLW landward to a marked change in material composition or in physiographic form (e.g., dune, bluff, marsh).

3. If no such marked change occurs, then the landward limit of the beach is defined by a line of woody vegetation or the nearest impermeable manmade structure.

Slide 6

IV. FEDERAL DEFINITION/JURISDICTION:

A. Wetlands.

1. Based on 3 parameters: soil, hydrology, vegetation.

2. "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

3. Includes both tidal and nontidal wetlands.

4. In tidal areas, wetlands under federal jurisdiction may encompass a broader area than the state/local jurisdiction (i.e., federal wetlands may extend to elevations greater than 1.5 times the mean tide range above MLW).

Slide List

1. Title slide
2. State/local laws
3. Federal laws
4. Cross-section drawing showing tidal datums and state/local jurisdiction
5. Cross-section drawing showing primary dune datums and jurisdiction
6. Cross-section drawing showing federal and state/local jurisdiction

Coastal Resources: Definitions and Jurisdictions Handout

Regulatory Authority

Activities on Virginia's shoreline are controlled by a number of federal and state laws. The laws create overlapping jurisdictions for the various regulatory agencies.

State/local (from Code of Virginia)

1. Tidal Wetlands Act (Title 62.1, Chapter 2.1).
2. Coastal Primary Sand Dune Protection Act (Title 62.1, Chapter 2.2).
3. Establishment of Commonwealth ownership of subaqueous land (Title 62.1, Chap. 1).

Federal (from U.S. Code)

1. Section 404 of the Clean Water Act of 1977 (33 U.S.C. 1251)—dredge and fill.
2. Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. 403)—navigation.

Tidal datums

mean low water (MLW)—the average elevation of low water observed over a specific 19 year period.

mean high water (MHW)—the average elevation of high water observed over a specific 19 year period.

mean tide range—the difference in elevation between MLW and MHW.

mean sea level—the average of hourly water elevations observed over a specific 19 year period.

Notes: The National Oceanic and Atmospheric Administration's National Ocean Service keeps tidal datum records at a network of gauge stations along the coast. The specific 19 year period used for calculating MLW and MHW, called the Metonic cycle or the National Tidal Datum Epoch, incorporates a number of the astronomical cycles which cause variations in tide levels.

The ***National Geodetic Vertical Datum (NGVD)*** is a fixed reference based on the earth's shape and the distance between the earth's surface and the center of the earth. NGVD is the datum for land elevations on USGS topographic maps. NGVD was formerly known as the Sea Level Datum of 1929. The name was changed because of confusion with the tidal datum Mean Sea Level (defined above). Relationships between NGVD and local tidal datums are variable and are published in conjunction with the tidal bench mark data by the National Ocean Service.

State/local definitions

vegetated wetlands are those lands which satisfy these criteria:

- between MLW and an elevation above MLW equal to 1.5 times the mean tide range.
- contiguous to MLW.
- vegetated with any of the listed wetland plant species.

nonvegetated wetlands are those lands which satisfy these criteria:

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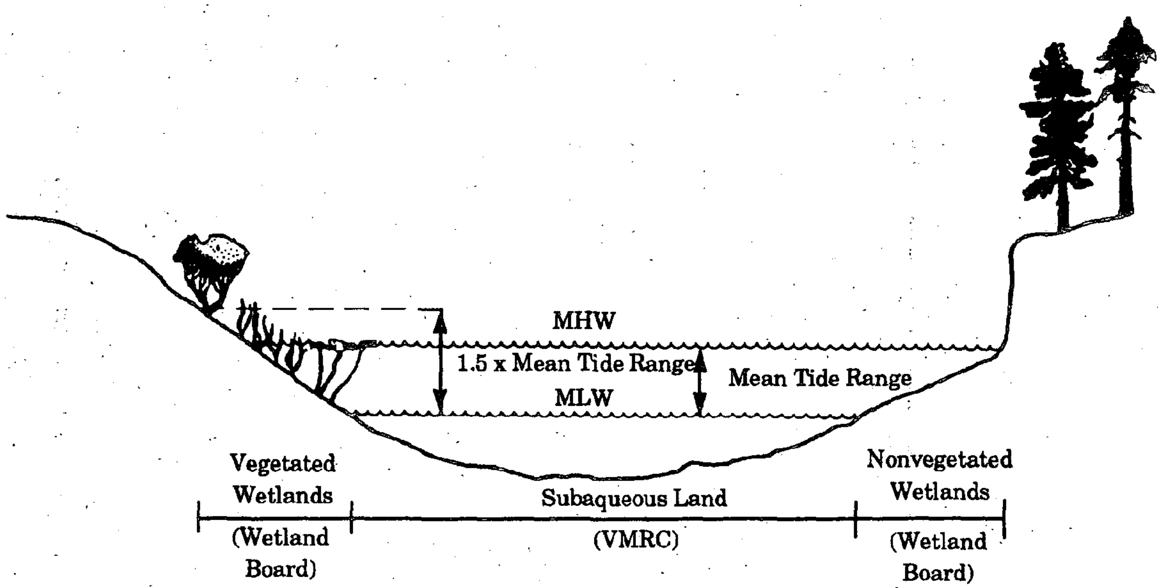
- between MLW and MHW.
- contiguous to MLW.
- not otherwise considered vegetated wetlands.



Subtidal land or ***subtidal bottom*** refers to the area channelward or seaward of MLW, without regard to political subdivision or land ownership.

Subaqueous land or ***subaqueous beds*** refer to ungranted beds of the bays, rivers, creeks and shores of the sea which are owned by the Commonwealth. This includes the beds of tidal and nontidal water bodies. Because property ownership in Virginia extends channelward to MLW in tidal areas, subaqueous land is the land channelward of MLW, with some exceptions:

Potomac River

The Potomac River is owned by the State of Maryland and the District of Columbia. The boundary between Maryland and Virginia is generally at MLW on the Virginia side of the river, except where embayments, creeks and inlets occur, at which the boundary line is from headland-to-headland. Therefore, VMRC often may not have jurisdiction over subtidal land on the Potomac River.

Manmade canals

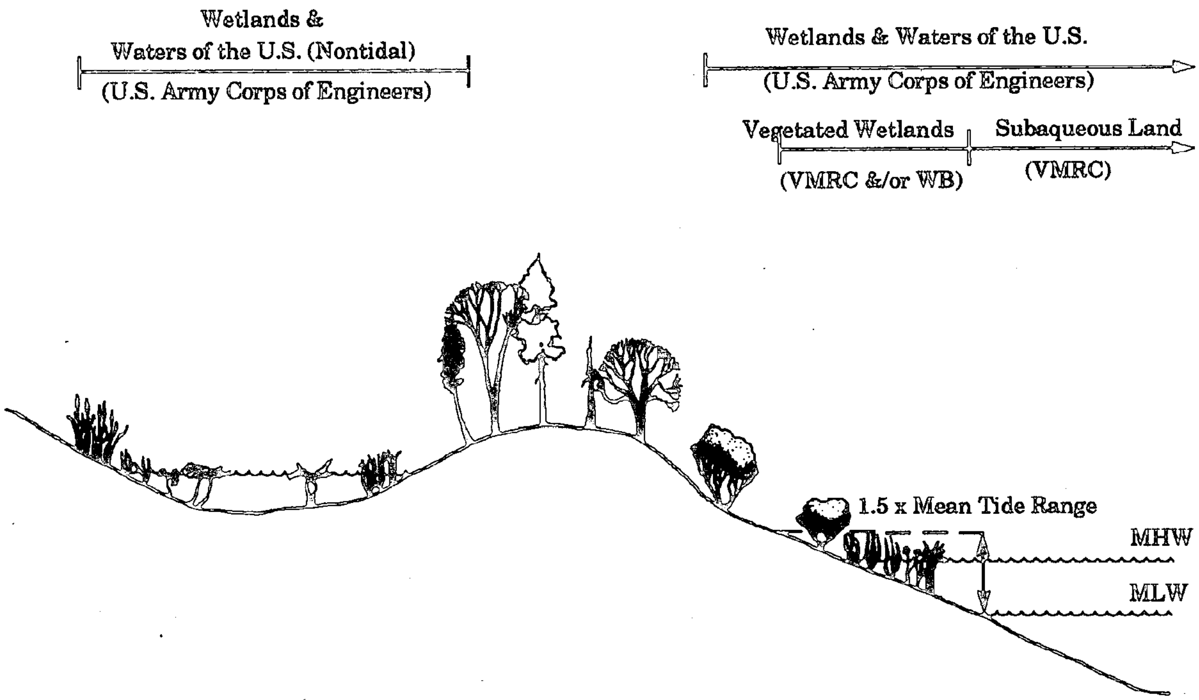
VMRC does not currently exert jurisdiction over subtidal land in manmade canals. However, the Commonwealth's Tidal Wetlands Act does apply to vegetated and nonvegetated wetlands within manmade canals.

Federal definitions

The federal definition of **wetlands** is based on three parameters: soil, hydrology, and vegetation. Specifically, wetlands are: "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

The federal definition includes both tidal and nontidal wetlands.

In tidal areas, wetlands under federal jurisdiction may encompass a broader area than the state/local jurisdiction (i.e., federal wetlands may extend to elevations greater than 1.5 times the mean tide range above MLW).



List of wetlands plant species in Virginia's Tidal Wetlands Act

saltmarsh cordgrass	(*Spartina alterniflora*)	cattails	(*Typha* spp.)
saltmeadow hay	(*Spartina patens*)	three-squares	(*Scirpus* spp.)
saltgrass	(*Distichlis spicata*)	buttonbush	(*Cephalanthus occidentalis*)
black needlerush	(*Juncus roemerianus*)	bald cypress	(*Taxodium distichum*)
saltwort	(*Salicornia* sp.)	black gum	(*Nyssa sylvatica*)
sea lavender	(*Limonium* sp.)	tupelo	(*Nyssa aquatica*)
marsh elder	(*Iva frutescens*)	dock	(*Rumex* sp.)
groundsel bush	(*Baccharis halimifolia*)	yellow pond lily	(*Nuphar* sp.)
wax myrtle	(*Myrica* sp.)	marsh fleabane	(*Pluchea purpurascens*)
sea oxeye	(*Borrichia frutescens*)	royal fern	(*Osmunda regalis*)
arrow arum	(*Peltandra virginica*)	marsh hibiscus	(*Hibiscus moscheutos*)
pickerelweed	(*Pontederia cordata*)	beggar's tick	(*Bidens* sp.)
big cordgrass	(*Spartina cynosuroides*)	smartweed	(*Polygonum* sp.)
rice cutgrass	(*Leersia oryzoides*)	arrowhead	(*Sagittaria* spp.)
wildrice	(*Zizania aquatica*)	sweet flag	(*Acorus calamus*)
bulrush	(*Scirpus validus*)	water hemp	(*Amaranthus cannabinus*)
spikerush	(*Eleocharis* sp.)	reed grass	(*Phragmites communis*, now called *P. australis*)
sea rocket	(*Cakile edentula*)		
southern wildrice	(*Zizaniopsis miliacea*)	switch grass	(*Panicum virgatum*)

Suggested Reading List

Hicks, Steacy D. 1985. Tidal datums and their uses—a summary. Shore and Beach. January 1985: 27-32.

Hull, Wesley V. 1978. The significance of tidal datums to coastal zone management. Coastal Zone '78: 965-971.

National Ocean Service. 1990. Tide Tables 1991: High and Low Water Predictions, East Coast of North and South America including Greenland. U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

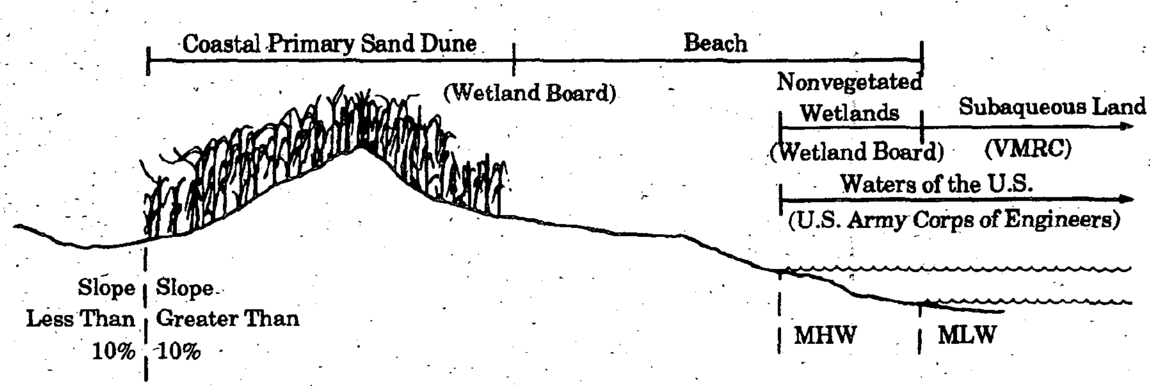
coastal primary sand dunes are those lands which have the following characteristics:

- mound of unconsolidated sandy soil.
- contiguous to MHW.
- landward and lateral limits marked by a change in grade from 10% or greater to less than 10%.
- applies only to Counties of Accomack, Lancaster, Mathews, Northampton, Northumberland, and Cities of Hampton, Norfolk, and Virginia Beach.
- vegetated with any of these plant species:

American beach grass	(*Ammophila breviligulata*)
beach heather	(*Hudsonia tomentosa*)
dune bean	(*Strophostyles umbellata* var *paludigena*)
dusty miller	(*Artemisia stelleriana*)
saltmeadow hay	(*Spartina patens*)
seabeach sandwort	(*Arenaria peploides*)
sea oats	(*Uniola paniculata*)
sea rocket	(*Cakile edentula*)
seaside goldenrod	(*Solidago sempervirens*)
short dune grass	(*Panicum amarum*)

beaches are those lands which meet the following criteria:

- the shoreline zone of unconsolidated sandy material.
- extends from MLW landward to a marked change in material composition or in physiographic form (e.g., dune, bluff, marsh).
- if no such marked change occurs, then the landward limit of the beach is defined by a line of woody vegetation or the nearest impermeable manmade structure.



Wetlands Ecology

Pamela A. Mason

Notes

Length of Presentation: 25 min.

Objectives

The purpose of this unit is to review wetland ecology including the wetland types defined in the wetlands guidelines.

Upon completion, students should be able to:

- Define/describe the following: hydrophyte, detritus, food web, primary production, secondary production, zonation.

Materials

1. 35 mm projector
2. Screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Review reference material
4. Practice

Procedure

1. Introduce yourself and others
2. Announce any special information, field trips, etc.
3. Distribute handouts

Lecture Notes

I. INTRODUCTION

Slide 1

A. What is a wetland: components.

1. Soils.

2. Plants - Indicative wetland species are **hydrophytes** (water-loving). However, not all wetlands are vegetated.

3. Hydrology/Water.

a. Waters may be tidal or nontidal. Note - This discussion focuses on tidal (jurisdictional) wetlands in Virginia.

b. Waters may be salt or fresh.

II. WETLANDS IN THE ESTUARY

Slide 2

A. **Ecosystem** Function (Food Web).

1. Green plants of the wetland convert sun energy to plant tissue. This process is know as **photosynthesis**. As the first level of production this is called **primary production**.

2. Wetlands have high levels of primary production. 4-6/ton/acre/year.

3. Little of the plant material is consumed directly by **primary consumers**, mainly insects.

4. The majority of the plant material becomes **detritus** (partially decomposed material). Some material is exported to the **estuary**, the amount depends on the system.

Slide 3

5. The detritus is populated by microorganisms (bacteria, protozoa, fungi) which increase the food value of the detritus.

6. The detritus is consumed by many animals (crabs, fish and shellfish).

7. The detritus consumers digest the microorganisms growing on the detritus. The detritus itself is partially broken down in the process but passes through undigested. The detritus is then repopulated by microorganisms as the process is repeated.

8. The higher level consumers in this process are shorebirds, finfish and mammals.

III. WETLAND TYPES

A. General description based on salinity regime.

Slide 4

1. **Saline.** Typical of the vast expansive marshes behind the barrier islands on the Eastern Shore. Dominant vegetative species include saltmarsh cordgrass (*Spartina alterniflora*), saltmeadow hay (*Spartina patens*), saltgrass (*Distichlis spicata*) and groundsel tree (*Baccharis halimifolia*).

a. Zonation patterns are simple.

1) Tall form saltmarsh cordgrass (*S. alterniflora*) along the creeks (or **low marsh**).

2) Short form saltmarsh cordgrass (*S. alterniflora*), often mixed with *Salicornia* spp. in the **mid-marsh**.

3) A mixed community of saltmeadow hay (*S. patens*) and saltgrass (*D. spicata*) with saltbush in the **high marsh**.

b. **Fauna**. The following animals are common to saline marshes (but may be found in other marshes as well).

Slide 5 — 1) Oysters.

Slide 6 — 2) Oystercatchers.

Slide 7 — 3) Shorebirds - egrets, etc.

Slide 8 — 4) Pelicans - pelicans are returning to the southeastern portions of the state.

Slide 9 — 2. **Brackish. (Mesohaline)**. Large marshes in the lower Chesapeake Bay and extending up the major tributaries and associated creek systems. Common vegetative species include saltmarsh cordgrass (*S. alterniflora*), saltmeadow hay (*S. patens*), saltgrass (*D. spicata*), black needlerush (*Juncus roemerianus*), groundsel tree (*B. halimifolia*) and marsh elder (*Iva frutescens*). This community has more diverse vegetative patterns than saline marshes including bulrush, sea lavender and cattails.

a. Zonation.

1) *S. alterniflora* (low marsh).

2) Mixed community of saltmeadow hay (*S. patens*) and saltgrass (*D. spicata*) in mid marsh.

3) and groundsel tree (*B. halimifolia*) with marsh elder (*I. frutescens*) along the upland edge.

b. Fauna. The following animals are common to brackish marshes (may be found in other marshes).

Slide 10	1) Grasshopper - one of the few animals that feed directly on saltmarsh cordgrass.
Slide 11	2) Littorina - marsh snail.
Slide 12	3) Clapper rail - this bird not only feeds in the marsh, but nests there as well.
Slide 13	4) Fiddler crab.
Slide 14	3. **Oligohaline.** These wetlands are the gradient from brackish to tidal freshwater. They are located upriver from the brackish marshes and experience greater freshwater influence. While *S. alterniflora* may still be present along the creek banks, less saline tolerant species are also found. *Spartina cynosuroides* and many *Scirpus* species are found here.
	a. Zonation is less pronounced as you move toward fresh water along the Chesapeake tributaries; however, it is typical to find the following.
	1) *S. alterniflora.*
	2) Big cordgrass (*S. cynosuroides*), bulrush, *Scirpus* spp., marsh mallow and cattails.
	b. Fauna.
Slide 15	1) Raccoon.
Slide 16	2) Blue crab - particularly important habitat for juveniles and adult males.
Slide 17	3) Otter.
Slide 18	4) Canada geese.
Slide 19	4. **Tidal Freshwater.** Located upstream of the oligohaline wetlands and down stream of the nontidal freshwater. The average salinity is 0.5 ppt, or lower, except during droughts. The vegetative diversity of the tidal fresh community is much greater than the other tidal wetlands. Fifty species per acre is typical. Common species include: the broad-leaved emergents- pickerelweed *(Pontedaria cordata)*, arrow arum (*Peltandra virginica*), yellow pond lily (*Nuphar luteum*); and many species of grasses, sedges and rushes (*Leersia oryzoides, Zizania aquatica, Spartina cynosuroides*). Cattails (*Typha latifolia* and *Typha angustifolia*) and smartweeds (*Polygonum* spp.) are also common.

a. Zonation is less sharply defined; however, a general profile follows (Odum, 1984).

1) Arrow arum - pickerelweed community (*Peltandra virginica* and *Pontedaria cordata*).

2) Smartweeds, wild rice, big cordgrass, rice cutgrass.

3) Cattails near the upland edge.

4) Wax myrtle and red maple along the upland edge.

b. Fauna (Mitsch & Gosselink, 1986).

Slide 20 1) Turtle.

Slide 21 2) Migrating waterfowl - snow geese.

Slide 22 3) Muskrat lodge.

Slide 23 4) Baby muskrat.

Slide 24 5. **Tidal Swamps.** At the upper end of tidal influence, these communities grade into nontidal wetlands. Differentiated from tidal freshwater marshes by to the presence of trees. Common species include gums (*Nyssa sylvatica* and *Nyssa aquatica*), red maple (*Acer rubrum*), and bald cypress (*Taxodium distichum*). Important nursery areas for fisheries. Important in **nutrient cycling.**

b. Fauna.

Slide 25 1) Tree frog.

Slide 26 2) Snake.

Slide 27 B. Communities (Wetland types according to wetlands guidelines).

Slide 28 1. **Type I. Saltmarsh Cordgrass Community** (*Spartina alterniflora*). Grows from mean sea level to about mean high water. Very high primary productivity. Important spawning/nursery ground for fish, waterfowl feed on roots and rhizomes, shorebirds use for nesting material. Effective as an erosion buffer and as a sediment trap improving water quality.

Slide 29	2. **Type II. Saltmeadow Community.** Saltmeadow hay (*Spartina patens*) and saltgrass (*Distichlis spicata*). Grows about mean high water to limit of spring tides; saltgrass at lower elevations, saltmeadow hay predominates at higher elevations. High levels of primary productivity, however litter is flushed out mostly during spring tide and storm events. Provides nesting area and food source for birds. Typically the oldest part of the marsh, the peat of this community may accumulate to great depths allowing for absorption of flood waters. Dense vegetation and deep peat filter sediments and waste material.
Slide 30	3. **Type III. Black Needlerush Community.** (*Juncus roemerianus*). Grows in pure stands at about mean high water to somewhat below spring tide limit. High productivity, however decomposes slowly and is not flushed daily by tides. Little evidence of waterfowl or wildlife use. Dense roots and rhizomes highly resistant to erosion. Effective for sediment trapping and flood buffering (not as effective as saltmeadow).
Slide 31	4. **Type IV. Saltbush Community.** Groundsel tree (*Baccharis halimifolia*) marsh elder (*Iva frutescens*). Grows at about the upper limit of the marsh. Fairly low productivity, detritus of little value. Provides diversity for wildlife, nesting habitat for small birds. Little food value. Serves somewhat as an erosion buffer and traps larger flotsam.
Slide 32	5. **Type V. Big Cordgrass Community.** (*Spartina cynosuroides*). Grows at or slightly above mean high water extending to the upland margin. Very high productivity but detrital availability limited by elevation. Habitat for small animals; geese eat rhizomes. Dense stands of vegetation and intertwining roots stabilize marsh peat. Usually found in older parts of the marsh which may have deep peat with a high flood water capacity.
Slide 33	6. **Type VI. Cattail Community.** Narrowleaf cattail (*Typha angustifolia*), Broadleaf cattail (*Typha latifolia*). Grows in very wet areas, sometimes standing water. Often found along the upland edge of the marsh. Productivity 2-4 tons/acre, detritus not readily available to marine environment. Habitat for some birds, muskrat feed on roots. Growing location and shallow roots make for poor erosion buffer. Position along upland edge ranks this community type high as a sediment trap.

Slide 34	7. **Type VII. Arrow Arum - Pickerelweed Community.** Arrow arum (*Peltandra virginica*), pickerelweed (*Pontedaria cordata*). Grows on mud flats to about mean tide in low salinity to freshwater. Productivity 2-4 tons/acre, detritus readily available due to daily tidal fluxes. Above-ground parts of plants decompose rapidly and completely in the fall of the year. Ducks feed on shoots and seeds. Often associated with confirmed spawning and nursery areas for herring and shad. The lack of a vast network of roots, rhizomes and peat typical of saltmarshes reduces effectiveness as an erosion buffer. However, this community is often the only buffer to shoreline erosion in freshwater. Some sediment trapping from flood waters occurs.
Slide 35	8. **Type VIII. Reed Grass Community.** (*Phragmites australis*). Grows above mean high tide, on drier areas in disturbed sites. Productivity high 4-6 tons/acre, detritus available only in storm conditions. Little use by wildlife except as cover. Good erosion deterrent, especially on dredged material.
Slide 36	9. **Type IX. Yellow Pond Lily Community.** (*Nuphar luteum*). Grows submerged except for floating leaves at high tide. Low productivity approximately 1 ton/acre, detritus available but not a significant contribution. Excellent cover and habitat for aquatic animals and algae. Forage area for fish, shorebirds and waterfowl. Plants do reduce wave action from wind and boats. Can slow flood waters allowing sediment settling.
Slide 37	10. **Type X. Saltwort Community.** Also know as glasswort (*Salicornia* spp.). Grows above mean high tide in pannes or sparsely vegetated areas. Often found in areas where evaporation has greatly increased salt content of the soil. The community has low productivity less than 1/2 ton/acre. There is some evidence of feeding by waterfowl. Functions poorly as an erosion deterrent or flood buffer.
Slide 38	11. **Type XI. Freshwater Mixed Vegetation Community.** A mixed community of many species growing from submerged habitat to the upper limits of the marsh. Highly productive 3-5 tons/acre. Detritus of the intertidal species (arrow arum, pickerelweed, yellow pond lily) are readily available. The great diversity provides habitat, foraging area and food sources for waterfowl, shorebirds and small mammals. Adjacent waters are spawning and nursery grounds for striped bass, herring and shad. Erosion buffer is that provided by the arrow arum, pickerelweed community. However, the presence of hardy, resilient grasses and a peaty substrate increases the function of sediment trapping and flood water assimilation.

Slide 39	12. **Type XII. Brackish Water Mixed Vegetation Community.** A mix of many species growing from about mean sea level to the upland margin. Highly productive 3-4 tons/acre, detritus readily available. Great diversity provides foraging area and food sources for waterfowl, shorebirds and small mammals. Often used as spawning and nursery grounds for finfish and crabs. As most brackish marshes are bordered by saltmarsh cordgrass, erosion protection is high (see Type I). Also, the higher marsh vegetation serves as an assimilator of flood waters and a sediment trap (see Type II).
Slide 40	13. **Type XIII. Intertidal Beach Community.** Associated invertebrate species- mole crabs, beach fleas, clams, oligochaete and polychaete worms. Most species live just below sand surface. Primary productivity is low relative to vegetated wetlands. Very important foraging area for shorebirds. Some species nest above mean high water (terns, skimmers, plovers). During high tide serves as foraging area for fish. The slope and substrate characteristics make the beach a natural wave energy dissipator and buffer to storm waves.
Slide 41	14. **Type XIV. Sand Flat Community.** Invertebrates - sandworm, bloodworm, razor clam, amphipods. Most species live at the surface or in burrows. Primary production less than marshes, but just slightly lower than other tidal flats. Primary production enters food chain directly through grazing. Provides nursery and feeding area for fish and blue crabs, foraging area for shorebirds. Dissipates wave energy and reduces erosion potential on shoreline.
Slide 42	15. **Type XV. Sand/Mud Mixed Flat Community.** Invertebrates - hard clam, soft clam, polychaetes and mud snails. Inhabitants are surface dwellers and burrowers, with some permanent tube builders. Primary production similar to sand flats, however due to high organics, secondary microbial production may be higher. Important habitat for wading birds, blue crabs and finfish. Slows wave velocity and may reduce erosion.
Slide 43	16. **Type XVI. Mud Flat Community.** Invertebrates - mud snails, razor clams and bloodworms. Surface dwellers and burrowers. Likely to have the highest primary production of nonvegetated wetlands. Often associated with vegetated wetlands, this community interacts with vegetated areas in nutrient cycling. Important forage area for waterfowl, shorebirds and finfish.
Slide 44	17. **Type XVII. Intertidal Oyster Reef Community.** Invertebrates - oysters, hard clams, sand worms, mud crabs. Shells provide habitat diversity allowing for high diversity of attached organisms such as barnacles, sponges, hydroids and mussels. Important food chain interactions. Used as foraging area by finfish and blue crabs.

References

Hackney, C.T. and A.A. de la Cruz. 1982. The structure and function of brackish marshes in the north central Gulf of Mexico: a ten year case study. In: B. Gopal, et al. (eds.). Wetlands. International Scientific Publications. C-70 A.L. Selhi Nagar, Jaipur, India. pp. 89-107.

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Mitsch, W.J. and J.G. Gosselink. 1986. *Wetlands*. Van Nostrand Reinhold. New York, New York. 539p.

Odum, W.E., T.J. Smith III, J.K. Hoover and C.C. McIvor. 1984. The ecology of tidal freshwater marshes of the United States east coast: a community profile. U.S. Fish Wildl. Serv. FWS/OBS-83/17. 177p.

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Wass, M.L. and T.D. Wright. 1969. Coastal wetlands of Virginia. SRAMSOE #10. Virginia Institute of Marine Science, Gloucester Point, VA. 154 pp.

Wetlands Guidelines. 1982. Virginia Marine Resources Commission (VMRC). Prepared by Department of Wetlands Ecology, Virginia Institute of Marine Science, College of William and Mary. Printed by VMRC, Newport News, VA. 57 pp.

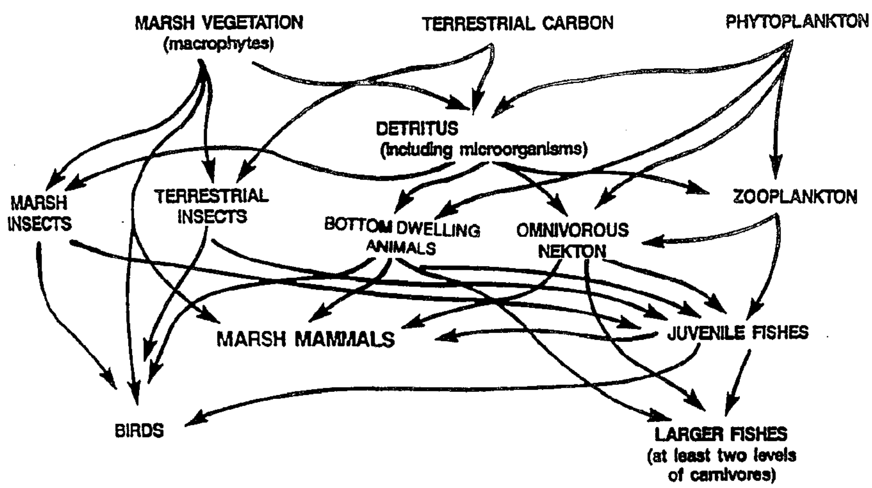
Slide List

1. Marsh picture
2. Food web
3. Detritus
4. Saline marsh
5. Oysters
6. Oystercatchers
7. Shorebirds, egrets, etc.
8. Pelicans
9. Brackish marsh
10. Grasshopper
11. Littorina - snail
12. Clapper rail
13. Fiddler crab
14. Oligohaline marsh
15. Raccoon
16. Blue crab
17. Otter
18. Canada geese
19. Tidal freshwater marsh
20. Turtle
21. Snow geese
22. Muskrat lodge
23. Muskrat
24. Tidal swamp
25. Tree frog
26. Snake
27. Wetland community types
28. Saltmarsh cordgrass
29. Saltmeadow community
30. Black needlerush
31. Saltbush
32. Big cordgrass
33. Cattail
34. Arrow arum - pickerelweed
35. Reed grass
36. Yellow pond lily
37. Saltwort

38. Freshwater mixed - schematic
39. Brackish mixed - schematic
40. Beach
41. Sand flat
42. Sand/mud flat
43. Mud flat
44. Oyster reef

Wetlands Ecology Handout

FOOD WEB



Glossary

Brackish . . . . water with less salt than sea water but undrinkable; salinities ranging from 0.5 to 17.
Detritus . . . . partially decomposed organic matter.
Ecosystem . . . . a functional system which includes the organisms of a natural community together with their environment.
Estuary . . . . a semienclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water, i.e. Chesapeake Bay.
Fauna . . . . animals.
Flora . . . . plants.
High marsh . . . . a relative term often related to the presence of a particular vegetative community contiguous to the uplands, often denoting the marsh-upland boundary.
Hydrophyte . . . . a plant that grows in a moist habitat.
Low marsh . . . . a relative term often related to the presence of a particular vegetative community contiguous to the water; lowest elevation in the marsh.
Mid-marsh . . . . a relative term indicating a position between the low marsh and the high marsh.
Nekton . . . . free-swimming aquatic animals, essentially independent of water movements.
Nutrient cycling . . . . . biological and chemical processes that involve the use, modification and reuse of nutrients.
Oligohaline . . . . water with less salt than brackish water but more than fresh water.
Omnivorous . . . . a mode of feeding that includes both vegetable and animal matter.
Photosynthesis . . . . . the creation of chemical compounds in light, especially the production of organic matter by green plants.
Primary consumer . . . an organism that feeds on organic matter resulting from primary production.
Primary production . . the manufacture of living tissue from non-living materials.
Saline . . . . water with the amount of salt in sea water.
Secondary production . production of organisms that consume the products of primary production.

Suggested Reading List

Teal, J. and M. Teal. 1969. *Life and Death of a Salt Marsh*. Boston. Little, Brown, and Co. 274 pp.

Wetlands Program

College of William and Mary
Virginia Institute of Marine Science
School of Marine Science
Gloucester Point, Virginia 23062

Common Wetland Plants

Wetland Species in the Wetlands Guidelines

Type (Wetlands Guidelines)	Common Name	Scientific Name
Type I	Saltmarsh cordgrass	*Spartina alterniflora*
Type II	Saltmeadow hay	*Spartina patens*
Type II	Saltgrass	*Distichlis spicata*
Type III	Black needlerush	*Juncus roemerianus*
Type IV	Groundsel tree	*Baccharis halimifolia*
Type IV	Marsh elder	*Iva frutescens*
Type V	Big cordgrass	*Spartina cynosuroides*
Type VI	Narrowleaf cattail	*Typha angustifolia*
Type VII	Arrow arum	*Peltandra virginica*
Type VII	Pickerelweed	*Pontedaria cordata*
Type VIII	Reed grass	*Phragmites australis*
Type IX	Yellow pond lily	*Nuphar luteum*
Type X	Saltwort	*Salicornia* sp.
Type XI	Freshwater Mixed Vegetation Community	
Type XII	Brackish Water Mixed Vegetation Community	
Type XIII	Intertidal Beach Community	
Type XIV	Sand Flat Community	
Type XV	Sand/Mud Mixed Flat Community	
Type XVI	Mud Flat Community	
Type XVII	Intertidal Oyster Reef Community	

Other Common Wetland Species

Sea lavender	*Limonium* sp.
Wax myrtle	*Myrica* sp.
Sea oxeye	*Borrichia frutescens*
Rice cutgrass	*Leersia oryzoides*
Wild rice	*Zizania aquatica*
Bulrush	*Scirpus validus*
Spikerush	*Eleocharis* sp.
Sea rocket	*Cakile edentula*
Southern wildrice	*Zizaniopis miliacea*
Beggar's tick	*Bidens* sp.
Smartweeds	*Polygonum* sp.
Sweetflag	*Acornus calamus*
Water hemp	*Amaranthus cannabinus*
Marsh hibiscus	*Hibiscus moscheutos*
Marsh fleabane	*Pluchea purpurascens*
Buttonbush	*Cephalanthus occidentalis*
Bald cyprus	*Taxodium distichum*
Black gum	*Nyssa sylvatica*
Tupelo	*Nyssa aquatica*

Wetland Values

Maryann Wohlgemuth

Notes

Length of Presentation: 1 hr.

Objectives

The purpose of this unit is to review tidal wetland values and functions.

Upon completion, students should be able to:

- Define the following terms: tidal wetlands, values, functions, watershed, aquatic productivity, detritus.
- Describe how the following values and functions are provided by tidal wetlands.

1. Water Quality Improvement
2. Aquatic Productivity
3. Fish and Wildlife Habitat
4. Shoreline Erosion Control
5. Flood Protection
6. Water Supply
7. Economic Values
8. Recreation Activities

Materials

1. 35 mm projector
2. Movie screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Review references (VIMS Technical Reports 90-5, 91-4, 91-A)
4. Be familiar with equipment: slide projector, slide screen

Procedure

1. Introduce self and other instructors
2. Announcements (field work etc...)

3. Explain general comments on lesson, eg. limitations - this is a general introduction to values and functions potentially found in wetlands but as wetland type, geographic position, and other variables change so do the potential wetland values
4. Distribute handouts

Lecture Notes

I. INTRODUCTION

A. Throughout the state of Virginia there is a variety of wetland types which range from tidal marshes and swamps near the coast, to nontidal wetlands found anywhere from the coastal plain to the mountains. Wetlands are found in topographic depressions or along rivers, lakes, and coastal waters. Wetlands, in general, are areas that are wet or have wet soils during some part of the growing season.

Slides 1-4

B. **Tidal wetlands** are found along the coastline where they are influenced by daily tidal fluctuations and include vegetated marshes and swamps or nonvegetated mud and sand flats.

Slides 5-6

C. The term **'wetland function'** usually refers to the ecological process a wetland provides, whereas the term **'wetland value'** generally connotes usefulness to humans. For example: a function may be wildlife habitat support, while the value to humans may be hunting or fishing.

Slide 7

D. Tidal wetlands provide many ecological and socio-economic values including: water quality improvement, aquatic productivity, fish and wildlife habitat, shoreline erosion control, stormwater treatment, flood protection, potable water supplies, economically valuable resources, and recreation. The level of these values varies with the type, setting, size, and hydrology of the particular wetland.

Slide 8

II. WATER QUALITY IMPROVEMENT

Slide 9

Slide 10

A. Wetlands can filter and trap sediments and pollutants from upland runoff before they reach an adjacent waterway. All wetlands within the Chesapeake Bay watershed have the potential to impact water quality in the Bay. A **watershed** can be defined as all the area that drains by surface or subsurface flow into the water body being considered. The Chesapeake Bay watershed extends north through parts of New York State and west to the Appalachian mountains, covering approximately 64,000 square miles (Chesapeake Bay Program, 1983).

B. Water pollution problems can be reduced when urban and agricultural runoff pass through a wetland before reaching the aquatic environment.

C. Wetlands can reduce levels of nutrients and increase levels of dissolved oxygen.

Slide 11

As wetland plants grow, they take up inorganic nutrients (nitrogen, phosphorous) and release organic or detrital forms (decaying plant material) of nutrients. The transformation from inorganic to organic forms of nutrients reduces potential problems from excessive nutrient loadings, while providing organic forms of nutrients that are more useful to aquatic animals.

Slide 12

D. It has been shown that some wetlands are successful at reducing pollutants found in stormwater runoff, including lawn fertilizers and herbicides, sediment from erosion, and sewage from failing systems.

Slides 13-14

E. Wetlands are being considered as economical alternatives for accomplishing secondary wastewater treatment. Wetlands have been shown to reduce nutrients, heavy metals, and bacteria from sewage effluent and other waters (eg. Wisconsin Marsh) (Spangler et al., 1976).

F. Wetlands stabilize river banks and reduce shoreline erosion, reducing the amount of sediment and nutrient runoff.

G. Trees stabilize river banks; their roots bind the soil, while their trunks and branches slow the flow of flooding waters and dampen wave height.

Slide 15

III. AQUATIC PRODUCTIVITY

Slide 16

A. Some wetlands produce more plant material per area than the most productive farmlands (Teal and Teal, 1969).

B. This large amount of productivity provides a food source for fish, birds, invertebrates, and furbearers.

Slide 17

C. Detritus (decaying plant material that is colonized by microorganisms (bacteria, protozoa, and fungi) is consumed by many small invertebrates, juvenile fish, and oysters, which support higher forms in the **food web**.

Slides 18-20

D. Benthic macroalgae and microalgae—also important primary producers in wetlands.

Slide 21

IV. FISH AND WILDLIFE HABITAT

Slides 22-23

A. Tidal wetlands are used by a large variety of birds, fish, mammals, and invertebrates for food, shelter, and spawning and nesting sites.

Slides 24-26	B. Approximately two-thirds of the fish and shellfish species that are harvested commercially are associated with wetlands. These species include: blue crab, oyster, clam, shrimp, striped bass, menhaden, bluefish, flounder, sea trout, spot, and croaker (Mitsch and Gosselink, 1986).
	C. Wetlands are a preferred habitat because of reduced competition, slow currents, scarcity of predators and an abundant food supply.
Slides 27-28	D. Some species, such as mummichogs (minnows) and fiddler crabs, utilize wetlands throughout their lifespan.
	E. Other species, such as striped bass, spawn in waters adjacent to tidal freshwater marshes, similar to those along the Pamunkey River.
	F. Many coastal fish, including spot, menhaden, striped bass, and mullet, use wetlands as nursery areas for their juvenile stage.
	G. Of the nation's endangered and threatened species, 50% of the animals and 28% of the plants are dependent on wetlands for their survival (Niering, 1988).
Slides 29-30	H. Migratory waterfowl are dependent on wetlands for feeding during their seasonal stopovers.
Slides 31-34	I. Various shore and wading birds use wetlands as a food source and a location for nest sites. Atlantic coast salt marshes are used for nesting by birds such as laughing gulls, Forster's terns, clapper rails, willets, and marsh hawks (Tiner, 1984).
Slides 35-36	J. Mammals that utilize wetlands include raccoon, muskrat.
Slide 37	V. SOCIO-ECONOMIC VALUES/SHORELINE EROSION CONTROL
	A. Wetlands provide a buffer against shoreline erosion by reducing wave energy and current velocity.
Slide 38	B. Vegetated wetlands can reduce shoreline erosion by three mechanisms:
	1. Increased stability of the sediment-root matrix.
	2. Wave damping as the waves propogate through a stand of grass.
	3. Reduction in current velocity from additional friction forces as it flows through grasses (Dean, 1979).

C. Wetlands have a complex root and rhizome system that binds shoreline sediments together which helps reduce the loss of uplands to coastal erosion.

D. A planted salt marsh fringe may be an effective, inexpensive, and ecologically-preferred alternative to a bulkhead or a revetment (Hardaway et al., 1984).

Slide 39

E. Wave height and current speed are also reduced by nonvegetated wetlands, such as beaches and mudflats by causing waves to spread out as they pass over the flat (Theberge and Boesch, 1978).

Slide 40

VI. FLOOD PROTECTION

A. Wetlands adjacent to watercourses slow surface water flow and may temporarily store flood waters.

Slide 41

B. Wetlands desynchronize peak flows by temporarily slowing and storing water, which results in a non-simultaneous gradual release of peak waters minimizing flow downstream (Zacherle, 1984).

VII. WATER SUPPLY

A. Most wetlands are areas of groundwater discharge. **Groundwater discharge** occurs where the groundwater table meets the surface of the land and discharges as springs or seeps.

B. Some wetlands may recharge groundwater aquifers, but most do not. **Groundwater recharge** is the movement of water into a potential drinking water supply or aquifer. Recharge potential varies according to wetland type, geographic location, season, soil type, water table location and precipitation (Tiner, 1984).

C. Most estuarine intertidal wetlands are discharge rather that recharge areas (Carter et al., 1979).

VIII. ECONOMIC

A. The economic benefits of wetlands are realized in natural products, shoreline erosion control, stormwater treatment, flood protection, water supply, livestock grazing, and recreation.

For example: The ability of wetlands to control flood waters reduces property damage from flooding, and reduces costs for flood control structures. Property damage from floods for 1975 in the U.S. was estimated to be $3.4 billion (U.S. Water Resources Council, 1978). The U.S. Army Corps of Engineers found that buying wetlands adjacent to the Charles River in Massachusetts was the most inexpensive solution to flooding problems in the Charles River Basin (Tiner, 1984).

B. Natural products include timber, fish, shellfish, waterfowl, furbearers, peat, and wild rice.

Slide 42-45

C. Commercially important species such as striped bass, menhaden, bluefish, flounder, spot, blue crabs, oysters, and clams are partially dependent on coastal wetlands during some part of their life history.

Slide 46

D. Economic benefits from recreational activities are significant: hunting, fishing, nature study, photography,

Slides 47-50

IX. RECREATIONAL VALUES

A. Recreational activities in wetlands include boating, swimming, fishing, hunting, and nature study.

X. CONCLUSION

Wetlands provide perpetual values, whereas economic benefits from wetland destruction are finite (Mitsch and Gossilink, 1986).

"In the beginning, wetlands were considered valueless. Only when most of the native waterfowl vanished was it determined that wetlands might ensure the survival of many endangered plants and animals. Only after billions of dollars were spent on structural flood control that resulted in further flooding were wetlands recognized for reducing flood peaks. Only after additional billions were spent to purify streams was it realized wetlands naturally filter pollutants for free." (Illinois Institute of Natural Resources, 1982)

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Slide List

1. Aerial of tidal creek
2. Mudflat and vegetated fringe
3. Aerial tidal wetland
4. Swamp
5. Term function and value (text)
6. Limits on values (text)
7. Table of values
8. Water quality values
9. Schematic, wetlands purify water
10. Chesapeake Bay watershed
11. Nutrient cycling
12. Upland erosion
13. Discharge pipe
14. Table, marsh reduction in pollutants in sewage effluent
15. Aquatic productivity
16. Wetland productivity, bar chart
17. Detritus (productivity)
18. Macroalgae
19. Microalgae
20. Food web
21. Fish and wildlife
22. Nursery grounds
23. Goose Creek fish catch
24. Goose Creek blue crab
25. Oyster bed on mudflat
26. Snails on mudflat
27. Fiddler crab
28. Fiddlers and *S. alterniflora*
29. Ducks
30. Canada geese
31. Great blue heron
32. Egret rookery
33. Red-winged blackbird nest
34. Shorebirds feeding in panne
35. Raccoon
36. Muskrat lodge
37. Socio-economic values
38. Planting vegetation for erosion control

39. Wave run-up
40. Flood buffer for town
41. Schematic, flood peak reduction
42. Pound net
43. Oyster catch
44. Fish catch
45. Wetland associated fish and shellfish
46. Duckblind
47. Recreational users
48. Recreational fishing
49. Aesthetic, nature study
50. Aesthetic, nature study

Wetland Values Handout

Wetland Values

ENVIRONMENTAL QUALITY VALUES

Water Quality Improvement

- Pollutant removal (heavy metals, pathogens)
- Sediment trapping
- Nutrient uptake and recycling
- Oxygen production
- Wastewater treatment
- Stormwater treatment

Aquatic and Terrestrial Productivity

Fish and Wildlife Habitat

- Spawning and nesting sites
- Nursery areas for young
- Shelter from predators
- Foraging areas

SOCIO-ECONOMIC VALUES

- Shoreline erosion control
- Flood protection
- Groundwater recharge and discharge
- Natural products (timber, fish, waterfowl)
- Recreation (boating, fishing, hunting)
- Aesthetics

Glossary

Tidal wetlands . . . . land areas periodically flooded due to tidal action.

Wetland function . . . . . ecological processes wetlands provide, e.g. wildlife habitat.

Wetland value . . . . connotes usefulness to humans, e.g. hunting or fishing.

Watershed . . . . all area that drains by surface or subsurface flow into a water body.

Inorganic nutrients . . . . nutrients such as phosphorus or nitrogen that are generally from an abiotic origin, e.g. nitrogen (ammonia, nitrite, nitrate).

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Organic nutrients . . . . nutrients originating from living things (e.g. nitrogen, urea, protein, nucleic acids).

Detritus . . . . decaying plant material that is colonized by microorganisms (bacteria, protozoa, and fungi).

Food web . . . . set of complex feeding interactions that occur in an ecosystem; a pattern of interlocking food chains; a food chain is the transfer of food energy from the source, primary producers through a series of organisms with repeated eating and being eaten.

Groundwater discharge . occurs where the groundwater table meets the surface of the land and discharges as springs or seeps.

Groundwater recharge . movement of water into a potential drinking supply or aquifer.

Suggested Reading List

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5

Cardinal®

Coastal Structures

Julie G. Bradshaw

Notes

Length of Presentation: 25 min.

Objectives

The purpose of this unit is to review the various structures used for shoreline protection, including purpose, design considerations, and terminology.

Upon completion, students should be able to define the following shoreline protection methods, state their purpose/mode of action, and state the general design considerations associated with each: bulkheads, riprap, marsh toe protection, breakwaters, groins, jetties, and vegetative control.

Materials

1. 35mm projector
2. Screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review slides
3. Practice with equipment
4. Prepare handouts
5. Prepare for field trip, if applicable

Procedure

1. Introduce self and other instructors
2. Announcements (explain field trip, if applicable)
3. General comments (explain objectives of unit)
4. Distribute handouts

Lecture Notes

Slide 1

I. BULKHEADS

Slides 2-4

A. Definition and purpose: vertical walls aligned parallel to the shoreline which act to retain upland material and prevent wave-induced erosion.

Slide 5	B. Design considerations and terminology for wood bulkheads (the most common type of bulkhead):
Slide 6	1. Piles driven or "jetted in".
	2. Vertical tongue-and-groove sheet pile driven or jetted in.
Slide 7	3. Depth of penetration should equal or exceed exposed portion.
Slides 8-11	4. **Filter cloth**: synthetic textile placed between sheeting and backfill which prevents soil loss but is water-permeable.
	5. **Deadmen and tiebacks**: anchors on the landward side of the bulkhead, to which the bulkhead is tied by tiebacks or tie-rods.
	6. **Screw anchors**: another anchoring device (rods that screw into the upland).
Slides 12-13	7. **Return walls**: walls located at each end of the bulkhead, approximately perpendicular to the bulkhead and shoreline, which tie the bulkhead into the upland and prevent the bulkhead from being flanked.
Slide 14	II. RIPRAP REVETMENTS
	A. Definitions
Slide 15	1. **Revetment**: a sloped structure consisting of multiple layers of stone or other material placed along a bank.
	2. **Riprap**: the stone used to build a revetment; often, the structure itself is called riprap.
	B. Purpose: dissipation of incoming wave energy, to prevent erosion of the shoreline against which it is constructed.
	C. Design considerations and terminology.
Slide 16	1. Toe of riprap should be buried to prevent scouring.
Slides 17-18	2. Filter cloth is placed against bank and underneath riprap to prevent loss of soil and sediment.
Slide 19	3. **Core**: the smaller stone used as the base of the revetment; not directly exposed to waves.

	4. **Armor**: the larger stone used as the outer layers of the revetment; directly exposed to waves.
Slides 20-25	5. Size of materials should be sufficient to handle wave energy at the location without being dislodged.
Slides 26-30	III. MARSH TOE PROTECTION
	A. Definition: a low-profile rock structure placed channelward of a marsh.
	B. Purpose: to protect the marsh from erosive wave energy.
	C. Design considerations same as riprap revetment (above).
Slide 31	IV. BREAKWATER
	A. Definition: an offshore structure which is aligned parallel to the shoreline.
Slides 32-33	B. Purpose: to intercept and dissipate energy of incoming waves, forming a quiescent, low energy zone between the breakwater and the shore. Sand moving along the shoreline may then be trapped in this low energy zone. The energy may be reduced enough to allow wetlands vegetation to become established or spread.
	C. Design considerations and terminology.
Slides 34-38	1. **Fixed** breakwaters: generally of stone or gabion baskets (wire baskets or mattresses which are filled with stone), placed on the bottom.
Slide 39	2. **Floating** breakwaters: may be constructed of tires, logs, specially fabricated boxes and baffles, or other floating materials. Should be firmly anchored.
	3. Breakwaters may be gapped or continuous.
	4. Breakwaters may be constructed in a range of heights. Lower profile structures allow some overtopping by waves.
Slide2 40-41	5. **Sill**: a continuous low-profile breakwater structure.
Slide 42	6. **Tombolo**: name given to the build-up of sand landward of gapped breakwaters.
Slides 43-44	7. As with revetments, stone size should be sufficient to withstand wave environment of site. Stones are placed on filter cloth on the bottom.

Slide 45	V. GROINS
	A. Definition: structures that are perpendicular to the shoreline and extend into the water.
Slide 46	B. Purpose: to trap sand moving along the shore. When functioning properly, sand accumulates on the updrift side of the groin, and the groin acts to widen and heighten the beach. Incoming waves attack the accumulated sand before getting to the upland.
	C. Design considerations and terminology.
Slide 47	1. **Updrift** and **downdrift**: refers to longshore drift, or the movement of sediment along the shore. Sediment may move in both directions along a particular shoreline. The net direction of movement determines the net accumulation of sediment by a groin. Groins necessarily deprive downdrift shorelines of their sand supply, worsening any existing erosion problems.
Slide 48	2. Timber groins: as with a bulkhead, piles and tongue-and-groove sheeting are driven or jetted in.
Slide 49	3. Stone groins: stone is placed on filter cloth. Cross-section of groin is a trapezoidal shape.
Slides 50-51	4. **Low-profile**: recommended design for either timber or stone groins, in which the elevation of the channelward end of the groin is no greater than that of mean low water. This allows the sand to bypass the groin more quickly once the groin cell is filled, lessening the interruption of sediment movement to downdrift shorelines.
Slides 52-56	5. **Spur**: attached to the downdrift side of the groin and oriented perpendicular to the groin, and parallel to the shoreline. Aligned anywhere between MLW and the channelward end of the groin. Purpose is to prevent characteristic erosion of sand immediately downdrift of groin.
Slide 57	VI. JETTIES
	A. Definition: as with groins, jetties are perpendicular to the shoreline.
Slide 58	B. Purpose: jetties are used to define and protect inlets and harbors from shoaling by trapping sand before it travels across the inlet.

Slide 59

VII. VEGETATIVE CONTROL

Slides 60-63

A. Definition and purpose: use of wetlands vegetation to deter erosion, either alone or in concert with an offshore breakwater or sill. Vegetation may be planted or allowed to colonize naturally.

B. Some types of marshes are very good at dissipating wave energy, and form an effective barrier to wave-induced erosion.

Slide 64

C. Not all situations suitable for vegetative control (e.g., freshwater areas; high energy areas).

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U.S. Army Corps of Engineers. 1990. Chesapeake Bay shoreline erosion study. Feasibility report. Baltimore and Norfolk Districts. 111 pp.

Slide List

1. Title slide
2. Typical bulkhead
3. Large timber bulkhead
4. Aluminum bulkhead
5. Cartoon of bulkhead and large wave
6. Jetting in bulkhead sheet piling
7. Short-sheeted bulkhead
8. Cross-section of riprap toe protection and bulkhead
9. Bulkhead with tiebacks, filter cloth
10. Bulkhead with tiebacks, deadmen
11. Bulkhead tiebacks, deadmen
12. Return wall
13. Plan view drawing of return walls on bulkhead
14. Typical riprap
15. Cross-section drawing of riprap
16. Riprap construction - digging toe
17. Riprap construction - filter cloth and stones in toe trench
18. Riprap construction - filter cloth
19. Riprap construction - core and armor stone
20. Storm waves at ferry pier, VIMS
21. Too-small riprap - before
22. Too-small riprap - after
23. Very large stone riprap
24. Riprap construction - toe trench landward of marsh
25. Riprap after construction
26. Typical marsh toe protection structure
27. Cross-section drawing of marsh toe protection structure
28. Marsh toe protection structure - shows still water behind
29. Before - construction of VIMS marina marsh toe protection
30. After - VIMS marina marsh toe protection
31. Plan view drawing of breakwater showing change in shoreline
32. Gapped breakwater - before
33. Gapped breakwater - after
34. Gapped breakwater - taken on breakwater
35. Gabion gapped breakwaters under construction
36. Gabion basket breakwater
37. Close-up of gabion
38. Gabion revetment under construction

39. "Waveguard" floating breakwater/dock
40. Plan view drawing of sill and perched beach
41. Marsh toe stabilization/breakwater
42. Aerial view of gapped breakwaters with tombolos
43. Construction of breakwater - showing filter cloth
44. Cross-section drawing of stone breakwater
45. Typical groin
46. Aerial view of groin field
47. Plan view drawing showing groin-adjusted shoreline
48. Timber groin - showing elevation difference when filled
49. Typical stone groin
50. Cross-section drawing of low-profile timber groin
51. Filled timber groin
52. Timber groin with spur
53. Timber groin with spur
54. Timber groin with gabion spurs
55. Timber groin with spur
56. Flanked groins
57. Infrared aerial view of jetties
58. Aerial view of jetties
59. Marsh vegetation dissipating wave energy
60. Planting marsh grass
61. Recently planted marsh
62. Same marsh 3 months later
63. Grading back to reduce erosion and encourage marsh growth
64. Storm waves on Byrd Hall at VIMS

Coastal Structures Handout

I. BULKHEADS

A. Definition and purpose: vertical walls aligned parallel to the shoreline which act to retain upland material and prevent wave-induced erosion.

B. Terminology.

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B. Purpose: to protect the marsh from erosive wave energy.

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C. Terminology.

Tombolo: name given to the build-up of sand landward of gapped breakwaters.

V. GROINS

A. Definition: structures that are perpendicular to the shoreline and extend into the water.

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Introduction to the Permit Application for Wetland Board Members

Julie G. Bradshaw

Notes

Length of Presentation: 30 min.

Objectives

The purpose of this unit is to introduce wetland board members to the Joint Permit Application and explain common mistakes that are made in filling it out.

Upon completion, students should be able to:

- Understand the application form.
- Judge whether the application form is complete and consistent.
- Discern from a completed application form what an applicant proposes to do.

Materials

1. 35mm projector
2. Screen
3. Slides
4. Handouts (Joint Permit Application)
5. Joint Permit Application - copy for instructor to review

Instructor Preparation Tasks

1. Review lesson outline
2. Review Joint Permit Application
3. Review slides
4. Practice with equipment
5. Obtain copies of Joint Permit Application for participants
6. Prepare for field trip, if applicable

Procedure

1. Introduce self and other instructors
2. Announcements (explain field trip, if applicable)
3. General comments (explain objective of unit)
4. Distribute Joint Permit Applications

	Lecture Notes
Slide 1	I. GENERAL ORGANIZATION OF THE APPLICATION
Slide 2	A. Basic application form.
Slides 3-6	1. 4 pages.
	2. General questions about project type, project location, purpose, wetlands impacts.
Slide 7	B. Appendices
	1. 11 of them.
	2. One appendix for each type of structure or activity.
	3. Includes specific questions about project design and impacts.
	C. Adjacent property owner form and other forms.
Slide 8	D. Checklist—can use to make sure the application is complete.
	E. The application is the source of the information that you, as wetland board members, will use to evaluate a project and decide whether or not to grant a permit. From another perspective, once you grant a permit, the application becomes the standard by which you determine whether the applicant has complied with the permit. In order to properly evaluate the application and monitor permits for compliance, the board should require a complete, consistent application.
	II. COMMON MISTAKES MADE IN FILLING OUT THE APPLICATION FORM
	A. Next to simply failing to fill in all the blanks, the most commonly made mistakes generally seem to fall into one of three categories:
	1. Applicants do not understand the definition of wetlands or subaqueous land or how to determine their extent on their property.
	2. Applicants do not understand the questions in the application, particularly the ones asking for distances channelward and landward of the tidal datums (MLW, MHW). Vertical and horizontal distances are often confused.

3. Answers to questions and project drawings are inconsistent with each other, or drawings are inconsistent with the actual conditions onsite.

B. Examples:

1. Basic Application, p.15, # 13. Wetland alteration. Estimates of wetland impacts are quite often incorrect and must be determined onsite. (review wetland definitions)

2. Appendix C—Boat ramps.

a. # 3. How many feet channelward of MHW and MLW? (emphasize that it's a horizontal distance)

b. # 4. How many square feet of the ramp located on subaqueous land, nonvegetated wetlands, vegetated wetlands? (review wetland definitions)

c. # 9. Dimensions of proposed ramp: length=landward end to channelward end; width=distance perpendicular to length.

Slides 9-10

3. Appendix D—Bulkheads.

Slide 11

a. # 3. How many feet channelward of MHW & MLW (again, emphasize that this is a horizontal distance; the answer here is often inconsistent with the drawings).

Slide 12

b. # 4. How many linear feet of shoreline to be bulkheaded.

c. # 5. Overall length = answer to # 4 + length of return walls.

4. Appendix E—Fill.

a. # 1. Emphasize horizontal distance.

b. # 2. Review wetlands definitions.

Slide 13

5. Appendix F—Riprap.

a. # 5. Emphasize horizontal distance.

b. # 6. Review wetlands definitions.

Slides 14-15

c. # 11&12. Explain slope.

Slide 16	6. Appendix G—Dredging or Excavating.
	a. # 2,3,4. Emphasize that #2=new, #3=maintenance, and that they call for horizontal distances. Emphasize that #4 has to do with how much of #2 & #3 is in wetlands. Often the amounts don't add up, or an applicant will say in #2 or #3 that there's intertidal dredging, but fail to put this amount in #4.
Slide 17	b. #6. Look at base width and top width. From this you can figure out what side slopes the applicant expects to achieve—often they are not realistic.
Slide 18	7. Appendix H—Jetties, Groins, Breakwaters.
	a. # 3. Emphasize horizontal distance.
	b. # 4. Review wetlands definitions.
	c. # 7. Review definition of low-profile design (elevation of channelward end of groin is no greater than that of MLW).
Slide 19	d. # 8. Emphasize that the application is asking for distances landward of the tidal datums (i.e., how far back into the upland the groins will be seated).
Slide 20	e. # 9. Review definition/purpose of spur.
	8. Permit drawings.
Slides 21-22	a. Review the drawing checklist.
	b. Often not consistent with information in application.
Slide 23	c. Often fail to include scale.
	d. Often fail to accurately depict site.
	e. Often fail to have benchmarks/tiedowns—explain that these are measurements between ends and turns in structures and permanent reference points on the upland. Benchmarks make it easy to determine where the structure will be placed, and provide a standard by which permit compliance may be evaluated.
	9. Conclusion—restate importance of requiring consistent, complete applications.

Slide List

1. Title slide
2. Cover of Joint Permit Application
3. First page of basic application form
4. Second page of basic application form
5. Third page of basic application form
6. Fourth page of basic application form
7. List of appendices
8. Applicant's checklist
9. Appendix D (bulkheads), page 1
10. Appendix D, page 2
11. Cross-section drawing of bulkhead
12. Plan view drawing of bulkhead and other activities
13. Appendix F (riprap), page 1
14. Appendix F, page 2
15. Cross-section drawing of riprap
16. Appendix G (dredging), page 1
17. Appendix G, page 2
18. Appendix H (jetties, groins, breakwaters), page 1
19. Appendix H, page 2
20. Cross-section drawing of groin and jetties
21. Drawing checklist, page 1
22. Drawing checklist, page 2
23. Plan view drawing of jetties

Human Activities, Impacts and Alternatives

Walter I. Priest, III

Notes

Length of Presentation: 1 hr. 15 min.

This talk allows less than one minute per slide. Will have to be timed very closely by speaker.

Objectives

The purpose of this education module is to provide a comprehensive and consistent format for the review and evaluation of permit applications.

Upon completion, students should be able to:

- Accurately characterize the nature and extent of the proposed construction activity.
- Discern the purpose of the project.
- Describe the resources to be impacted.
- Identify the anticipated impacts of the proposed project on the adjacent resources.
- Analyze alternative actions to reduce the anticipated impacts.
- Make recommendations to reduce the impacts to an acceptable level.

Materials

1. 35 mm slide projector
2. Screen
3. Slides
4. Handout materials

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Review references
4. Practice with audiovisual equipment

Procedure

1. Introduce yourself and other instructors
2. Annoucements (field work etc...)
3. Explain general comments on the lesson
4. Distribute handouts

Lecture Notes

Permit Application Review

I. PROJECT DESCRIPTION

The purpose of this section is to accurately characterize the nature and extent of the proposed project so that its impacts can be accurately assessed.

Slide 1

A. Dredging.

1. New or maintenance.
2. Method (dragline, hydraulic cutterhead, bucket and scow etc.).
3. Dimensions (length, width and depth).

Slide 2

4. Spoil disposal method (bermed area, overboard, beach nourishment etc.).
5. Sediment characteristics.
6. Specific location in project area.
7. Distance from wetlands.
8. Side slope of dredgecut, 3:1 for mud or 2:1 for sand.

Slide 3

B. Filling.

1. Fill characteristics (particle size, source etc.).
2. Area of fill.
3. Cubic yardage.
4. Containment method.

Slide 4

C. Bulkheading.

1. Length.
2. Construction materials (type and dimensions).
3. Filter cloth employed.

	4. Position relative to MHW or upper limit of vegetated wetlands.
	5. Backfill characteristics (quantity, source and composition).
	6. Installation method (jetted or driven).
	7. Type of construction (horizontal or vertical).
	8. Return walls.
Slide 5	D. Riprap.
	1. Length.
	2. Cross-section (height, base width and slope).
	3. Construction material (size; quarry stone or rubble).
	4. Construction method (armor stone, bedding stone, filter cloth).
Slide 6	E. Boat ramp.
	1. Dimensions.
	2. Construction material.
Slide 7	F. Groins and jetties.
	1. Length.
	2. Spacing.
	3. Construction materials (type and dimensions).
	4. Design (low profile, spur, T-head).
	5. Adjacent shorelines with or without groins.
Slide 8	G. Commercial structures.
	1. Length or distance channelward.
	2. Area.
	3. Configuration (e.g., "L"-head, "T"-head, finger piers).

4. Construction materials (type and dimensions).

Slide 9

H. Submarine pipeline.

1. Length.

2. Location.

3. Placement depth.

4. Construction method.

5. Material to be transported.

II. PURPOSE

A statement on the purpose of the proposed project is important when considering alternatives to the proposal.

A. Use (public and/or private).

B. Need (public and/or private).

C. Water dependency (is the project inherently dependent on its proximity to the waterway or not?).

Impact Assessment

III. EXTENT OF RESOURCES INVOLVED

An appraisal of the habitat types directly and indirectly involved is critical to assessing the impacts of the proposal. This information can be derived from a site visit, resource inventories or other sources.

A. Wetlands.

1. Tidal and/or non-tidal.

2. Vegetated and/or non-vegetated.

B. Subtidal bottom.

C. Seagrass beds.

D. Sand dunes.

E. Shellfish beds.

F. Spawning areas.

IV. POTENTIAL EFFECTS OF THE PROPOSED PROJECT

This section involves the detailed evaluation of the potential for the proposed project to impact any number of ecological and socio-economic values. The following is not intended to be a comprehensive list of potential impacts. It is designed to cover the most frequently encountered situations and to hopefully stimulate the imagination to consider less routine circumstances.

A. Navigation.

Slide 10

1. Channel deepening which would facilitate or increase boat traffic.

    a. Increased erosion from boat wakes.

    b. Increased potential for discharges.

Slide 11

2. Siltation.

    a. Uncontained dredge spoil deposition.

    b. Change in natural siltation patterns from structures or dredging.

Slide 12

3. Maintenance dredging frequency.

Slide 13

4. New structures that hinder or impede navigation.

5. Proximity of structure to project channel should be no less than 50 feet.

B. Flood Plain.

Slide 14

1. Increase or decrease in tidal amplitude caused by changes in channel cross section.

Slide 15

2. Stream channelization and/or diversion.

3. Effect of the project on flood heights and/or duration.

Slide 16

4. Removal of wetland flood buffer areas.

	C. Shoreline Erosion or Accretion.
Slide 17	1. Alteration of littoral currents and drift by jetties, groins, etc. and the resultant changes in scour and deposition patterns.
Slide 18	2. Scouring from changes in inlet configuration.
Slide 19	3. Maintenance dredging required in inlets, channels, and dead-end canals caused by littoral shoaling.
Slide 20	4. Removal of erosion buffering marshes by shoreline protection structures.
Slide 21	5. Reflectance of wave energy by vertical structures adjacent to unprotected areas.
	D. Fish and Wildlife Resources.
	1. Loss of wetland and subaqueous habitats will impact production.
Slide 22	a. Detritus production of wetlands.
Slide 23	b. Forage fishes and invertebrates important to aquatic food webs.
Slide 24	c. Nursery area for juvenile fishes.
Slide 25	d. Commercially important finfish and shellfish.
Slides 26, 27	e. Feeding, nesting and resting areas for waterfowl, shorebirds and wading birds.
Slide 28	2. Turbidity increases from dredging impact resources through decreased light penetration and stress on filter feeders.
Slide 29	3. Repopulation of dredged areas upon completion can be expected within one or two years depending on new water depths, substrate and food availability.
Slide 30	4. Spawning areas for anadromous fishes can be adversely impacted by increased turbidity, loss of habitat and impoundments.
Slides 31, 32	5. Rare or endangered species have very specific habitat requirements with little tolerance for modification or disturbance.

	E. Water Quality.
Slide 33	1. Dredging.
	a. Degree and duration of turbidity increases are generally greater with decreasing size of the waterway.
	b. Increase in biochemical oxygen demand from the resuspension of organic sediments.
	c. Effects of resuspension of sediments containing pesticides and heavy metals.
Slide 34	2. Increase in coliform bacteria levels due to ineffective sewage disposal including failing septic systems, boats and sewage treatment plants.
Slide 35	3. Non-point source inputs of nutrients, sediment and other pollutants from upland runoff.
Slide 36	4. Effects of the removal of marshes on nutrient cycling within the water body.
	a. Remineralization - conversion of nutrients from organic particulate to more available dissolved forms.
	b. Role as a nutrient sink which can absorb pulses and release more slowly.
Slide 37	5. Dead-end canals.
	a. Poor flushing.
	b. Organic material accumulation.
	c. Nutrient accumulation.
	d. Algal blooms.
	e. Low dissolved oxygen.
Slide 38	f. Fish kills.
Slide 39	6. Virginia Pollutant Discharge Elimination System permit required - might cause additional degradation.

Slides 40, 41	7. Increased potential for spills of petroleum products or other hazardous materials.
	F. Aesthetics.
Slide 42	1. Replacement or removal of dilapidated or derelict structures.
Slide 43	2. Removing or covering of solid fill and rubbish fill areas with topsoil and seeding.
Slide 44	3. Changes in pristine attributes.
	4. Unnecessary structures detracting from the natural beauty of the area.
	G. Archaeological and Historical Sites.
Slide 45	1. State Historic Preservation Office.
Slide 46	2. Virginia Historic Landmarks.
	3. National Register of Historical Properties.
	H. Recreation.
Slide 47	1. Enhancement of existing recreational facilities such as improved access to waterways.
Slide 48	2. Degradation of existing recreational facilities such as restriction of access to waterway.
Slide 49	3. Creation of new recreational opportunities.
	4. Benefits primarily public or primarily private.
	I. Socioeconomics.
Slide 50	1. Local tax base - real estate development.
Slide 51	2. Employment and/or payrolls.
Slides 52, 53	3. Government services.
Slide 54	a. Transportation.
	b. Schools.

c. Utilities.

d. Police and firefighting services.

Slide 55 4. Foreign and domestic water-borne commerce.

Slide 56 5. Commercial fisheries.

Slide 57 6. Satellite industries.

Slide 58 7. Local zoning and land use plans that control urban growth.

8. Economic effect on applicant (e.g. increased business).

Slide 59 9. Externalization of business costs by filling wetlands or discharging wastewater into river.

J. Water Supply.

Slide 60 1. Effects on the quantity and quality of any public or private water supply.

2. Impacts of impoundments on wetlands and fisheries.

a. Changes in salinity regime (e.g., reduced freshwater inflow that could cause changes in vegetation patterns or fish utilization).

b. Prevent access to spawning areas.

Slide 61 3. Effects on groundwater and aquifers caused by water-intensive industries that hasten saltwater intrusion and lower groundwater levels.

V. ANALYSIS OF ALTERNATIVES

This portion of the process involves making the determination of which impacts appear to be avoidable and which appear unavoidable. It also includes the development of reasonable means to reduce the impacts of the proposal and reestablish the values lost when possible.

A. Avoidance of wetlands and subtidal areas.

Slide 62 1. Alternative locations.

2. Alternative methods or time periods for construction.

Slide 63 a. Access to site.

Slide 64

b. Time-of-year restrictions.

Slides 65-69

c. Best Management Practices (BMP's).

3. Alternative means of achieving stated purpose.

B. Reduction in scope to minimize impacts.

1. Use of previously disturbed areas that minimize project impacts to healthy habitats.

Slide 70

2. Use of areas of lesser ecological significance where justified to avoid impacting the more ecologically important habitats.

Slide 71

C. Restoration of damaged areas.

Slide 72

D. Compensation for unavoidable losses.

VI. RECOMMENDATIONS AND CONCLUSIONS

Slide 73

This is where the weighing of the public and private benefits versus detriments, and where the formulation of recommendations to ensure that the benefits outweigh the detriments, occur.

A. Any extenuating circumstances or any other relevant information either pro or con not mentioned in the above paragraphs that might affect recommendations.

B. Recommendations for additions, deletions or modifications in the proposal including any reasonable alternatives necessary to make the project environmentally acceptable.

References

Clark, J.R. 1974. *Coastal Ecosystems: Ecological Considerations for Management of the Coastal Zone*. The Conservation Foundation, Washington, D.C. 178 pp.

Daiber, F.C. 1986. *Conservation of Tidal Marshes*. Van Nostrand Reinhold Co., Inc., New York, NY. 341 pp.

Mulvihill, E.L., C.A. Fransico, J.B. Glad, K.B. Kaster, and R.E. Wilson. 1980. Biological impacts of minor shoreline structures on the coastal environment: state of the art review. U.S. Fish and Wildlife Service, Biological Services Program. FWS/OBS-77/51. 2 vol.

Slide List

1. Dredge
2. Disposal area
3. Fill in wetlands
4. Bulkhead construction
5. Riprap construction
6. Boat ramp
7. Groin with spur
8. Commercial pier
9. Pipeline crossing
10. Tangier Island harbor aerial
11. Overboard disposal area
12. Channel across sand shoal
13. Norshipco drydock
14. Cabin Point Creek Inlet
15. Flood hydrograph
16. Flood plain marsh
17. Buckroe Beach groins
18. Wave overtopping groin
19. Salt Ponds inlet
20. Filled fringe marsh
21. Yorktown Beach
22. Detritus debris
23. Goose Creek fishes
24. Beach haul seine
25. Oyster baskets
26. Egret
27. Willet nest
28. SAV bed
29. Bucket dredge
30. Striped bass
31. Egret rookery
32. Skimmer nest
33. Soloman dredge
34. Scummy water
35. Papermill Creek
36. Filled fringe marsh
37. Chickahominy Haven
38. Fish kill

39. Wastewater treatment plant
40. Oil spill
41. Toxic spill
42. Sunken menhaden boat
43. Urban waterfront
44. Halstead property - Back Bay
45. Jamestown aerial
46. Fort Monroe aerial
47. Fisherman in boat
48. Sailboat
49. Duckblind
50. Sarfan Canal
51. Lonestar
52. New house
53. Fire hydrant
54. Road construction
55. Dominion terminals
56. Pound net fishermen
57. Miles Oyster Co.
58. Hampton River
59. Discharge pipe
60. Stumpy Lake Spillway
61. Perdue
62. Bulkhead landward of marsh
63. Scotts Creek Marina
64. Turbidity curtain
65. Boat lift
66. Dry stack storage
67. Riprap rather than bulkhead
68. Gapped breakwaters
69. Lonestar
70. High marsh vs. low marsh
71. Monkey Bottom
72. Goose Creek
73. Closing

Human Activities, Impacts and Alternatives Handout

I. PROJECT DESCRIPTION

A. Dredging

B. Filling

C. Bulkheading

D. Riprap

E. Boat ramp

F. Submarine pipeline

G. Groins and jetties

H. Commercial structures

II. PURPOSE OF PROJECT

A. Use

B. Need

C. Water dependency

III. EXTENT OF RESOURCES INVOLVED

A. Wetlands

B. Subtidal bottom

C. Seagrass beds

D. Sand dunes

E. Shellfish beds

F. Spawning areas

IV. POTENTIAL EFFECTS OF THE PROPOSED PROJECT

A. Navigation

B. Flood plain

C. Shoreline erosion and accretion

D. Fish and wildlife resources

E. Water quality

F. Aesthetics

G. Archaeological and historical sites

H. Recreation

I. Socioeconomics

J. Water supply

V. ANALYSIS OF ALTERNATIVES

A. Avoidance of wetlands and subtidal areas

B. Reduction in scope to minimize impacts

C. Use of previously impacted areas

D. Use of areas of lesser ecological significance

E. Restoration of damaged areas

F. Compensation for unavoidable losses

G. Alternative locations

H. Alternative methods of construction

I. Alternative means of achieving stated purpose

VI. RECOMMENDATIONS AND CONCLUSIONS

A. Extenuating circumstances

B. Modifications and conditions

The Role of the Wetlands Board

Lyle M. Varnell

Notes

Length of Presentation: 25 min.

Objectives

The purpose of this module is to explain the basic foundation and functions of the Wetlands Board within the joint permit process. This entails explanations of (1) how and why the Wetlands Board was formed, (2) the functions of the Wetlands Board as compared to other permit-granting bodies (the VMRC and the Corps of Engineers), and (3) its function as a decision-maker at the local level.

Materials

1. 35 mm slide projector
2. Screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review outline
2. Review and choose visual aids
3. Prepare handouts (if any)
4. Review references (VIMS Technical Report 91-2)
5. Ensure that equipment is in good working order

Procedure

1. Introduce yourself and others as required
2. Announcements
   a. Will take questions at end of talk or as we go along
   b. With limited time this can be only a limited overview

Lecture Notes

I will explain to you today your role in the Joint Permit Application Process AND your role as a decision-maker towards applications.

Slide 1	I. MANDATE: CODE OF VIRGINIA
Slide 2- Urge audience to become familiar with these chapters of the Virginia Code	A. Chapter 2.1 of the Code of Virginia (sections 62.1-13.1 to 62.1-13.20) declares wetlands policy and defines the management of jurisdictional wetlands. B. Chapter 2.2 of the Code of Virginia (sections 62-1-13.21 to 62.1-13.28) declares coastal primary sand dune policy and defines the management of dunes and beaches.
Slide 3	II. WETLANDS AND DUNES ORDINANCE
	A. Your local government (county board of supervisors or city council) adopted the Wetlands Zoning Ordinance and/or the Coastal Primary Sand Dune Zoning Ordinance prior to the formation of this board. B. Municipalities which have not adopted the Wetlands Zoning Ordinance or the Coastal Primary Sand Dune Zoning Ordinance have the VMRC act as their Wetlands Board. C. These ordinances give you, the Wetlands Board, the authority to regulate the use and development of your municipality's wetlands, dunes and beaches within the guidelines set forth by law.
Slide 4A	III. ORDINANCE SUMMARIES: PERMISSIBLE USES
	A. The Wetlands Zoning Ordinance defines jurisdiction, outlines the permit process and operational procedures for the Wetlands Board, and outlines permissible uses of wetlands. These uses are summarized below: 1. Construction and maintenance of noncommercial structures supported by pilings. 2. Cultivation and harvesting of shellfish and bait worms. 3. Noncommercial recreational activities provided no structures are required beyond those which are permissible under (1) above. 4. Cultivation and harvesting of agricultural, forestry or horticultural products; grazing and haying. 5. Conservation, repletion and research activities. 6. Government authorized navigation aids.

7. Emergency decrees for protection of public health.

8. Normal maintenance, repair or addition to existing wetland crossings provided no waterway is altered and no additional wetlands are covered.

9. Governmental activity on wetlands owned or leased by the Commonwealth.

10. Normal maintenance of drainage ditches provided no additional wetlands are covered.

11. Outdoor recreational activities which do not impair the functions of or alter the contour of wetlands.

Slide 4B

B. The Coastal Primary Sand Dune Zoning Ordinance defines jurisdiction, outlines the permit process and operational procedures for the Wetlands Board, and outlines permissible uses of dunes and beaches. These are summarized below:

1. Construction and maintenance of noncommercial walkways and/or observation platforms which do not alter the dune contour.

2. Plantings of vegetation or placement of sand fences for the purpose of dune stabilization.

3. Sand replenishment activities provided no sand is removed from the coastal primary sand dune.

4. Normal maintenance of erosion control structures which may abut a coastal primary sand dune.

5. Normal maintenance or repair of existing roads or railroads provided no primary dunes are altered.

6. Recreational activities provided the primary dune and/or its vegetation is not altered.

7. Conservation and research activities of state governmental agencies or institutions.

8. Construction and maintenance of governmental authorized navigation aids.

IV. APPOINTMENT OF BOARD MEMBERS

A. Any municipality which adopts the Wetlands Zoning Ordinance must also create a Wetlands Board.

B. The Wetlands Board shall consist of either 5 or 7 residents of the respective municipality.

C. The Wetlands Board is appointed by the same governing body which adopted the Wetlands Zoning Ordinance.

D. Excepting initial terms of office, each member shall serve a five year term.

E. Members may serve successive terms.

V. MUNICIPAL JURISDICTION: CITIES AND TOWNS

A. Cities or towns within counties which have adopted the Wetlands Zoning Ordinance have one (1) calendar year from the county's adoption date to adopt the Wetlands Zoning Ordinance (if they desire to manage their wetlands separately).

B. If cities or towns within the county do not adopt the Wetlands Zoning Ordinance within the allotted time, the county's Wetlands Board automatically retains jurisdiction of wetlands within the town's boundaries.

VI. OFFICERS

A. Each Wetlands Board will elect, from its membership, a chairman.

B. Other officers may be elected if deemed necessary, such as a vice-chairman who serves as chairman in his/her absence.

C. Each elected officer's term will be one (1) year.

D. Officers may serve successive terms.

VII. PERMIT REVIEW

A. This Wetlands Board was formed for the management of use of Virginia's tidal wetlands.

B. Management is achieved through a permit process. Any activity which encroaches upon or over jurisdictional wetlands (with few exceptions as outlined previously) requires a permit from the Wetlands Board, the United

States Army Corps of Engineers, and in come cases the Virginia State Water Control Board.

C. Each party requesting use of Virginia's jurisdictional wetlands must apply for a permit directly to the Wetlands Board or through the VMRC.

Slide 5

D. The JOINT PERMIT APPLICATION was created to streamline the permit process. This permit application package is the document from which all project requests are reviewed by the Wetlands Board, the VMRC, VIMS, Virginia State Water Control Board, Virginia Department of Conservation & Historic Resources, Virginia Department of Transportation, adjacent property owners and other claimants such as oyster ground leaseholders.

Slide 6

Discuss Flow Chart

E. The United States Environmental Protection Agency, United States Fish & Wildlife Service, and the United States Department of Commerce National Marine Fisheries Service review the application for the permit required from the United States Army Corps of Engineers. The permit process is outlined in the accompanying flow chart.

VIII. DECISION-MAKING

Slide 7

A. Your primary role is to review the application and determine whether the benefits outweigh the detriments, or whether the detriments outweigh the benefits.

B. You are NOT alone in this determination. You have several avenues of information to help you weigh your decision.

Slide 8

1. **The Application.** Review the application carefully. A wealth of information is included in an accurately completed application. Inaccuracies should be addressed.

Slide 9

2. **Site Visit.** Essentially, a "picture" is worth a thousand words. A site visit is a necessary step in order to accurately assess the situation upon which you will be making a decision.

Slide 10

3. **Public Comment.** This will bring to light socio-economic benefits and/or detriments from the persons who may be affected.

Slide 11

4. **VIMS Evaluation.** We report on each application filed. VIMS wetlands staff (we) provide you with an accurate and unbiased evaluation of the environmental impacts of the proposed project. We enumerate specific impacts and comment on potential secondary impacts and other environmental concerns.

Slide 12
Slide 13
Slide 14

5. **VIMS Published Literature.** The Virginia Wetlands Report (published periodically), a monthly Technical Report Series addressing wetlands issues, and a special series on wetlands flora are published by the VIMS Wetlands Program. These are intended to educate you on the importance of wetlands and their basic functions and values.

Slide 15

6. **VIMS Wetlands Staff.** We are available to answer questions as well as perform selected duties in support of the boards.

C. If the benefits outweigh the detriments, then approval of the project as proposed may be in order.

D. If detriments outweigh benefits, you have several options:

1. Deny project;

2. Require the project be modified; or

3. Require mitigation (this should always be your LAST option).

IX. VMRC REVIEW OF WETLANDS BOARD DECISIONS

A. The VMRC has the authority to review Wetlands Board decisions as outlined in section 62.1-13.11 of the Virginia Code.

B. As stated, the VMRC SHALL review a decision if:

1. An appeal is taken to the VMRC by the applicant or municipality;

2. The Commissioner of the VMRC requests to review a decision, or;

3. 25 or more property holders from the municipality of the proposed project petition the VMRC. Requests for review must be made within ten (10) days of the decision by the Wetlands Board.

C. The VMRC may modify, remand or reverse Wetlands Board's decisions if they deem necessary upon review. This authority is granted them in section 62.1-13.13 of the Virginia Code.

D. Judicial review, if necessary, may be pursued after review by the VMRC.

References

Laws of Virginia Relating to the Marine Resources of the Commonwealth, 1989 Edition and 1990 Supplement.

Slide List

1. Code book cover
2. Code Chapter 2.1 & Table of Contents
3. Wetlands Ordinance

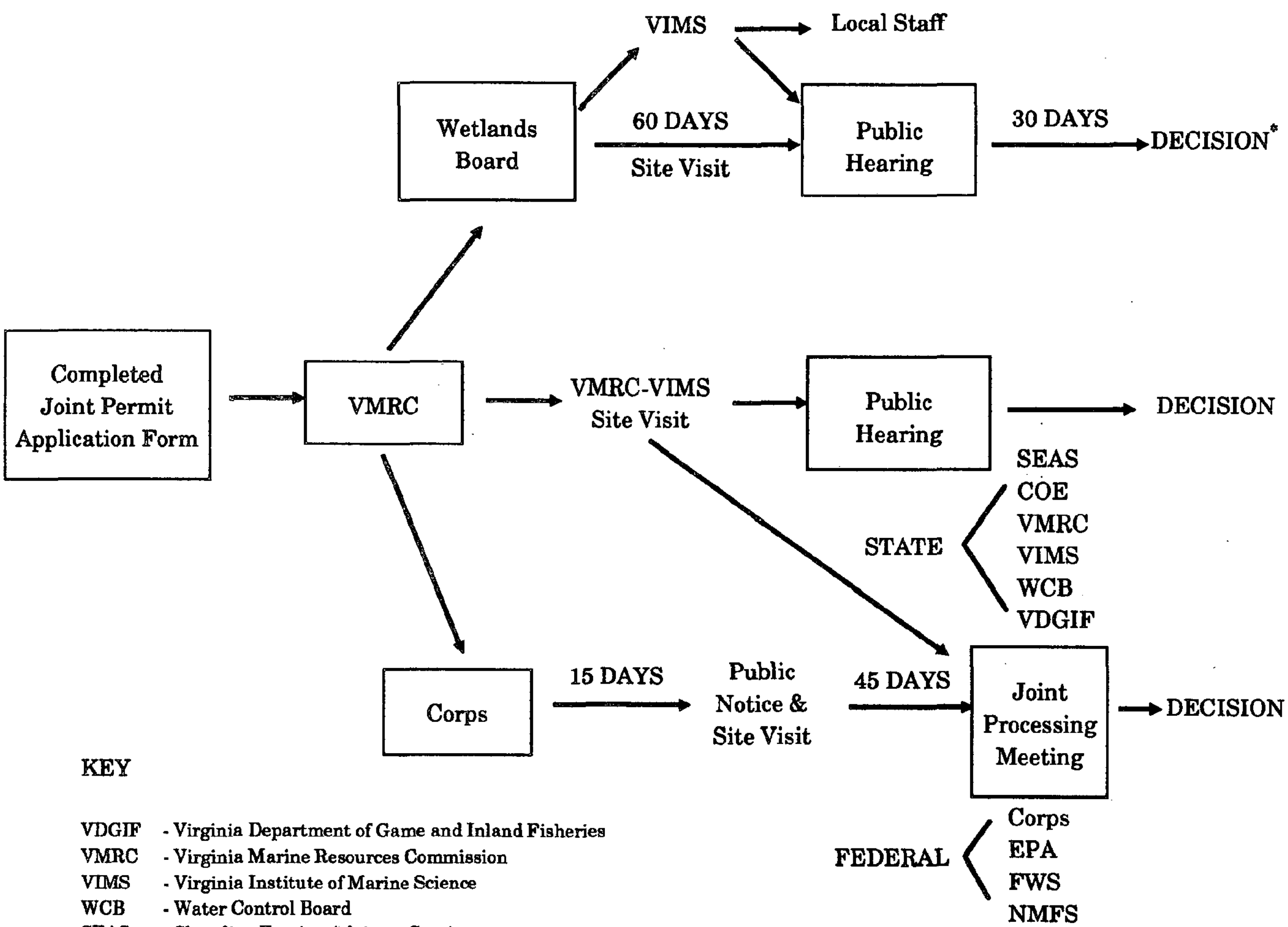
4A. Permissible uses of wetlands not requiring a permit

4B. Permissible uses of dunes not requiring a permit

5. Cover of Permit Application packet
6. Permit process flow chart
7. Weighing scale: benefits vs. detriments
8. Sample application drawing
9. Project site photograph
10. Photograph of a public hearing
11. VIMS report
12. Virginia Wetlands Report cover
13. Technical Report cover (91-2)
14. Wetlands Flora cover
15. Member of staff shown on-site

The Role of the Wetlands Board Handout

Virginia's Shoreline Permit Process



KEY

VDGIF - Virginia Department of Game and Inland Fisheries
VMRC - Virginia Marine Resources Commission
VIMS - Virginia Institute of Marine Science
WCB - Water Control Board
SEAS - Shoreline Erosion Advisory Service
COE - Council on the Environment
EPA - Environmental Protection Agency
FWS - Fish and Wildlife Service
NMFS - National Marine Fisheries Service
Corps - Corps of Engineers

*VMRC Review of Wetlands Board Decision

- appeal by applicant or municipality
- at request of Commissioner of Marine Resources
- petition by 25 or more property owners from the municipality of the proposed project

VMRC May Modify, Reverse or Remand the Wetlands Board Decision
Judicial Review

Wetlands Program
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Virginia Institute of Marine Science
School of Marine Science
Gloucester Point, Virginia 23062

Wetlands Board Operational Procedures

Kirk J. Havens

Notes

Length of Presentation: 20 min.

Objectives

The purpose of this unit is to familarize students with the proper procedure for a wetlands board public meeting.

Upon completion, students should be able to explain and use the following terms or procedures:

- Quorum
- Virginia's policy concerning wetlands
- Public testimony
- Public and private benefits vs. detriments
- Closing hearing to public comment
- Bond or letter of credit
- Denial without prejudice
- Appeal process

Materials

1. 35 mm slide projector
2. Movie screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Review reference material (VIMS Technical Report 91-2, Coastal Resources and the Permit Process: Definitions and Jurisdictions)
4. Practice with equipment: slide projector

Procedure

1. Introduce self and other instructors
2. Announcements (other workshops, etc.)
3. Explain general comments on lesson, eg. limitations - this module is a general procedural format and any procedure adopted by the board should first be reviewed by its city or county attorney
4. Distribute handouts

Lecture Notes

I. INTRODUCTION

In order for a meeting to function properly and efficiently, it is necessary to follow procedural guidelines. Following such guidelines will allow the meeting to proceed quickly and avoid unnecessary delays or confusion.

II. PRIOR TO MEETING/HEARING

Slide 1

A. The board members and staff should review basic materials. This may include the Virginia State Wetlands Act (Section 62.1, Chapter 2.1), Coastal Primary Sand Dune Protection Act (Section 62.1, Chapter 2.2), the Virginia Marine Resources Commission guidelines, and appropriate VIMS Technical Reports found in the Virginia Wetlands Management Handbook.

B. The board members and staff should study all applications, and VIMS reports. If needed, questions may be raised, tentative evaluations, motions, conditions, and time limits developed.

Slide 2

C. On the day of the meeting/hearing, staff telephones a reminder to board members, confirms the availability of the meeting chamber, checks that lights and speakers are on, sets out name plates; pads and pencils; brings appropriate area maps, State and local laws; photographs of sites, posts agendas for the public.

III. HOLDING THE MEETINGS/HEARINGS

A. Preliminary.

Slide 3

1. Chairman calls meeting to order.

2. Chairman or staff takes visual attendance and confirms a **quorum**.

   a. A quorum is four members of a seven member board present or three members of a five member board present. If a quorum is not present, the board should adjourn until a quorum can be established.

3. Chairman explains the **purpose** of the meeting. Reads opening statement.

   a. Sample opening statement- The (________) wetlands board is now in session. (Gavel) Let the record show that _____ members of the board are present. This (does/does not) constitute a quorum. Before we begin the hearing, I will read excerpts from the code of Virginia to let everyone in the room know what it is that we are trying to do. We are carrying out the **Policy** of the Commonwealth as stated in Title 62.1:

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

We will be guided by this policy as well as by the legal standards and the VMRC guidelines. That is the rather difficult task we will try to accomplish in this hearing.

Now let me explain the **procedure** for each hearing item. To begin, we will discuss the project requested. We will then read the recommendation by VIMS. If the person who has made the request or that person's agent is here, I will ask him or her to speak. If there are others in the room who want to comment, it will be their turn next. After that, the board will make its decision. When you come to the podium please state your name and address for the record. Try to be brief so that all parties can be equally heard.

Finally, the applicant will receive a memo advising him of the action taken. Unless appealed, board approval will result in a permit within 14 days. If the request is denied, the applicant may appeal to the VMRC within 10 days from today.

4. Chairman states where agendas are posted for the public.

5. Chairman calls for comments, questions, corrections on the minutes.

6. Chairman inquires about old business.

B. Hearing Items

Slide 4

1. Chairman may shift the hearing order, administer oaths, limit presentations, and discussions. If a time limit is set, it should be stated before anyone in the audience speaks. You should not halfway through a hearing decide that people are taking too long and impose a time limit on the remaining speakers. Everyone should be afforded the same opportunity to express their concerns.

2. Chairman or staff state case number and present a brief description of the proposed project.

3. Chairman or staff read VIMS comments into the record if supplied.

Slide 5

4. Chairman requests the applicant or designated representative to come forward to the podium, to state name and mailing address with ZIP, and to give any additional testimony or answer questions as required by the board.

> *** NOTE * any material submitted to the board at the public hearing must be kept by the board.** It is good policy to state this early so that people who have aerial photos, etc., realize that they must be kept by the board as part of the public record of the hearing.

5. Chairman asks if anyone else wishes to speak on behalf of the application; anyone opposed. Chairman asks one more time for anyone else who wishes to speak either in opposition or support of the application.

Slide 6

6. Chairman closes hearing to the public.

7. Chairman asks for comments from the board members. The Record should display a consideration of social, economic, physical, and environmental impacts as they relate to the policies and standards contained in the Wetlands and/or Sand Dune Acts. A benefits vs. detriments conclusion format is helpful.

Slide 7

8. Chairman asks for an evaluation and recommendation from the staff.

9. Chairman asks for any additional comments from VIMS (if present).

10. The Chairman will entertain a motion on the question or ask, "What is your pleasure?" Motions may include the following:

   a. Approval as submitted.

Slide 8

   b. Approval in a modified form with stated conditions/time limits (either at the request of the applicant or board members).

   c. Approval with bonding or letter of credit required (money required of applicant by the board and placed in an account to ensure compliance with permit requirements).

   d. Denial.

e. Denial without prejudice (to deny the specific permit but allow the applicant to submit a new application to accomplish the same purpose but in a different manner).

f. Direct the applicant to provide more information prior to final action.

g. Defer a decision for up to 30 days. Caution: If a decision is not made within 30 days, the permit is automatically approved as submitted. The applicant may request a deferral removing the 30 day limit.

11. The motion is seconded and chairman calls for voice or roll call vote.

Slide 9

12. Chairman, as appropriate, informs applicant & VMRC he or she will be notified in writing 48 hours after the decision; 10 days to appeal; description of the appeal process; receive permit in mail; permit dated 14 days from approval date; need to apply for any changes including extension of time.

13. Chairman or board staff fills out Wetlands Board Modification Sheet.

IV. OTHER THAN HEARING ITEMS

1. Chairman calls for other new business, violations.

2. Asks for comments, communications, letters from members.

3. Asks for comments, questions, introductions in audience.

4. Announces future meetings, conferences.

Slide 10

V. HELPFUL HINTS

References

Virginia Wetlands Act, Section 62.1, Chapter 2.1, Code of Virginia.

Coastal Primary Sand Dune Protection Act, Section 62.1, Chapter 2.2, Code of Virginia.

Virginia Institute of Marine Science Technical Report Series. 1990-1991. Wetlands Program. Virginia Institute of Marine Science (VIMS), Gloucester Pt., VA.

Virginia Marine Resources Commission (VMRC). 1982. Wetland Guidelines. Prepared by the Department of Wetlands Ecology, Virginia Institute of Marine Science, printed by VMRC, Newport News, VA. 57 pp.

Virginia Marine Resources Commission (VMRC). 1986. Coastal Primary Sand Dunes/Reaches Guidelines. VMRC, Newport News, VA. 57 pp.

Virginia Marine Resources Commission (VMRC). 1990. Criteria for the Siting of Marinas or Community Facilities for Boat Mooring. VMRC, Newport News, VA. 8 pp.

Slide List

1. List of review readings
2. Prior to meeting
3. Holding public hearing
4. Hearing items
5. Hearing items - continued
6. Hearing items - continued
7. Board decision
8. Motions
9. After board decision
10. Helpful hints

Wetlands Board Operational Procedures Handout No. 1

Holding Public Hearing

1. Meeting called to order
2. Attendance recorded, quorum confirmed
3. Chair explains purpose of meeting, reads opening statement*
4. Chair states where agendas are posted
5. Chair calls for comments, questions, corrections on minutes
6. Chair inquires about old business

**Many boards choose to read the policy statement at the beginning of the Wetlands Act*

Hearing Items

1. Chair may shift hearing order, administer oaths, limit presentations and discussions
2. Chair or staff state case number and present brief description of proposed project
3. Chair or staff read VIMS report into record
4. Applicant or representative speaks
5. Others speak
6. Chair closes hearing to public

Board Discussion

1. Chair asks for comments from Board members
2. Record should display a consideration of:
   a. Social concerns
   b. Economic concerns
   c. Physical concerns
   d. Environmental concerns
3. Chair asks for staff evaluation/recommendation
4. Chair asks if any additional comments from VIMS
5. Chair entertains motion

A benefits vs. detriments format is recommended

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Motions May Include

1. Approval as submitted
2. Approval in modified form
3. Approval with bonding or letter of credit required
4. Denial
5. Denial without prejudice
6. Direct applicant to provide more information
7. Defer decision for up to 30 days

After Board Decision

1. Chair informs applicant and audience of appeal process
2. Time limit on permit

Glossary

Quorum . . . . a quorum is obtained when there are 3 members of a 5 member board or 4 members of a 7 member board present.

Bond or Letter of Credit . . money required of applicant by the board and placed in an account to ensure compliance with permit requirements.

Suggested Reading List

Virginia Wetlands Act, Section 62.1, Chapter 2.1, Code of Virginia.

Coastal Primary Sand Dune Protection Act, Section 62.1, Chapter 2.2, Code of Virginia.

Virginia Institute of Marine Science Technical Report Series. 1990-1991. Wetlands Program. Virginia Institute of Marine Science (VIMS), Gloucester Pt., VA.

Virginia Marine Resources Commission (VMRC). 1982. Wetland Guidelines. Prepared by the Department of Wetlands Ecology, Virginia Institute of Marine Science, printed by VMRC, Newport News, VA. 57 pp.

Virginia Marine Resources Commission (VMRC). 1986. Coastal Primary Sand Dunes/Reaches Guidelines. VMRC, Newport News, VA. 57 pp.

Virginia Marine Resources Commission (VMRC). 1990. Criteria for the Siting of Marinas or Community Facilities for Boat Mooring. VMRC, Newport News, VA. 8 pp.

Just Prior to Meeting Staff Should:

1. Telephone reminder to Board Members

2. Confirm availability of meeting chamber

3. Check lights and speakers

4. Set out name plates, pads, and pencils

5. Bring appropriate area maps

6. Bring state and local laws

7. Bring photographs of site

8. Post agendas for public

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Wetlands Board Operational Procedures Handout No. 3

Helpful Hints:

1. Require speaker from public to approach Board, state name/address, speak, return to audience

2. Limit speakers to issues germane to Wetlands Board

3. Allow everyone an opportunity to speak

4. Direct all public comment or questions to Board

5. Discourage interaction between audience and speaker

6. State decision rationale in benefit vs. detriment format

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Guide to Wetlands Board Modification Sheet

Pamela A. Mason

Notes

Length of Presentation: 10-15 min.

Objectives

The purpose of this unit is to review the purpose and correct use of the wetlands board modification sheets.

Upon completion, students should be able to properly fill out a board modification sheet for various projects.

Materials

1. 35 mm projector
2. Movie screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Practice

Procedure

1. Introduce yourself and others as appropriate
2. Announce any special information
3. Distribute handouts

Lecture Notes

I. WHAT IS A MODIFICATION SHEET

A. It is generated by the VIMS Wetlands Program database. It has two identical columms listing shoreline activities and wetlands types. The first column is filled in with the applicable information from the proposed project in the permit application. The second column is used to record the shoreline activity and its impacts permitted by the Wetlands Board.

II. WHY IS IT IMPORTANT

A. Often VIMS reports include alternatives to minimize project impacts. The inclusion of these alternatives, or any other changes, by the applicant or as required by the Board often modifies the environmental impacts of the project. The modification sheet provides spaces for notation of the impacts of the project as permitted. Returning the information to VIMS allows for corrections to be made to the database. The data is then used to calculate annual permitted shoreline activities and their impacts to wetlands, dunes and subaqueous bottoms.

III. EXAMPLES

Slides 1-3

A. Riprap. This project involves the construction of 167 feet of riprap.

Slides 4-6

1. In the first scenario the riprap is constructed in the wetlands with a 6 foot encroachment resulting in the fill of 501 square feet of wetlands and impacting 1002 square feet.

2. In the second scenario the riprap is placed behind the wetlands resulting in 84 square feet filled and 167 square feet impacted.

Slides 7-8

B. Bulkhead (once again the structure is 167 feet in length).

Slides 9-10

1. First scenario - bulkhead is built in the wetland with a 6 foot encroachment resulting in 1002 square feet of filled (impacted) wetlands.

2. Second scenario - bulkhead is built behind the wetlands with 167 square feet of filled (impacted) wetlands.

Slide List

1. Riprap in wetlands - plane view
2. Riprap in wetlands - side view
3. Riprap in wetlands - modification sheet
4. Riprap behind wetlands - plane view
5. Riprap behind wetlands - side view
6. Riprap behind wetlands - modification sheet
7. Bulkhead in wetlands - side view
8. Bulkhead in wetlands - modification sheet
9. Bulkhead behind wetlands - side view
10. Bulkhead behind wetlands - modification sheet

Guide to Wetlands Board Modification Sheet Handout

To Be Included With Permit And Sent To VMRC

Application Number: XX-XXXX

Name: John Doe
Location: Waterview
Waterway: Chesapeake Bay a tributary to Chesapeake Bay

ACTIVITIES

Proposed		Permitted	
Bulkhead (ft.)		Bulkhead (ft.)	
Commercial Structure (ft^2)		Commercial Structure (ft^2)	
Existing Slips (no.)		Existing Slips (no.)	
Proposed New Slips (no.)		Proposed New Slips (no.)	
Filled Wetlands (ft^2)	501	Filled Wetlands (ft^2)	84
Filled Subtidal (ft^2)		Filled Subtidal (ft^2)	
Boat Ramps (ft^2)		Boat Ramps (ft^2)	
New Dredging (y^3)		New Dredging (y^3)	
Maintenance Dredging (y^3)		Maintenance Dredging (y^3)	
Intertidal Dredging (y^3)		Intertidal Dredging (y^3)	
Disposal (y^3)		Disposal (y^3)	
Riprap (ft.)	167	Riprap (ft.)	167
Breakwaters (ft.)		Breakwaters (ft.)	
Groins (no.)		Groins (no.)	
Groin Length (ft.)		Groin Length (ft.)	
Overhead Crossings (ft.)		Overhead Crossings (ft.)	
Submarine Crossings (ft.)		Submarine Crossings (ft.)	
Subtidal (y^3)		Subtidal (y^3)	

AMOUNT OF WETLANDS IMPACTED BY PROJECT

Proposed			Permitted		
Type I	Saltmarsh Cordgrass (ft^2)	1002	Type I	Saltmarsh Cordgrass (ft^2)	167
Type II	Saltmeadow Community (ft^2)		Type II	Saltmeadow Community (ft^2)	
Type III	Black Needlerush (ft^2)		Type III	Black Needlerush (ft^2)	
Type IV	Saltbush Community (ft^2)		Type IV	Saltbush Community (ft^2)	
Type V	Big Cordgrass Comm. (ft^2)		Type V	Big Cordgrass Comm. (ft^2)	
Type VI	Cattail Community (ft^2)		Type VI	Cattail Community (ft^2)	
Type VII	Arrow Arum-Pickerel (ft^2)		Type VII	Arrow Arum-Pickerel (ft^2)	
Type VIII	Reed Grass Comm. (ft^2)		Type VIII	Reed Grass Comm. (ft^2)	
Type IX	Yellow Pond Lily (ft^2)		Type IX	Yellow Pond Lily (ft^2)	
Type X	Saltwort Community (ft^2)		Type X	Saltwort Community (ft^2)	
Type XI	Freshwater Mixed (ft^2)		Type XI	Freshwater Mixed (ft^2)	
Type XII	Brackish Water Mixed (ft^2)		Type XII	Brackish Water Mixed (ft^2)	
Type XIII	Intertidal Beach (ft^2)		Type XIII	Intertidal Beach (ft^2)	
Type XIV	Sand Flat Comm. (ft^2)		Type XIV	Sand Flat Comm. (ft^2)	
Type XV	Sand/Mud Flat (ft^2)		Type XV	Sand/Mud Flat (ft^2)	
Type XVI	Mud Flat Comm. (ft^2)		Type XVI	Mud Flat Comm. (ft^2)	
Type XVII	Intertidal Oyster (ft^2)		Type XVII	Intertidal Oyster (ft^2)	
Intertidal Rubble/Riprap (ft^2)			Intertidal Rubble/Riprap (ft^2)		
Subtidal Bottom (ft^2)			Subtidal Bottom (ft^2)		

Certified By: ______________________________

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Wetland Mitigation, Compensation

Thomas A. Barnard, Jr.

Notes

Length of Presentation: 30 min.

Objectives

Upon completion, students should be able to:

- Explain the terms mitigation and compensation within the regulatory context.
- Understand and use the recommended procedures when employing these management tools.
- Recognize concerns regarding the limitations of these concepts within wetlands management.

Materials

1. 35 mm slide projector
2. Screen
3. Slides
4. Handouts

This talk contains slides of actual compensation wetlands. You may wish to add slides of created wetlands with which you are familiar.

Instructor Preparation Tasks

1. Review outline
2. Review and choose visual aids
3. Prepare handouts (if any)
4. Review references
5. Ensure that equipment is in good working order

Slides depicting examples of compensatory wetlands should be used as a talk supplement at the end of the presentation.

Procedure

1. Introduce self
2. Announcements
   a. Will take questions at end of talk only, or as we go along
   b. With limited time we will not be able to analyze all aspects in depth
   c. Suggest reading the VIMS Technical Report 90-7, Compensatory Mitigation Within the Tidal Wetlands of Virginia
   d. For further in-depth discussion, see Kusler and Kentula, 1990
3. Distribute handouts

Lecture Notes

Slide 1

I. DEFINITIONS

II. TECHNICAL DISCUSSION

A. Scientific questions.

Slide 2

1. How long does it take to produce a wetland of equal value to a natural system?

a. A saltmarsh can be established in 3 years or less; a non-tidal swamp may take 40 or more years.

b. The question of when created systems reach ecological parity with natural systems cannot be answered at this time.

2. How do we measure success?

a. There are many different ways.

1. Productivity.

2. Vegetative cover.

3. Diversity of species.

4. Densities of organisms.

5. All of the above.

b. There is no standard measure of success in wetland systems at this time.

3. Compensation in Virginia has met with mixed success to this point.

4. On-site vs. off-site compensation can only be evaluated on a case-by-case basis.

a. On-site is intuitively best.

b. When on-site is not feasible, off-site in the same basin may be preferred.

Go through the rest of the questions on slide 2 very briefly.

5. Many more technical questions such as the ones shown on this slide need to be evaluated before compensation becomes a standard practice.

	III. POLICY QUESTIONS

Slide 3

III. POLICY QUESTIONS

A. How much compensation is enough?

1. Compensation is generally not 100% successful.

2. There is a loss of wetland function between the time the natural wetland is lost and the created compensation system is fully established.

B. How can one ensure the created wetland will survive?

1. Proper planning.

2. Knowledgeable experts.

3. Bonding the activity.

4. Monitoring.

C. Can "low value" wetland be enhanced and become of higher ecological value?

1. Case by case determination.

2. Little scientific research in this area.

The list of questions in slide 3 should be discussed as time allows.

D. What are the legitimate forms of wetland compensation?

1. Restoration?

2. Preservation?

3. Enhancement?

4. Donating money for research?

E. Is monitoring necessary?

1. Should be determined on a case-by-case basis.

2. Larger projects are more likely to require monitoring.

IV. COMPENSATION POLICY IMPLEMENTATION

Slide 4

* **NOTE** * : As can be seen from the preceding discussion, there remain numerous questions regarding the use of compensation as a management tool. For this reason Virginia has basically taken a "go slow" approach in its mitigation-compensation policy. An applicant must meet an initial set of criteria before being allowed to destroy and compensate wetlands. When compensation is allowed, the supplemental guidelines must be followed.

A. Specific criteria.

These lists are only partial. Other options should be added.

1. The proposal must eliminate or minimize all possible wetlands losses.

   a. Look at alternative sites.

   b. Reduce the size of the project.

   c. Redesign to avoid wetland encroachment.

2. The proposal must be water dependent in nature.

   a. Marina.

   b. Boat ramp.

   c. Shipyard.

   d. Port facilities.

3. Proposal must be in wetlands by necessity and have overwhelming public and private benefits.

B. Supplemental guidelines.

Slide 5

1. 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.

2. 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.

3. 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.

4. 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.

Slide 6

5. 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.

6. 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.

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

8. 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.

Slide 7

9. 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.

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

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

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

13. 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.

Slide 8

14. 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.

15. 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.

16. 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 62.1-13.17 of the Code of Virginia.

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

References

Barnard, Thomas A., Jr. 1990. Compensatory Mitigation Within the Tidal Wetlands of Virginia. Wetlands Program, Virginia Institute of Marine Science, College of William and Mary. Technical Report 90-7.

Kusler, John A. and Mary E. Kentula, eds. 1990. *Wetland Creation and Restoration: the Status of the Science*. Island Press. Washington, D.C. 591 pp.

Virginia Marine Resources Commission. 1989. Wetlands Mitigation-Compensation Policy. Newport News, Virginia.

Slide List

1. Definitions
2. Technical questions
3. Policy questions
4. Specific compensation criteria
5. Supplemental compensation guidelines (1-4)
6. Supplemental compensation guidelines (5-8)
7. Supplemental compensation guidelines (9-13)
8. Supplemental compensation guidelines (14-17)

Wetland Mitigation, Compensation Handout

Glossary

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

Mitigation . . . . 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.

Suggested Reading List

Barnard, Thomas A., Jr. 1990. Compensatory Mitigation Within the Tidal Wetlands of Virginia. Wetlands Program, Virginia Institute of Marine Science, College of William and Mary. Technical Report 90-7.

Kusler, John A. and Mary E. Kentula, eds. 1990. *Wetland Creation and Restoration: the Status of the Science*. Island Press. Washington, D.C. 591 pp.

Virginia Marine Resources Commission. 1989. Wetlands Mitigation-Compensation Policy. Newport News, Virginia.

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Marinas and Marine Environmental Considerations

Kirk J. Havens

Notes

Length of Presentation: 1 hr. 20 min.

Objectives

The purpose of this unit is to outline the marine environmental concerns involving marina construction and operation.

Upon completion, students should be able to:

- Define the following terms: direct and indirect impacts, dissolved oxygen, fecal coliforms, modelling, flushing time, petroleum products, dry storage, biochemical oxygen demand, pump-out facility, wake-induced erosion, zonation mooring, and Best Management Practices.

- Contrast:

1. Dry storage vs wet storage
2. Direct impacts vs indirect impacts
3. Flushing model vs dissolved oxygen model

- Discuss and design:

1. A zonation mooring area
2. A spill contingency plan
3. Stormwater Best Management Practices for a marina
4. A marina pollution management plan
5. A marina patron education plan

Students should have a strong working knowledge of the Commonwealth's *Criteria for the Siting of Marinas or Community Facilities for Boat Mooring.*

Materials

1. 35 mm projector
2. Movie screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Review reference material (Criteria for the Siting of Marinas or Community Facilities for Boat Mooring)
4. Practice with equipment: slide projector

Procedure

1. Introduce self and other instructors
2. Announcements (field work, etc...)
3. Explain general comments on lesson, eg. limitations - this a general introduction concerning marine environmental review of marina applications
4. Distribute handouts

Lecture Notes

I. INTRODUCTION

Marina development and protection of the marine environment are not mutually exclusive activities. Marina development can generally be divided into two categories in regard to marine environmental impacts: direct and indirect impacts.

Slides 1-8

II. DIRECT IMPACTS

A. Shoreline Defense Structures.

1. Bulkheads- Only for erosion control and as landward as possible.

2. Riprap- Preferable over bulkheads but as landward as possible.

3. Breakwaters- Most preferable if conditions warrant.

Slides 9-14

B. Upland Support Facilities.

1. **Dry Storage**- preferable to wet slips, less incidental pollution.

2. Travel lifts- open pile piers, ability to move to work yard.

3. Boat work yard- gravel yard with cement **washdown pad** and **settling tank**.

Slides 15-23

Explain difference between hydraulic and clamshell. Discuss zonation mooring.

C. Dredging and Piers.

1. Depths- buffer from wetlands, minimum depths needed, connect to ambient depths, type of sediment (clay, sand), type of dredge - **hydraulic** or **clamshell**. Utilization of **zonation mooring**.

2. Spoils disposal area away from wetlands, sized properly.

3. Pier shading- crossing over wetlands minimized, height of pier a minimum of one foot less than pier width above vegetation.

III. INDIRECT IMPACTS

A. Shoreline Erosion.

Slides 24-27

1. **Wake-induced erosion**- can be significant along shorelines with exposed points of land in narrow creeks or coves and steep banks with easily-erodable material.

2. **Reflective wave energy**- bulkheads tend to reflect wave energy to unprotected adjacent areas and may cause increased erosion. The further landward the bulkhead is located the less it is exposed to wave energy. Riprap dissipates wave energy and is preferable over bulkheads.

B. Pollution

Slides 28-31

1. **Petroleum products**- incidental pollution from automobile oil runoff, outboard motor lubricants and exhaust gases, incidental fuel spills, bilge drainings, etc. can be expected in the normal operation of a marina. Petroleum products can increase **biochemical oxygen demand (BOD)** and decrease the amount of dissolved oxygen in the water column. Petroleum products can have lethal impact on marine larvae at concentrations as low as 0.1 mg/liter and sublethal effects, such as disruption of physiological processes of feeding and reproduction, at concentrations of 10 to 100 μg/liter. All marinas that deal with petroleum products should have a **spill contingency plan**.

Slides 32-45

2. **Plastics**- Litter in the form of **uncompacted garbage** can be expected. During the peak boating season, approximately two and one-half to five cubic yards (one-third to one-half of a dump truck load) can be expected per day per 400 boats. Plastics have been found in the stomachs of sea birds, marine mammals, marine turtles, and fish, and can cause intestinal blockage, stomach and intestinal ulcerations, inhibit feeding, damage anatomical structures and contribute synthetic chemicals to body tissues. Marinas should have numerous, easily accessible trash containers located throughout the facility.

3. Organic matter- food, excess cooking waste, fish entrails, etc. can increase the biochemical oxygen demand in surrounding waters and decrease the amount of **dissolved oxygen** available to marine life. This is especially important in areas of reduced flushing.

Slide 46

4. Recycling stations- Bins for recycling aluminum, plastics, glass, and paper should be supplied. A tank for recycling oil should be located on a bermed concrete pad.

C. Sewage.

Slides 47-48

1. **Human health risk**- Pollution of waters by fecal matter from warm-blooded animals is a means whereby disease can spread. Oysters and clams pump large volumes of water, filter out suspended matter and accumulate substances to levels far in excess of that found in the water. Known pathogens associated with feces-contaminated shellfish include typhoid fever, infectious hepatitis, dysentery, and gastroenteritis. Recreational activities such as swimming require clean water to protect participants from sickness.

Slide 49

2. **Nutrient loading**- Sewage that enters the marina water, either directly from boats or from improperly functioning or poorly located septic systems, causes an increase in the nutrient supply of adjacent waters as well as an increase in the biochemical oxygen demand.

Slide 50

3. **Pumpout facilities** and portable toilet dump stations- These facilities can help reduce the amount of fecal matter entering the water. Such facilities should be clearly identified, cleanly maintained and easily accessible.

D. Stormwater Runoff.

Slides 51-52

1. Potential Impacts- Stormwater runoff can impact water quality by washing pollutants, such as sediment, nutrients, petroleum hydrocarbons, metals, and bacteria, into the marina waters. Excessive amounts of **suspended solids** can adversely impact marine organisms by direct stress on adults and juveniles, hindering successful development of eggs and larvae, and reducing food abundance. Addition of nutrients and petroleum products can increase biochemical oxygen demand, decrease dissolved oxygen levels, and have toxic effects on marine organisms.

Slides 53-56

2. Preventative Measures- Stormwater concerns can be addressed by incorporating **Best Management Practices** (BMP), such as vegetative buffers, grass filter strips, gravel parking areas, grassed swales, and retention basins in series.

IV. DISSOLVED OXYGEN

Slide 57

A. Description - Bacteria, phytoplankton, zooplankton, and larger marine organisms in general require oxygen to live. **Phytoplankton** produce oxygen as a by-product of **photosynthesis**, but also consume oxygen in respiration. During daylight periods, oxygen production usually exceeds oxygen consumption and the excess oxygen raises the amount of oxygen dissolved in the water. During night periods photosynthesis ceases and there is no oxygen production, but there is continued respiration of oxygen by the phytoplankton and other marine organisms. Consequently, oxygen concentrations are reduced during nighttime. When sunlight is again available at dawn, the phytoplankton begin producing oxygen and dissolved oxygen levels rise dramatically. This is, in part, due to the increase in the phytoplankton population that can occur during nighttime when the majority of phytoplankton reproduction occurs and the oxygen-starved condition of the cells. During the daylight hours the phytoplankton population is reduced by grazing and the cycle repeats itself. Accordingly, the lowest dissolved oxygen levels occur just before dawn.

Slide 58

B. Importance - Low dissolved oxygen levels can lead to stress and mortality of marine organisms. Dissolved oxygen levels below 3.0 mg/l have been shown to exert significant negative effects on growth and production rates of estuarine fishes. Dissolved oxygen levels below 3.5 mg/l have been shown to increase mortality in aquatic insects. Fish embryonic and larval stages are especially vulnerable to reduced oxygen concentrations because their ability to extract oxygen from the water is not fully developed, and they cannot move away from adverse conditions. It is believed that a dissolved oxygen level of around 5.0 mg/l is sufficient to support a well-rounded population of fish.

Slide 59

C. Marina Impacts - Inadequate flushing of the marina, excessive depths, and pollutant and nutrient loading of the marina proper can increase the biochemical oxygen demand and decrease the dissolved oxygen levels.

V. FLUSHING

A. Environmental Concerns - **Flushing** and circulation are important physical characteristics that determine the dispersion and transport of pollutants. Pollutants that are not flushed will accumulate in the bottom sediments and increase the demand on the available dissolved oxygen and increase toxic levels of marina bottom sediments.

1. Pollutant accumulation- **Runoff** from marinas may introduce pollutants that can degrade the quality of adjacent waters. Without proper design, pollutants such as sediments, pesticides, herbicides, oil and road dirt, heavy metals, and nutrients, may be washed from a marina into the

water. Not only may these substances be toxic to marine life at certain concentrations, but they may have **sublethal** effects. These sublethal effects may include reducing the ability of some marine organisms to survive predation or competition, reducing the ability to reproduce, giving some organisms competitive advantages over other organisms, or causing anatomical anomalies.

2. Fecal coliforms- **Coliform bacteria** are commonly used as an index of fecal contamination because they are easily identified and counted. These bacteria are always present in the human intestinal tract and, generally, an increase in fecal coliform counts may indicate an increase in pathogen density. The measure of bacterial contamination is a statistical value called the Most Probable Number (MPN) for the number of organisms in a given volume of water.

VI. MODELS

Slides 60-61

A. General concept - In everyday usage, the term **"model"** refers to a simple representation of something real. A model car, for example, may have the general shape of a car but it is not exactly like the real thing. It may not have doors that open, windows that roll down, or a motor that runs. Models of nature should be considered in the same light. Models are used to try to make complex situations simpler. The key point in model making involves the **assumptions** that are used. Suppose you want to predict the amount of litter that will accumulate every year along a certain section of roadway. You could just guess, of course, but you would be more credible if you had a rationale for your prediction. Maybe you could look up how many cars travel the roadway per year. Then you could conduct a survey of people to determine what percentage of the population would litter and how much litter comes from each car. Suppose you find that 10,000 cars travel the roadway per month and your survey tells you that 10% will litter. You also assume 1/2 lb of litter per car. You can now make a prediction using this assumed information. There are a couple of ways you can talk about this model. You could just say "Ten thousand cars travel the roadway each month. Ten percent or one thousand cars will litter one-half pounds each. This will result in five hundred pounds of litter each month or six thousand pounds of litter each year." Or you could put it in an equation:

Slide 62

Slide 63

Annual litter amount = 0.10 x 10,000 x 12 x 0.5

Or you could state the model in terms of a series of commands to a computer.

Slide 64	1) Take 10% of 10,000 2) Multiply by 0.5 3) Multiply by 12 4) The result (6,000) is the amount of litter generated per year in pounds along the stretch of roadway. It is important to keep in mind that no matter how you state your annual litter amount model, whether in plain English, mathematically, or through a computer, it is the same model. **The important message here is - translating a bad model into computer commands does not make it good.** Additionally, models may not take into account all the factors at work. Maybe the people that travel this area are more environmentally minded and will litter less than those surveyed. Maybe the people who do litter will not litter everytime or will litter along a different area. Possibly there is a gas station at the intersection of this roadway and some people may clean litter out of their cars before travelling this stretch. The point is that models will not be able to address all the factors at play. Also, the assumptions used in the initial formulation of the model must have some validity. The take home message here is that **when confronted with a model prediction, make sure the assumptions used are stated up front and have a basis in fact**. In other words, make sure they used the right kind of glue when putting the model together.
Slide 65	B. Fecal Coliforms - Models have been developed to predict the fecal coliform Most Probable Number (MPN) for certain conditions. These models take into account the number of boat slips, the average number of persons per boat, the expected occupancy rate, the amount of fecal coliforms produced per person over time, fecal coliform decay rate, and the percentage of **marine sanitary device (MSD)** failure. The percentage of MSD failure is a driving force in predicting fecal coliform concentrations. Simply put, percent MSD failure is the expected number of boat holding tanks that are pumped directly into the marina waters. This percentage is derived from survey estimates and educated guesses and can vary considerably. It is directly related to the care and concern of the users of the facility. The number used will determine the extent of fecal coliform dispersal into the adjacent waters. A reasonable MSD failure rate is probably between 25% and 50%. However, what is generally not taken into account is the natural load of fecal coliforms at the specific site and the nonpoint source input from surrounding fields or inadequate septic tanks.
Slide 66	C. Dissolved Oxygen - Models have been developed to predict the levels of dissolved oxygen that can be expected given certain conditions in different water bodies. These models attempt to take into account the biochemical oxygen demand (BOD) loading rate that can be expected for the area in question, the flushing time, the oxygen demand from the bottom sediments, and the reaeration rate. BOD is a measure of the amount of oxygen which will be consumed

as water constituents are oxidized by a variety of biological and chemical reactions. As stated earlier in the section concerning the expected amount of fecal coliforms, this loading rate is largely dependent upon the expected marine sanitary device failure. Simply stated, the amount of oxygen consumed in the basin is a function of the amount of organic material (fecal matter, hydrocarbons, plant detritus, etc.) that enters the area and the temperature. A properly designed marina management plan and stormwater management plan can have significant effects in BOD loading into the marina basin.

VII. MARINA OPERATION PLAN

Slide 67

A. Marina Management Plan- A **marina management plan** is an important part of a marina operation. A management plan should include education of marina users and staff, an oil spill contingency plan, professional janitorial services, secured and conveniently located trash receptacles, and recycling centers.

Slide 68

B. Patron Education- An important aspect of marina management is the education of the marina users. Pollution of the marina's waters is directly related to the care and concern of the marina users. Education of the marina patrons to certain little things that can be done to reduce the user's impact on the ecosystem should be a high priority.

1. Signs locating recycle centers, trash receptacles.
2. Brochures on preventative measures concerning pollution.

Slides 69-71

VIII. VIRGINIA'S CRITERIA FOR THE SITING OF MARINAS OR COMMUNITY FACILITIES FOR BOAT MOORING

A. Review of the General Siting Criteria.

B. Review of Specific Siting Criteria.

References

DIRECT IMPACTS

Chumura, G. L. and N. W. Ross. 1978. The environmental impacts of marinas and their boats, a literature review with management considerations. University of Rhode Island Marine Memorandum 45, Narragansett, RI, 32 pp.

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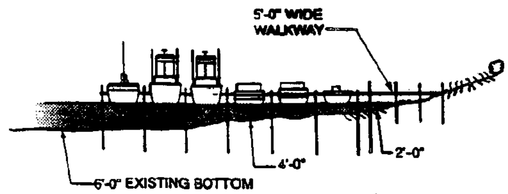
Slide List

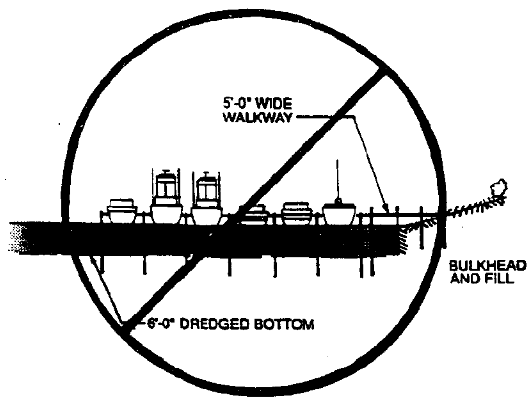
1. Marina overview
2. Text slide: direct and indirect impacts
3. Text slide: direct impacts
4. Text slide: shoreline defense structures
5. Mid-tide bulkhead protecting vegetated wetlands
6. Bulkhead landward of marsh fringe
7. Riprap landward of marsh fringe
8. Breakwaters
9. Text slide: direct impacts - upland support facilities
10. Dry storage facility
11. Travel lift
12. Gravel workyard
13. Washdown pad with grate
14. Cross-section of washdown apron and settling tank
15. Text slide: direct impacts - dredging and piers
16. Dredge buffer off wetlands
17. Cross-section of dredge cut connecting to ambient depths
18. Rosegill disposal blowout
19. Dredging: clamshell, hydraulic
20. Clamshell dredge
21. Hydraulic dredge
22. Zonation mooring, cross-section
23. Shading impacts of piers
24. Text slide: indirect impacts
25. Text slide: indirect impacts - shoreline erosion
26. Boat wake erosion
27. Reflective wave energy
28. Text slide: indirect impacts - pollution
29. Gas tank in boat
30. Fuel dispensers on concrete pad
31. Text slide: spill contingency plan
32. Cartoon
33. General debris
34. Offloading trash
35. Seal (monk)
36. Turtle (loggerhead)
37. Turtle stomach contents (2 lbs plastic)
38. Potato chip bag found in throat of turtle

39. Gull in six-pack ring
40. Fish in six-pack ring
41. Numerous trash containers
42. Secured, easily accessible trash containers
43. Trash receptacles
44. Fish/cleaning waste
45. Food/organic waste
46. Recycling center
47. Text slide: indirect impacts - sewage
48. Health risk sign
49. Exposed septic tank
50. Porta potty/pumpout sign
51. Text slide: indirect impacts - stormwater runoff
52. Pipe discharging into basin
53. Text slide: Best Management Practices
54. Gravel walkways
55. Vegetative buffer strips
56. Grassed swales
57. Photosynthesis slide
58. Fish kill
59. Artist drawing of poor marina basin
60. Model car
61. Real car next to model car
62. English statement
63. Equation
64. Computer commands
65. Schematic of fecal coliform inputs
66. Schematic of BOD components
67. Text of management plan
68. User education
69. Text of general siting criteria
70. Text of specific siting criteria
71. Closing slide

Marinas and Marine Environmental Considerations Handout



Zonation Mooring



BOX CUT DREDGING

Glossary

Best Management Practices (BMP) . . . . . . standardized methodologies used to minimize adverse impacts to the environment.

Biochemical Oxygen Demand (BOD) . . . . . . a measure of the demand on a water body's dissolved oxygen supply that will be generated, over a specific time period, by the biological decomposition of organic material. A high BOD may temporarily or permanently so deplete the oxygen in water that aquatic life is killed.

Clamshell or dragline dredging . . . . method of dredging that employs a crane and large metal bucket. Usually used in small scale sandy-sediment situations.

Coliform bacteria . . . . . bacteria found in fecal matter of warm-blooded animals.

Dry stack storage . . . . . the practice of storing boats on upland until needed by owner.

Flushing time . . . . the measure of time required to transport a conservative pollutant from some specific location.

Hydraulic dredging . . . . method of dredging that employs a centrifugal pump to move a slurry of water and material from the bottom through a system of pipes to the disposal site.

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Marine Sanitary Device (MSD) . . . . permanently installed onboard sanitation devices on boats having heads. Generally classified into three types. Types I and II discharge sewage after some level of treatment. Type III is a holding tank that prevents discharge.

Model . . . . a representation or abstraction of a real system; an attempt to present some of the important features of the real system in a simplified way to aid understanding.

Oil spill contingency plan a specific plan detailing a methodology for containing an oil spill near or in the marina.

Photosynthesis . . . . the process which occurs in the chloroplasts of green plants in which simple sugars are formed from carbon dioxide and water in the presence of light and chlorophyll.

Phytoplankton . . . . free floating aquatic plants.

Sediment Oxygen Demand (SOD) . . . . a measure of the amount of oxygen which will be consumed as bottom sediment constituents are oxidized by a variety of biological and chemical reactions.

Stormwater runoff . . . . . material washed during a rain event from upland facilities, spills and discharges from boats on the uplands. This material can include sediment, nutrients, petroleum hydrocarbons, metals, and bacteria.

Sublethal effects . . . . . . introduction of toxics or pollutants that cause a disruption of physiological processes such as feeding and reproduction or make an organism more susceptible to predation.

Suspended solids . . . . . . small particles of solid materials that resist separation by conventional means. Suspended solids level, along with BOD, is used as a measure of water quality.

Uncompacted garbage . . garbage such as plastics, paper, aluminum, styrofoam, food wastes, etc. blown, washed, or thrown into or near a waterway.

Wake-induced erosion . . . the wearing away of land due to water energy generated by motor boat wakes.

Zonation mooring . . . . . the practice of locating boats of shallow draft nearshore, and those boats requiring deeper drafts closer to the channel in naturally deeper water.

Suggested Reading List

U.S. Environmental Protection Agency. 1985. Coastal Marina Assessment Handbook. U.S. Environmental Protection Agency, Region IV, Atlanta, GA.

Virginia Marine Resources Commission (VMRC). 1982. Wetland Guidelines. Prepared by the Department of Wetlands Ecology, Virginia Institute of Marine Science, printed by VMRC, Newport News, VA. 57 pp.

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Virginia Marine Resources Commission (VMRC). 1990. Criteria for the Siting of Marinas or Community Facilities for Boat Mooring. VMRC, Newport News, VA. 8 pp.

Animal Adaptations to the Tidal Environment

Kirk J. Havens

Notes

Length of Presentation: 30 min.

Objectives

The purpose of this unit is to review some of the adaptations animals have evolved to cope with life in the intertidal zone.

Upon completion, students should be able to:

- Define the following terms: osmoregulator, osmoconformer, aerobic, anaerobic, facultative, desiccation, conduction, convection, euryhaline, stenohaline, pneumostome, glycoprotein, hyperosmotic, permeability, operculum, diffusion, air/water oxygen consumption ratio.

- Describe different adaptations and how they relate to elevation in the intertidal zone.

- Contrast:

1. Euryhaline & stenohaline
2. Osmoregulator & osmoconformer
3. Aerobic & anaerobic

- Describe the intertidal adaptative function of:

1. Pneumostome
2. Operculum
3. The gills of intertidal crabs
4. Shell gaping

Materials

1. 35 mm projector
2. Movie screen
3. Slides
4. Handouts

Instructor Preparation Tasks

1. Review lesson outline
2. Review visual aids
3. Review reference material (VIMS Technical Report 90-1)
4. Practice with equipment: slide projector

Procedure

1. Introduce self and other instructors
2. Announcements (field work, etc...)
3. Explain general comments on lesson, eg. limitations - this is a general introduction of adaptations of some of the more common intertidal animals to oxygen uptake, temperature fluctuations, salinity changes, and desiccation
4. Distribute handouts.

Lecture Notes

Slides 1-2

I. INTRODUCTION

Slide 3

Slide 4

The ability to survive in the harsh intertidal environment requires different physiologic characteristics. An intertidal animal experiences stress from a wide range of factors such as temperature fluctuations, salinity changes, desiccation, and oxygen availability.

Slides 5-6

II. TEMPERATURE

A. Heat

Slides 7-8

1. **Water retention** - In many intertidal animals such as snails and barnacles, water is retained for much of the intertidal period. Water held under the shell can significantly increase the time animals can maintain evaporative heat loss without incurring lethal concentrations of body fluids.

Slide 9

Explain conduction, silhouette area, and convection.

2. **Size and shape** - An increase in size of upper shore animals compared with those on the lower shore would reduce the relative surface area through which heat gain by radiation occurs, and would also minimize the rate of change of body temperature, since it takes longer for the tissues of a large animal to equilibrate with the surrounding environmental temperature during the low tide period. An increase in size and in shell sculpturing provides an effective means both of reduction of heat gain by radiation and increase of **heat loss by convection**. Strong shell

sculpturing represents an increased surface area through which heat can be transferred to the environment relative to the **silhouette area**. The silhouette area represents the surface area through which heat gain occurs. However, as body size increases, an increase in **heat gain by conduction** would result unless there is a change in other characteristics. In gastropods this change is in the size of the basal area. As the size of the animal increases, there is a relative reduction in the basal area which effectively reduces heat gain by conduction from the substrate. Some high shore snails have been observed hanging from vertical surfaces during the summer by means of a dried mucous sheet which is attached to the front lip of the shell. The only point of contact is the lip of the shell so that heat gain by conduction is effectively eliminated by this method of attachment.

Slide 10

3. Color - The possession of a light-colored shell increases heat loss by emission relative to absorption. It has been observed that upper shore animals are generally light in color while lower shore species are darker. A detailed study of the fiddler crab, *Uca pugilator,* revealed that the crab can blanch its carapace during the middle of the day. This shell blanching mechanism results in an increase in reflectance of solar heat of about 50% between unblanched and blanched crabs.

Slides 11-14

B. Cold

Slide 15

1. Intracellular ice formation - Intertidal invertebrates appear to be unusual in their tolerance of intracellular ice formation. Intertidal animals are more resistant to freezing than subtidal animals. It is has been shown that at -15 degrees C the percentage water frozen in some mussels, snails and oysters was 65%, 67%, and 56% respectively. Some snails and mussels could even survive for several days at -22 degrees C when the percentage water frozen in their tissues was as high as 76%.

Discuss desiccation effects of freezing.

Explain glycoproteins.

2. Anti-freeze molecules - Since high levels of water in the tissues of intertidal animals may be bound up as ice, the capacity to withstand freezing must involve not only the ability to accommodate the presence of ice within the tissues, but also to withstand severe dehydration of the body fluids. Studies have shown that animals inhibit ice formation by the synthesis of **glycoprotein** and protein anti-freeze molecules.

III. SALINITY

Slide 16

Explain osmotic pressure.

A. Osmoconformers and osmoregulators - The major mechanisms of adaptation by animals to salt involve control of the body's internal environment. The majority of simple marine animals are osmoconformers while the more complex marine animals tend to osmoregulate. Osmoconformers maintain their body fluid equal with sea water, so that a change in the concentration of sea water will result in a corresponding change in the body fluids. Osmoregulators maintain their body fluids **hyperosmotic** to (more salty than) sea water. This poses two physiological problems. Water flows inwards because of the higher salt concentration inside, while solutes flow outwards. Salts are replaced by active transport from the sea water, but this process requires an expensive expenditure of energy.

Slides 17-19

Slides 20-21

Slide 22

Define permeability.

B. Shell permeability - Transport of salts from sea water into the body requires a large amount of energy. To reduce this energy cost, the permeability of the shell or body wall is reduced and the concentration gradient between the blood and the sea water is lowered. For example, the cuticle of crabs generally follows a permeability of low to high from terrestrial to intertidal to subtidal conditions. The higher in the intertidal area the lower the shell permeability. This adaptation also reduces water loss during exposure to air and helps prevent desiccation.

C. Euryhaline and stenohaline - Animals that can withstand wide fluctuations in salinity are termed euryhaline (from the Greek word *eurys* - wide). Those animals that can tolerate only narrow salinity changes are considered stenohaline (from the Greek word *stenos* - narrow). Most intertidal animals are euryhaline, but they may be either osmoconformers or osmoregulators.

IV. DESICCATION

Slides 23-25

Slide 26

Point out opecular and pneumostome.

A. Structural adaptations - Desiccation is generally not a serious problem for mobile intertidal animals. However it may be a major problem for sessile animals living near the high tide line such as some barnacles and molluscs. Structural features allowing survival at the high tide line by barnacles include thick shells, large bodies, and the use of a small **pneumostome** through which air is drawn into the mantle cavity after the valves are closed. The pneumostome is a small, diamond-shaped opening between the **opercular valves**. In addition, water loss through the shell during exposure to air is reduced in amphibious and terrestrial crustaceans compared to aquatic species.

Slide 27

Slides 28-29

Slides 30-32

B. Behavorial adaptations - Some intertidal fish have fine grooves in their skin which hold moisture when exposed to air and allow the fish to survive up to several days out of water. Other fish burrow into the moist substrate until the subsequent inflow of the tidal water. Some bivalves, such as oysters and mussels, close their shells tightly during low tide or partially close their shell in a behavior known as **shell gaping**. Shell gaping is considered a behavioral adaptation which permits aerial respiration and colonization of the intertidal zone. Fiddler crabs retreat to their burrows as the tide rises and plug the burrow entrance with mud. During extended periods of low tides which tend to dry out tidal flats, the crabs will open the burrows, but remain at the bottom of the burrow in the moist soil. An interesting side note concerning fiddler crabs is that their activity at low tide is not related to the presence or absence of water, but rather to the lunar phase. If fiddler crabs are taken inland far from water they still become active when low tide would occur at their new location. A general relationship concerning desiccation and shore position is that desiccation rates are always found to be lower in invertebrates living at the water-air interface than in related fully aquatic animals. For intertidal animals such as molluscs, barnacles, crabs, and so on, the rate of water loss to the air correlates closely with the vertical distribution on the shore. Animals found in the higher or more landward position are exposed to a longer duration of air exposure at low tide. These animals have adapted to this environment by decreasing their rate of water loss.

V. OXYGEN

Slide 33

Slide 34

Discuss aerobic and anaerobic.

Define facultative.

A. Respiration - It is generally believed that intertidal animals have two major respiratory options when exposed to air at low tide; either to isolate themselves completely from the atmosphere and rely on anaerobic pathways for energy production, or to maintain gas exchange in air to support aerobic metabolism. However, most intertidal invertebrates probably behave as facultative anaerobes, simultaneously using various anaerobic pathways as well as aerobic metabolism, when exposed to air. Oxygen and carbon dioxide have very different properties in air and in water. Air contains 20 to 40 times more oxygen per unit volume than water. Conversely, carbon dioxide is much higher than oxygen in water. In addition, gas diffusion is higher for oxygen and carbon dioxide in air compared to water, thus making oxygen more readily available in air. As a result, flow across an animal's respiratory surface, such as a gill, must be higher in water than in air.

Slide 35

1. Physiological adaptations - When high shore barnacles are exposed to air, water is expelled from the mantle cavity. The periodic opening and closing of the pneumostome allow gas to enter, mainly by diffusion. This adaptation, which is not found in low shore or subtidal barnacles, is carefully regulated to ensure aerial respiration while avoiding excessive water loss.

Explain air / water oxygen consumption ratio.

Slide 36

Dual breathing is a common method for respiring in crabs when living in the intertidal area. Many intertidal crabs use their gills for respiration when exposed to air. When exposed, most of the water is drained away from the gill chamber, which is then ventilated in air. Some species, however, are able to retain gill water that is recirculated externally over the carapace for the purposes of aeration and for evaporative cooling. Some intertidal crabs such as the shore crab, *Carcinus maenas*, increase their heart rate when exposed to air, which compensates for decreased arterial oxygen content and allows for maintenance of a completely aerobic metabolism. Conversely, in some subtidal species, heart rate is considerably decreased in air, which correlates with a **low air/water oxygen consumption ratio** and a partial reliance upon anaerobic metabolism, which leads to lactate accumulation. A convenient way to evaluate the ability of intertidal invertebrates to breathe air is to measure the air/water oxygen consumption ratio. Generally, the higher the shore elevation where the animal thrives, the greater its reliance upon air breathing.

Slide 37

2. Behavorial adaptations - Periodic exposure to air on a predictable time basis is the rule for true intertidal animals. Most intertidal animals are basically designed for water breathing and can withstand only short term air exposure. Some animals isolate themselves from air as completely as possible by burrowing into the bottom or closing their shell. Others are able to use the aerial environment for respiratory gas exchange, but must suffer some degree of desiccation, such as shell gaping in bivalves. Finally, some seek residual water to avoid permanent air exposure, but can spontaneously leave when the oxygen in the water is used up. As stated earlier, some crabs are air breathers and use their gills or gill cavity lining for gas exchange. But many also require periodic visits to water to rehydrate or replenish their water stores in the gill cavity or shell.

Slide 38

Slide 39

Slide 40

Slide 41

VI. CONCLUDING REMARKS

Slide 42

It is necessary to point out the role food resources play in the distribution of animals in the intertidal area. Wolcott (1973) made an important general hypothesis which states that where the distribution of a species borders on an unexploited or under-exploited food resource, selection may favor an extension in range of the species to the limits of its tolerance of temperature, desiccation and salinity extremes. Reproductive gain due to opportunistic range extension must then be assumed to offset the increased chances of death. Thus, species that have juveniles that are initially established low on the shore and migrate upwards tend to exploit the food resources at high tide levels. There is a good correspondence between potentially lethal conditions and the tolerance of the individuals. Such species tend to have generalized food requirements, and the increased chances of mortality in the stressful habitat are offset by rapid growth, maturation, and a large reproductive capability.

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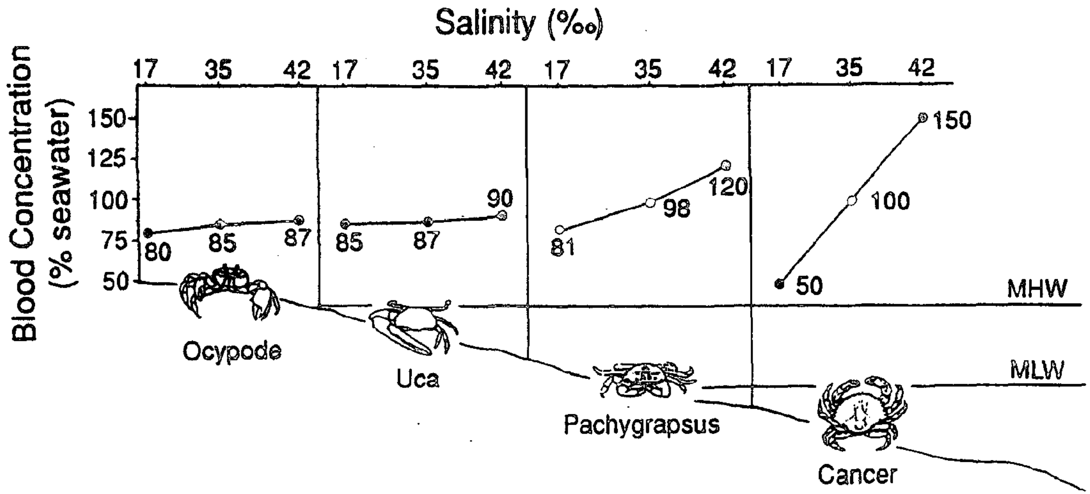
Slide List

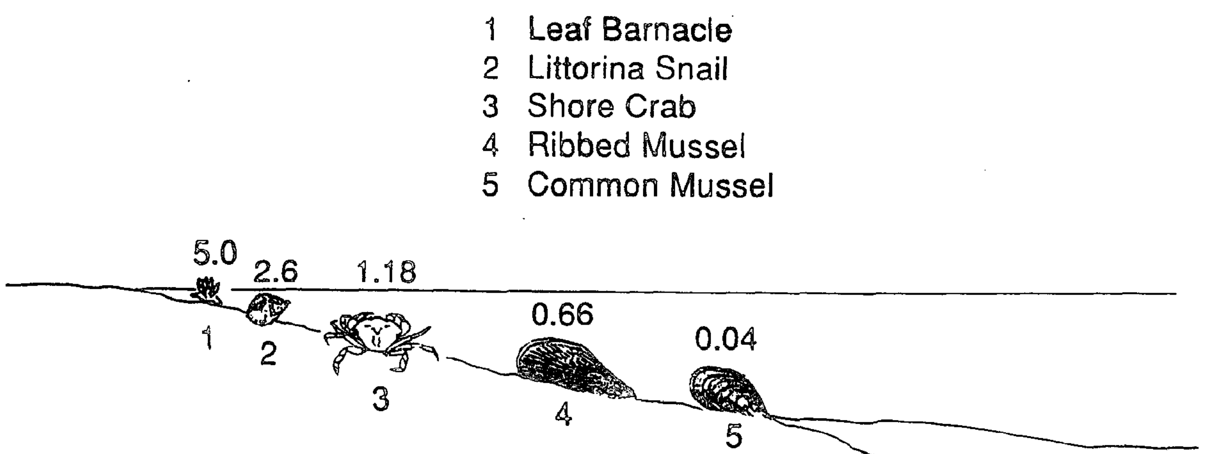
1. Oyster shell/marsh intertidal area
2. Split screen slide of intertidal area - submergence and emergence stress
3. Text slide - temperature, salinity, desiccation, oxygen
4. Text slide - temperature - extreme heat, freezing cold
5. Text slide - temperature - extreme heat
6. Hot, summer intertidal area - heat stress
7. Barnacles - water retention
8. Mud snails - water retention - minimize heat stress
9. Graph - shell sculpturing in relation to elevation
10. Lethal temperatures relative to shore elevation of certain intertidal species
11. Fiddler crabs - shell blanching
12. Text slide - temperature - freezing cold
13. Ice and snow in the intertidal area - cold stress
14. Ice in marsh
15. Ice on shore
16. Oysters - resistance to freezing
17. Text slide - salinity - osmoregulation and osmoconformers
18. Graph - salinity - blood/seawater concentrations
19. Text slide - salinity - osmoconformers
20. Blue crab feeding on fiddler crab - blue crab (osmoconformer)
21. Text slide - salinity - osmoregulators
22. Ghost crab - osmoregulation
23. Blue crab - shell permeability
24. Text slide - desiccation - structural and behavioral adaptations
25. Split screen slide
26. Text slide - desiccation - structural adaptations
27. Barnacle anatomy - opercular valves and pneumostome
28. Text slide - desiccation - behavioral adaptations
29. Minnow in mud - grooves to retain water
30. Shell gaping
31. Fiddler crab plugging burrow
32. Fiddler crab plugging burrow
33. Numerous fiddler crabs feeding at low tide
34. Text slide - oxygen - physiological and behavioral adaptations
35. Text slide - oxygen - aerobic and anaerobic
36. Text slide - oxygen - physiological adaptations
37. Graph - air/water consumption ratio
38. Text slide - oxygen - behavioral adaptations

39. Burrowing clam/worm slide
40. Shell gaping in the Pen Shell bivalve
41. Ghost crab and ghost crab burrows - needs to moisten gills periodically
42. Dead fiddler crab with four *Spartina alterniflora* seeds

Animal Adaptations to the Tidal Environment Handout



Comparison of osmoregulation between different crab species along a shoreline gradient



Oxygen Consumption
Air/Water Ratio

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Glossary

Aerobic . . . . Pertaining to conditions requiring free oxygen.
Anaerobic . . . . . Capable of growing in absence of oxygen.
Conduction . . . . The movement of heat, sound waves, or nerve impulses through cells or tissues without bulk motion of the matter.
Convection . . . . The diffusion of heat through a liquid or gas by motion of its parts.
Desiccation . . . . The act of drying thoroughly; exhausting or depriving of moisture.
Diffusion . . . . . . The process by which substances in a solution tend to become uniformly distributed.
Euryhaline . . . . . Capable of withstanding wide variations in osmotic pressure or salinity.
Facultative . . . . Not limited to a specific condition; having the ability to live under varying conditions.
Glycoprotein . . . A protein/carbohydrate mixed substance that retards freezing.
Hyperosmotic . . . Maintaining a condition where an organism's body fluids are of greater osmotic pressure than the surrounding water.
Operculum . . . . . Flaps or plates which close the opening in barnacles.
Osmoconformer . . An organism which is able to change its body fluid osmotically to adjust to the osmotic pressure of the water in which it lives.
Osmoregulator . . An organism which maintains a constant osmotic concentration in its body fluid regardless of the medium in which it lives.
Permeability . . . Factors associated with the transfer of substances across a membrane.
Pneumosome . . . The external opening of the respiratory chamber in some molluscs and crustaceans.
Stenohaline . . . . Capable of withstanding only slight variations in salinity.

Suggested Reading List

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Affiliation: ______________________________

Date of seminar: ______________________________

Location of seminar: ______________________________

	highest			lowest
Presenter(s) was (were) well prepared.	4	3	2	1
Information was relevant.	4	3	2	1
Information was sufficiently detailed.	4	3	2	1
Visual aids provided helpful information.	4	3	2	1
Handouts provided helpful information.	4	3	2	1

Which section did you find most informative? ______________________________

____

What topics would you like to see covered in the future? ______________________________

____

The seminar could have been improved in the following ways: ______________________________

____

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	highest			lowest
Presenter(s) was (were) well prepared.	4	3	2	1
Field sites were appropriate.	4	3	2	1
Field visits were educational.	4	3	2	1

Strengths of field visit were: ______________________________

____

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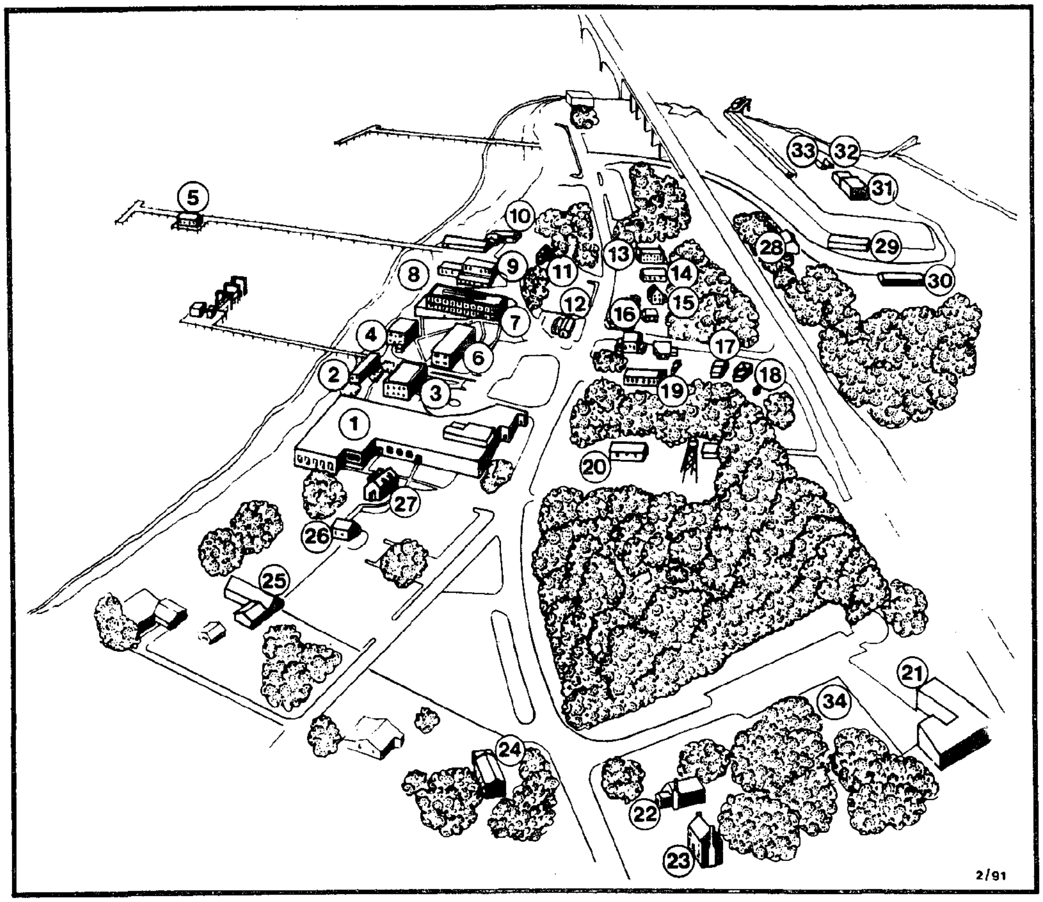

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