Lynnhaven River
Virginia Beach, Virginia
Shoreline Inventory Report

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Lynnhaven River - Shoreline Inventory Report

Prepared by the Virginia Institute of Marine Science, Center for Coastal Resources Management, Comprehensive Coastal Inventory Program

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Chapter 1. Introduction

1.1 Background

The Center for Coastal Resources Management (CCRM) has developed and implemented a technique for surveying and mapping conditions along tidal shoreline in Virginia. This protocol has been applied to tidal shoreline in numerous counties in Virginia, and all coastal localities in the state of Maryland. CCRM hopes to complete Virginia's Shoreline Inventory by the year 2010. For an update on the status of the Virginia Shoreline Inventory please visit: http://www.ccrm.vims.edu/shoreline_situation_rpts.html

The Shoreline Inventory Reports, also referred to as Shoreline Situation Reports, are a desktop reference for nearly all shoreline managers, regulators, and planners. They provide useful information pertaining to the stability, character, and degree of anthropogenic alterations that exists at any location on the shoreline. The product(s) integrate a combination of Geographic Information Systems (GIS), Global Positioning System (GPS) and remote sensing technology. Reports and maps are electronically distributed through the internet and are formatted to accommodate a wide variety of users including the GIS community.

The digital GIS coverages, along with all reports, tables, and maps are available on the web at http://ccrm.vims.edu/shoreline_situation_rpts.html by clicking on Lynnhaven River Watershed from the list of available inventories for Virginia.

1.2 Description of the Watershed

The Lynnhaven River Watershed encompasses 64 square miles within the City of Virginia Beach. There is approximately 169 miles of shoreline with an additional 86 miles covering the Broad Bay watershed. The watershed is highly developed with more than 200,000 people estimated to live within the watershed boundary (2006 State of the River Report). Most of the development is residential.

The Lynnhaven River discharges directly into the Chesapeake Bay. Pollution within the watershed is largely from upland runoff during rain events. The majority of the river is closed to shell fishing, and water clarity restricts the growth of SAV. Considerable measures have been made to enhance the Lynnhaven River system. On the upland these include designation of lands for preservation of open space, and sewered systems. In the river, a large oyster reef restoration effort is now underway which has engaged scientists, NGOs and citizens.

1.3 Purpose and Goals

This shoreline inventory is developed as a tool for assessing conditions along the tidal shoreline of the Lynnhaven River. Field data were collected between September, 2006 and June, 2007. Conditions are reported for three zones within the immediate riparian river area: riparian land use, bank and buffers, and the shoreline. A series of maps and tabular data are published to illustrate and quantify results of an extensive shoreline survey. The eastern and western branches of the Lynnhaven were surveyed inclusive of all small tributaries that could be reached by boat. The Broad Bay area was not surveyed as part of this study.

1.4 Report Organization

This report is divided into several sections. Chapter 2 describes methods used to develop this inventory, along with conditions and attributes considered in the survey. Chapter 3 identifies potential applications for the data, with a focus on current management issues. All products are located online. Chapter 4 provides information to aide users with the website interface.

1.5 Acknowledgments

The Lynnhaven River Shoreline Inventory was funded by the United States Army Corps of Engineers through contract number W91236-06-C-0065. The work was completed entirely with staff support and management from the Virginia Institute of Marine Science's Comprehensive Coastal Inventory Program. A host of individuals are acknowledged. In addition to those listed as preparers, the project directors would like to thank the VIMS Vessel Center for their support.

Chapter 2. The Shoreline Assessment: Approach and Considerations

2.1 Introduction

The Comprehensive Coastal Inventory Program (CCI) has developed a set of protocols for describing shoreline conditions along Virginia's tidal shoreline. The assessment approach uses state of the art Global Positioning Systems (GPS), and Geographic Information Systems (GIS) to collect, analyze, and display shoreline conditions. These protocols and techniques have been developed over several years, incorporating suggestions and data needs conveyed by state agency and local government professionals (Berman and Hershner, 1999).

Three separate activities embody the development of a Shoreline Inventory: data collection, data processing and analysis, and map generation. Data collection follows a three tiered shoreline assessment approach described below.

2.2 Three Tiered Shoreline Assessment

The data inventory developed for the Lynnhaven River Shoreline Inventory is based on a three-tiered shoreline assessment. This assessment characterizes conditions in the shore zone, which extends from a narrow portion of the riparian zone seaward to the shoreline. This assessment approach was developed to use observations that could be made from a moving boat. To that end, the survey is a collection of descriptive measurements that characterize conditions. GPS units log location of conditions observed from a boat. No other field measurements are performed.

The three tiered shoreline assessment divides the shore zone into three regions: 1) the immediate riparian zone, evaluated for land use; 2) the bank, evaluated for height, stability, cover, and natural buffers; and 3) the shoreline, describing the presence of shoreline structures for shore protection and recreational purposes. Each tier is described in detail below.

2.2a) Riparian Land Use: Land use adjacent to the bank is classified into one of ten categories (Table 1). The categories provide a simple assessment of land use, and give rise to land management practices that can be anticipated. GPS is used to measure the linear extent along shore where the practice is observed. The width of this zone is not measured. Riparian forest buffers are considered the primary land use if the buffer width equals or exceeds 30 feet. This width is calculated from digital imagery as part of the quality control in data processing.

Table 1. Tier One - Riparian Land Use Classes

Forest	stands greater than 18 feet high / width greater than 30 feet
Scrub-shrub	stands less than 18 feet high*
Grass	includes grass fields, and pasture land*
Agriculture	includes cropland*
Residential	includes single or multi family dwellings*
Commercial	includes small and moderate business operations, recreational facilities*
Industrial	includes large industry and manufacturing operations*
Bare	lot cleared to bare soil*
Timbered	clear-cuts*
Paved	areas where roads or parking areas are adjacent to the shore*
Unknown	land use undetectable from the vessel*

* forest fringe along the shore is present in conjunction with the dominant land use

2.2b) Bank Condition: The bank extends off the fast land, and serves as an interface between the upland and the shore. It is a source of sediment and nutrient fluxes from the fast land, and bears many of the upland soil characteristics that determine water quality in receiving waters. Bank stability is important for several reasons. The bank protects the upland from wave energy during storm activity. The faster the bank erodes, the sooner the upland will be at risk. Bank erosion can contribute high sediment loads to the receiving waters. Stability of the bank depends on several factors: height, slope, sediment composition and characteristics, vegetative cover, and the presence of buffers to absorb energy impact to the bank itself.

The bank assessment in this inventory addresses four major bank characteristics: bank height, bank cover, bank stability, and the presence of natural (beach, marsh) buffers at the bank toe (Table 2). Conditions are recorded continuously using GPS as the boat moves along the shoreline. The GPS log reflects any changes in conditions observed.

Bank height is described as a range, measured from the toe of the bank to the top. Bank cover is an assessment of the percent of either vegetative or structural cover in place on the bank face. Natural vegetation, as well as structural cover like riprap is considered “cover”. The assessment is qualitative (Table 2). Bank stability characterizes the condition of the bank face. Banks that have exposed root systems, down vegetation, or exhibit slumping of material qualify as“high erosion”. Banks that are otherwise stable but suffer erosion at the base may be classified as “undercut”. At the toe of the bank, natural marsh vegetation and/or beach material may be present. These features offer protection to the bank and enhance water quality. Their presence is

Table 2. Tier 2 - Bank Conditions

Bank Attribute	**Range**	**Description**
bank height	0-5 ft	from the toe to the edge of the fast land
	5-10 ft	from the toe to the edge of the fast land
	10-30ft	from the toe to the edge of the fast land
	> 30 ft	from the toe to the edge of the fast land
bank stability	low erosion	minimal erosion on bank face
	high erosion	includes slumping, scarps, exposed roots
	undercut	erosion at the base of the bank
bank cover	bare	<25% cover; vegetation or structural cover
	partial	25-75% cover; vegetation or structural
	total	>75% cover; vegetation or structural
marsh buffer	no	no marsh vegetation along the bank toe
	yes	fringe, extensive, or embayed
beach buffer	no	no sand beach present
	yes	sand beach present
Phragmites australis	no	no Phragmites australis present on site
	yes	Phragmites australis present on site

noted in the field.

Sediment composition and bank slope cannot be surveyed from a boat, and are not included.

2.2c) Shoreline Features: Structures added to the shoreline by property owners are recorded as a combination of points or lines. These features include defense structures, constructed to protect the shoreline from erosion; offense structures, designed to accumulate sand in transport; and recreational structures, built to enhance public or private use of the water (Table 3). The location of these features along the shore is surveyed with a GPS unit. Linear features are surveyed kinematically without stopping the boat. Structures such as docks, and boat ramps are point features, and a static six-second GPS observation is collected at the site. Table 3 summarizes shoreline features surveyed. Linear features are denoted with an “L” and point features are denoted with a “P.” The glossary describes these features, and their purpose along a shore.

Table 3. Tier 3 - Shoreline Features

Feature	Feature Type	Comments
Control Structures		
riprap	L	
bulkhead	L	
breakwaters	L	first and last of a series is surveyed
groinfield	L	first and last of a series is surveyed
jetty	P	generally to keep sand out of areas (inlets)
debris	L	can include tires, rubble, tubes, etc.
unconventional	L	composed on non-traditional materials
marsh toe revetment	L	placed in front of an eroding marsh
Recreational Structures		
pier/wharf	P	includes private and public
boat ramp	P	distinguishes private vs. public landings
boat house	P	all covered structures, assumes a pier
marina	L	includes piers, bulkheads, wharfs

2.3 Data Collection/Survey Techniques

Data collection is performed in the field from a small, shoal draft vessel, navigating at slow speeds parallel to the shoreline. To the extent possible, surveys take place on a rising tide, allowing the boat to be as close to shore as possible. The field crew consists of a boat operator, and one data surveyor. The boat operator navigates the boat to follow the shoreline geometry and collects data pertaining to shoreline features. The surveyor collects information pertinent to all land use and bank condition.

Data is logged using the handheld Trimble GeoExplorer III, GeoExplorer XT, or GeoExplorer XH GPS unit. GeoExplorers are accurate to within 4 inches of true position with extended observations and differential correction. Without post processing, these units can achieve accuracies around 3 ft (1 meter). Both static and kinematic data collection is performed. Kinematic data collection is a collection technique where data is collected continuously along a pathway (in this case along the waterway). GPS units are programmed to collect information at a rate sufficient to compute a position anywhere along the course. The shoreline data is collected at a rate of one observation every five seconds. Land use, bank condition, and linear shoreline structures are collected using this technique.

Static surveys pin-point fixed locations that occur at very short intervals. The boat actually stops to collect these data, and the boat operator must hold the boat against tidal current, and surface wind waves. Static surveys log 6 GPS observations at a rate of one observation per second at the fixed station. The GPS receiver uses an averaging technique to compute one position based on the 6 static observations. Static surveys are used to position point features like piers, boat ramps, and boathouses.

The Trimble GPS receivers being used include a function that allows a user to pre-program the complete set of features surveyed in a "data dictionary". The data dictionary prepared for this Shoreline Inventory includes all features described in section 2.2. As features are observed in the field, surveyors use scroll down menus to continuously tag each geographic coordinate pair with a suite of characteristics that describe the shoreland's land use, bank condition, and shoreline features present. The survey, therefore, is a complete set of geographically referenced shoreline data.

2.4 Data Processing

Data processing occurs in two phases. Phase one processes the raw GPS field data, and converts the data to GIS coverages (section 2.4a). Phase two corrects the GIS coverages to reflect true shoreline geometry (section 2.4b).

2.4a.) GPS Processing: Differential correction improves the accuracy of GPS data by including other "known" locations to tighten the geographic position. Any GPS base station within 124 miles of the field site can serve as one additional location. The CORS base stations operated by the National Geodetic Survey in Virginia Beach and Chesapeake, Virginia were used for the data processing on Lynnhaven Watershed Data.

Trimble's Pathfinder Office GPS software is used for differential processing. The software processes time synchronized GPS signals from field data and the selected base stations. Differential correction improves the position of the GPS field data based on the known location of the base station, the satellites, and the satellite geometry. When Selective Availability was turned off in late Spring, 2000, the need to post process data has nearly been eliminated for the level of accuracy being sought in this project.

Although the Trimble GeoExplorers are capable of decimeter accuracy (~ 4 inches), the short occupation of sites in the field reduces the accuracy to 5 meters (~16 feet). In many cases the accuracy achieved is better, but the overall limits established by the CCI program are set at 5 meters. This means that features are registered to within 5 meters (~16 feet) or better of their true position on the earth's surface. In this case, positioning refers to the boat position during data collection.

An editing function is used to clean the GPS data. Cleaning corrects for breaks in the data that occur when satellite lock is lost during data collection. Editing also eliminates erroneous data collected when the boat circles off track and the unit is still collecting data.

The final step in GPS processing converts the files to three separate ArcInfo® shape files. These are converted into three coverages: a land use and bank condition coverage (lynn_lubc), a shoreline structure coverage (lines only) (lynn_sstruc), and a shoreline structure coverage (points only) (lynn_astruc_points).

2.4b.) GIS Processing: GIS processing embodies one major step that combines ESRI's ArcGIS® software, and ERDAS' Imagine® software. Several data sets are integrated to develop the final inventory products. The processing is intended to correct the new GIS coverages so they reflect conditions at the shoreline, and not along the boat track. All attributes summarized in Tables 1, 2, and 3 are included. A digital shoreline coverage is generated to use as a base map. For this inventory, a digital shoreline data set generated as part of the 2002 Virginia Base Mapping Program (VBMP) was used as the projects baseline shoreline. This shoreline is not referenced to a tidal datum, but is the most recent available data and developed from very high resolution products. The shoreline is extracted from the digital terrain model. The VBMP imagery is also used as background data in processing and map production. They are an important quality control tool for verifying the location of certain landscape attributes, and provide users with additional information about the coastal landscape.

GIS processing corrects the coverages generated from the GPS field data to the shoreline record. These field coverages are geographically coincident with the boat track; from where observations are made. They are, therefore, located somewhere in the waterway. Processing transfers these data back to the shoreline base map so the data more precisely reflect the location being described along the shore.

Data processing uses all three data sets simultaneously: the baseline shoreline, the post-processed GPS field data, and the ArcInfo coverages. The imagery is used in the background for reference. The processing re-codes the base shoreline with the attributes mapped along the boat track.   Each time the boat track data (i.e. GPS data) indicates a change in attribute type or condition, the digital shoreline arc is split, and coded appropriately for the attributes using ArcInfo techniques.

The GIS processing under goes a rigorous sequence of checks to insure the positional translation is as accurate as possible. Each field coverage; land use, bank condition, and shoreline condition, is processed separately. The final products are three new coded GIS shoreline coverages; lynn_lubc (depicting land use and bank cover), lynn_sstruc (depicting linear structures), lynn_astru_point (depicting point structures).

The Quality Control and Assurance plan requires each shape file be checked twice onscreen by different GIS personnel. Draft hardcopy maps are printed and reviewed in the third and final QA/QC step. When complete, maps and tables are generated for the website.

2.4c.) Maps and Tables: Maps and tables can be viewed or downloaded as PDF files. A color printer is required on the user end. Color maps are generated to illustrate the attributes surveyed along the shore.   A four-part map series has been designed to illustrate the data represented in Tables 1-3.

Plate A describes the riparian land use as color-coded bars along the shore. A legend keys the color to the type of land use. If the line is hatched, there is forest fringe on site. The background imagery is natural color VBMP imagery at a publication scale of 1:12,000. Users should note that the imagery is sometime rotated in order to meet the scale requirements. This means that "north" is not always to the top of the page.

Plate B depicts the condition of the bank. Three lines, and a combination of color and pattern symbology give rise to a vast amount of bank information. The line furthest inland describes the bank cover. Bank cover is distinguished by colors. Bare banks (<25% cover) are illustrated in fuchsia, partial cover (25-75%) is pale orange line, and total cover (>75%) is indicated by a light blue line.

Bank height and stability is the next line sequence seaward. These are red, green or yellow lines with a red line indicating an unstable bank, a green line indicating stability, and a yellow line indicating evidence of undercutting. Bank height varies with the thickness of the line; where the thickest lines designate the highest banks (> 30 feet). The length of the each of these symbols described along the shore reflects the length alongshore that the features persist. The symbology changes as conditions change. Plate B uses a grey scale version of the natural color image for the backdrop.

Plate C combines recreational and shoreline protection structures in a composition called Shoreline Features. Linear features, described previously (Table 3), are mapped using color coded bar symbols that follow the orientation of the shoreline. Point features use a combination of colors and symbols to plot the positions on the map. Gray scale imagery is used as a backdrop, upon which all shoreline feature data are superimposed.

Plate D illustrates the presence of natural buffers: beaches and marshes.   Beach is denoted with a chain of open pale orange circles. Three marsh types are classified. Embayed marshes are typical of cove or headwater marshes. They are illustrated with solid green dots. Extensive marshes representing large marsh complexes are illustrated using solid fuchsia dots. Fringe marshes are shown as solid yellow dots.   Phragmites australis is illustrated as a solid blue line.   It is possible for combinations of these to occur together at a site.

For publication purposes the watershed is divided into a series of 6 maps. Maps are scaled at 1:12,000 for publication at 11x17.   Scale will vary if printed at a different size.   For each map there are four plates (e.g. plate 1a, 1b, 1c, and 1d.) for a total of 24 map compositions. On the website, an index is provided to help users locate the area of interest and view the orientation of the maps to each other. Each plate can be individually selected and viewed from the plate list along the left hand column of the index page.

Tables 4 and 5 quantify features mapped along the rivers using frequency analysis techniques in ArcInfo.   The values quantify features on a plate-by-plate basis. For linear features, values are reported in actual miles surveyed. The number of point features surveyed is also listed on a plate by plate basis. The total miles of shoreline surveyed for each plate is reported. A total of 112.60 miles were surveyed. Only 1.31 miles of the survey was performed using remote sensing techniques. This was necessary due to navigation impediments or accessibility problems associated with shallow water.   These areas include headwaters of small creeks that could not be reached by boat. Since there is plate overlap, total survey miles cannot be reached by adding the total shoreline miles for each plate. The last row of Tables 4 and 5 reports the total shoreline miles surveyed (field and remotely) for the river (112.60 miles), and the total amount of each feature surveyed along the measured shoreline.   Table 6 reports the amount of Phragmites australis delineated along shore.

Chapter 3. Applications for Management

3.1 Introduction

There are a number of different management applications which the Shoreline Inventory supports. This section discusses several high profile issues within the Commonwealth or Chesapeake Bay watershed. The Inventory is a data report, and the data provided are intended for interpretation and integration into other programs. This chapter offers some examples for how data from the Inventory can be analyzed to support current watershed management programs.

3.2 Shoreline Management

The first uses for shoreline inventory were to prepare decision makers to bring about well-informed decisions regarding shoreline management. This need continues today, and perhaps with more urgency. In many areas, undisturbed shoreline miles are almost nonexistent. Development continues to encroach on remaining pristine reaches, and threatens the natural ecosystems that have persisted. At the same time, the value of waterfront property has escalated, and the exigency to protect shorelines as an economic resource using stabilization practices has increased. However, protection of tidal shorelines does not occur without incidence.

Management decisions must consider the current state of the shoreline, and understand what actions and processes have occurred to bring the shoreline to its current state. This includes evaluating existing management practices, assessing shore stability in an area, and determining future uses of the shore. The inventory provides data for such assessments.

For example, land use, to some extent, directs the type of management practices one can expect to find along the shoreline. The land use data, illustrated in plate “a” illustrates current land use at the time of survey that may be an indicator of shoreline management practices existing or expected in the future. Residential and commercial areas are frequently altered to counter act shoreline erosion problems or to enhance private access to the waterway. In contrast forested or agricultural uses are frequently unmanaged even if chronic erosion problems exist. Small forest tracks nestled among residential lots have a high probability for development in the future. These areas are also target areas then for shoreline modifications if development does occur. Local governments can do some enhanced and proactive planning if resources allow and the these data is readily available. Areas primed for development can be assessed in advance to determine the need for shoreline stabilization, and the type of stabilization that should be recommended.

Stability at the shore is illustrated in plate “b”. The bank is characterized by its height, the amount of cover on the bank face, the state of erosion. Plate ‘d” denotes if natural buffers are present at the bank toe. Upland adjacent to high, fully covered, and stable banks with a natural buffer at the base are less prone to flooding or erosion problems resulting from storm activity. Upland adjacent to banks of lesser height (< 5feet) are at greater risk of flooding, but if banks are stable with marshes or beaches present, erosion may not be a significant concern. Survey data reveals a strong correlation between banks of high erosion, and the absence of natural buffers. Conversely, the association between stable banks and the presence of marsh or beach is also well established. This suggests that natural buffers such as beaches and fringe marshes play an important role in bank protection. This is illustrated on the maps. Banks without natural buffers, yet classified as low erosion, are often structurally controlled with riprap or bulkheads. Check plate “c” to verify this.

Plate “c” delineates structures installed along the shoreline. These include erosion control structures, and structures to enhance recreational use of the waterway. This map is particularly useful for evaluating new requests from property owners seeking structural methods for controlling shoreline erosion problems. Shoreline managers can evaluate the current state of the surrounding shore including: impacts of earlier structural decisions, proximity to structures on neighboring parcels, and the vicinity to undisturbed lots. Alternative methods such as vegetative control may be evaluated by assessing the energy or fetch environment from the images. Use this plate in combination with Plate B that indicates the qualitative erosion assessment made during the survey.

A close examination of shore conditions may suggest whether certain structural choices have been effective. Success of groin field and breakwater systems is confirmed when sediment accretion is observed. Low erosion conditions surveyed along segments with bulkheads and riprap indicate structures have controlled the erosion problem. The width of the shore zone, estimated from the background image, also speaks to the success of structures as a method of controlling erosion. A very narrow shore zone implies that as bulkheads or riprap have secured the erosion problem at the bank, they have also deflated the supply of sediment available to nourish a healthy beach. The structure may actually be enhancing erosion at the base of the structure due to scour and wave reflection. This is a typical shore response, and remains an unresolved management problem.

Shoreline managers are encouraged to use all four plates together when developing management strategies or making regulatory decisions. Each plate provides important information independent of the others, but collectively the plates become a more valuable management tool.

3.3 Stream Restoration for Non-Point Source Management

The identification of potential problem areas for non-point source pollution is a focal point of water quality improvement efforts throughout the Commonwealth. This is a challenge for any large landscape. Fortunately, we are relatively well informed about the landscape characteristics that contribute to the problem. This shoreline inventory provides a data source where many of these landscape characteristics can be identified. The three tiered approach provides a collection of data which, when combined, can allow for an assessment of potential non-point source pollution problem areas in a waterway. Managers can effectively target river reaches for restoration sites. Below, methods for combining these data to identify problem sites are described.

Grass land and agricultural land, which includes pasture land and cropland, respectively, have the highest potential for nutrient runoff. These areas are also prone to high sediment loads since the adjacent banks are seldom restored when erosion problems persist. In agriculturally dominated watersheds this is particularly useful. Residential, bare, and commercial land uses are also hot spots for non-point source pollution. Runoff of pesticides and herbicides applied to lawn and gardens are good examples. The Lynnhaven is dominated by residential land use which can be detected in plate “a”.

To identify areas with the highest potential for non-point source pollution combine these land uses with “high” bank erosion conditions, bare bank cover, and no marsh buffer protection. The potential for non-point source pollution moderates as the condition of the bank changes from “high” bank erosion to “low” bank erosion, or with the presence or absence of stable marsh vegetation to function as a nutrient sink for runoff. Where defense structures occur in conjunction with “low” bank erosion, the structures are effectively controlling erosion at this time, and the potential for non-point source pollution through sediment input is reduced. However, since the introduction of most pollution into the Lynnhaven is through storm run-off, the vehicle for transport is not sediment erosion, but rather water flowing over impervious surface. The imagery provides a lot of information about impervious surface cover through simple observations.

At the other end of the spectrum, forested and scrub-shrub sites do not contribute significant amounts of non-point source pollution to the receiving waterway. Forest buffers, in particular, are noted for their ability to uptake nutrients running off the upland. Forested areas with stable or defended banks, a stable fringe marsh, and a beach would have the lowest potential as a source of non-point pollution. Scrub-shrub with similar bank and buffer characteristics would also be very low.

3.4 Designating Areas of Concern (AOC) for Best Management Practice (BMP) Sites

Sediment load and nutrient management programs at the shore are largely based on installation of Best Management Practices (BMPs). Among other things, these practices include fencing to remove livestock from the water, installing erosion control structures, and bank re-vegetation programs. Installation of BMPs is costly. Cost share programs provide relief for property owners, but funds are scarce in comparison to the capacious number of waterway miles needing attention. Targeting Areas of Concern (AOC) can prioritize spending programs, and direct funds where most needed.

Data collected for the inventory can assist with targeting efforts for designating AOCs. AOCs can be areas where riparian buffers are fragmented, and could be restored. Use Plate A to identify forested upland. Breaks in the continuity of the riparian forest can be easily observed in the line segments, and background image. Land use between the breaks relates to potential opportunity for restoring the buffer where fragmentation has occurred. Agricultural tracts which breach forest buffers are more logical targets for restoration than developed residential or commercial stretches. Agricultural areas, therefore, offer the highest opportunity for conversion. Priority sites for riparian forest restoration should target forested tracts breached by “agriculture” or “grass” land.

Plate “b” can be used to identify sites for BMPs. Look for where eroding bank conditions persist. The thickness of the line tells something about the bank height. The fetch, or the distance of exposure across the water, can offer some insight into the type of BMP that might be most appropriate. Marsh planting may be difficult to establish at the toe of a bank with high exposure to wave conditions. Look for other marsh fringe in the vicinity as an indicator. Plate “c” should be checked for existing shoreline erosion structures in place.

Tippett et.al.(2000) used similar stream side assessment data to target areas for bank and riparian corridor restoration. These data followed a comparable three tier approach and combine data regarding land use and bank stability to define specific reaches along the stream bank where AOCs have been noted. Protocols for determining AOCs are based on the data collected in the field.

As water quality programs move into implementation phases the importance of shoreline erosion in the lower tidal tributaries will become evident. Erosion from shorelines has been associated with high sediment loads in receiving waters (Hardaway et.al., 1992), and the potential for increased nutrient loads coming off eroding fast land is a concern (Ibison et.al., 1990). The contribution to the suspended load from shoreline erosion is not quantified. Water quality modelers are challenged by gathering appropriate data for model inputs. In Maryland, where there is a complete Shoreline Inventory for each coastal locality, data from the inventory is being used to assess shoreline areas where the introduction of sediment from shoreline erosion in possible. Using data illustrated in plate “c”, Maryland is able to identify areas that have been stabilized versus those that are undefended. . They are combining these data with computed shoreline erosion rates to determine the volume of sediment entering the system at points where the shoreline is unprotected.

This type of assessment would be very beneficial in Virginia and may assist in the water quality modeling efforts underway; especially those addressing suspended sediment loads. The inventory provides a resource of relatively recent data that could assist in defining areas of high erosion, and potential high sediment loads (e.g. plate “b”). Waterways with extensive footage of eroding shorelines represent areas that should be flagged as hot spots for sediment input. The volume of sediment entering a system is generally estimated by multiplying the computed shoreline recession rate by the bank height along some distance alongshore. Estimated bank height is mapped along all surveyed shorelines in plate “b”. Banks designated as “eroding” and in excess of 30 feet would be target areas for high sediment loads. Plate “a” can be used in combination with Plate “b” to determine the dominant land use practice, and assess whether nutrient enrichment through sediment erosion is also a concern. This would be the case along agriculturally dominated shoreline Table 4 quantifies the linear extent of high, eroding banks on a plate by plate basis.

3.5 Summary

These represent only a handful of uses for the inventory data.. Users are encouraged to consider merging these data with other local or regional datasets. Now that many agencies and localities have access to some GIS capabilities, the uses for the data are even greater. While the conditions mapped represent a snap shot in time, the Center for Coastal Resources Management hopes to update these on a regular basis. Unfortunately, this goal is hindered by an absence of recent funds available for data collection. The program continues to seek resources and will modify goals and objectives as necessary.

Chapter 4. The Shoreline Inventory

The shoreline condition is described for primary and secondary shoreline in the Lynnhaven Watershed. Characteristics are described for all navigable tidal waterways contiguous to these shorelines. The survey covers 112.60 miles of the total 139.42 miles of the shoreline in the river. Less than 2 miles (1.3 miles) were coded remotely. For remotely sensed areas, photo interpretation was made using VBMP imagery to detect land use, natural buffers, and shoreline structures where possible. Along remotely coded shoreline, there is an assumption that upland banks are well protected by vegetation, and erosion low. It is possible, however, for these banks to experience undercutting from tidal currents. This cannot be verified since field visits were not performed. Bank height conditions along reaches characterized using remote sensing techniques were estimated from USGS 1:24,000 topographic maps.

The Shoreline Inventories are only available electronically. From this website: http://www.ccrm.vims.edu/shoreline_situation_rpts.html users can access digital maps, tables, reports, GIS data, and metadata by clicking on the Lynnhaven River icon. The website is organized to encourage users to navigate through a series of informational pages before downloading the data. A map of Virginia and Maryland highlights each county or watershed with a completed inventory. There is a list of completed inventories by state below the map.

From the page below, the user will be linked to a project review and disclaimer page where basic project and data use limitations are presented. The link to maps will take you to an index page illustrating the plate boundaries (Figure 2). This is useful if you are interested in a specific area. There are 6 links on the disclaimer page. These links are self-explanatory. When you click on “Maps” the index page will appear. The index illustrates the distribution of plates geographically.

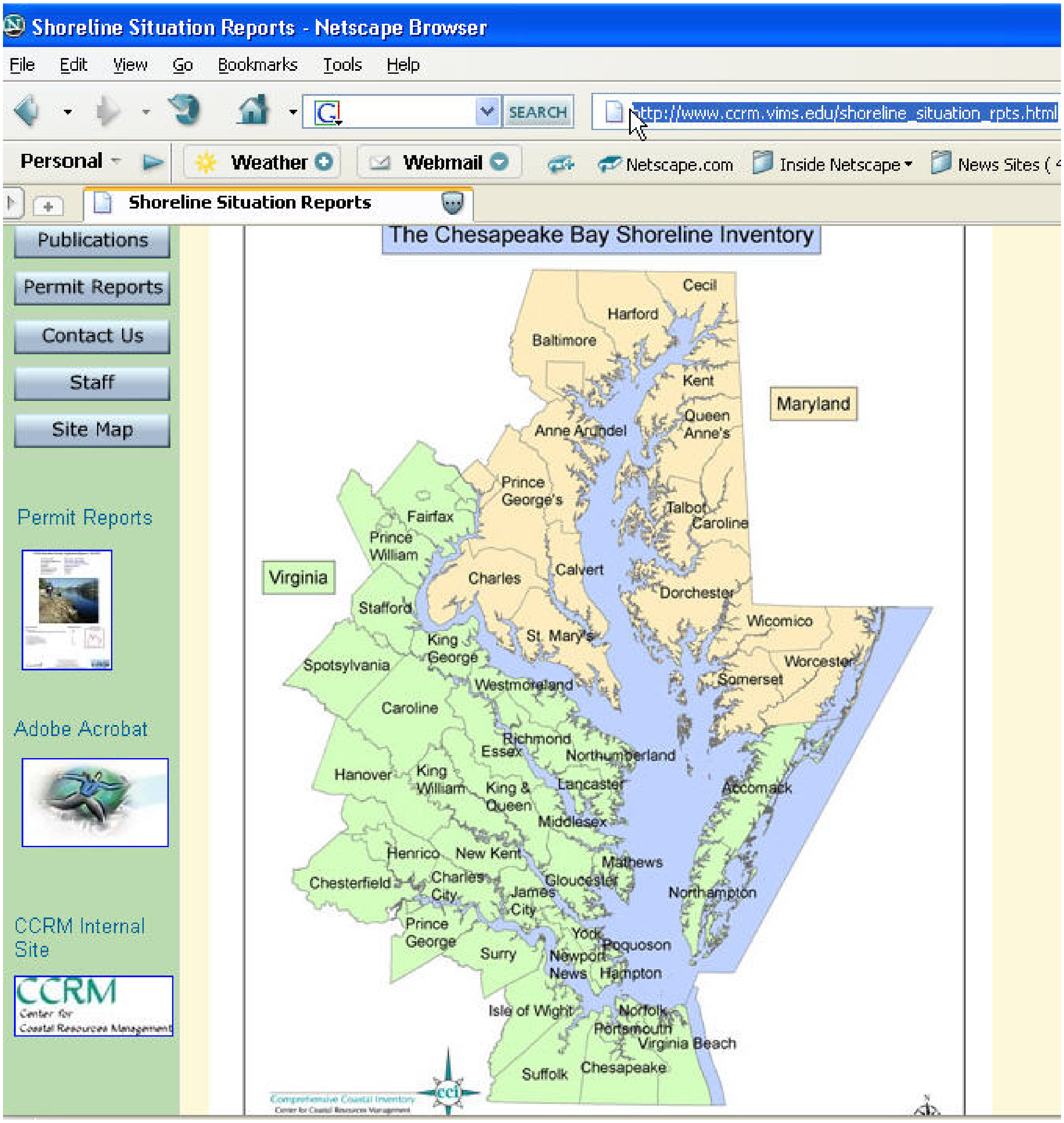
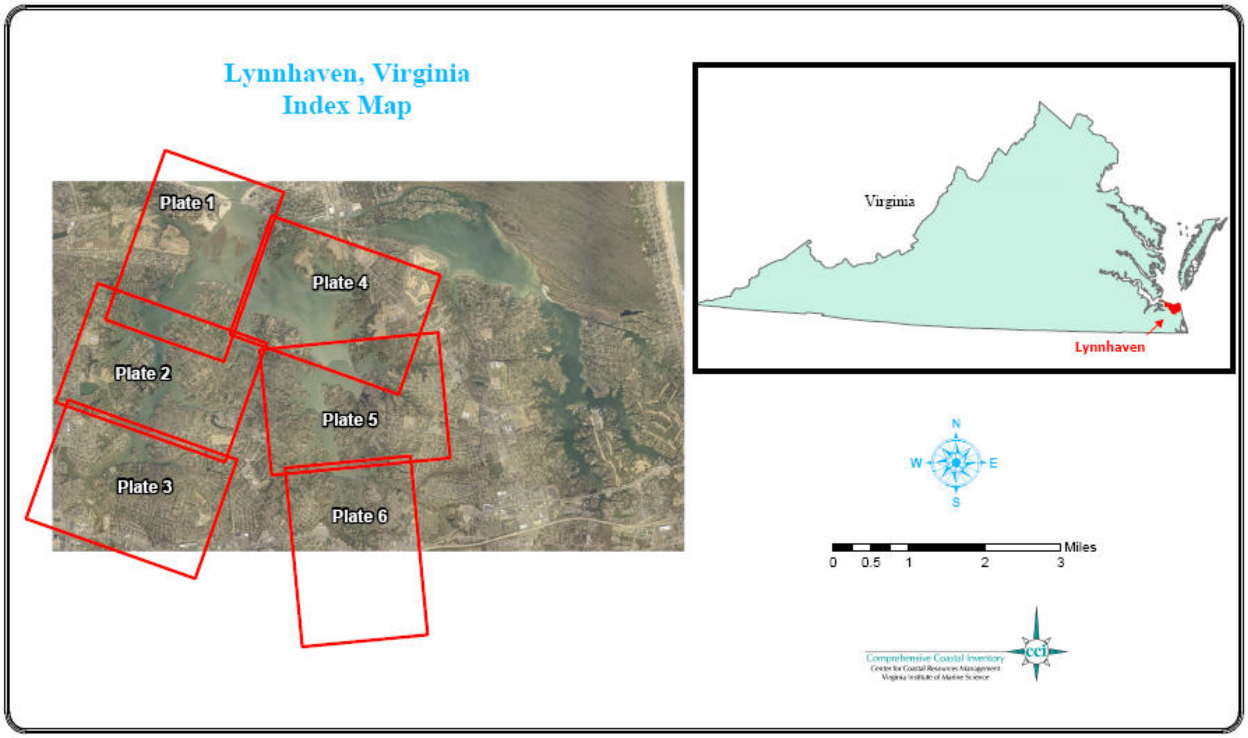


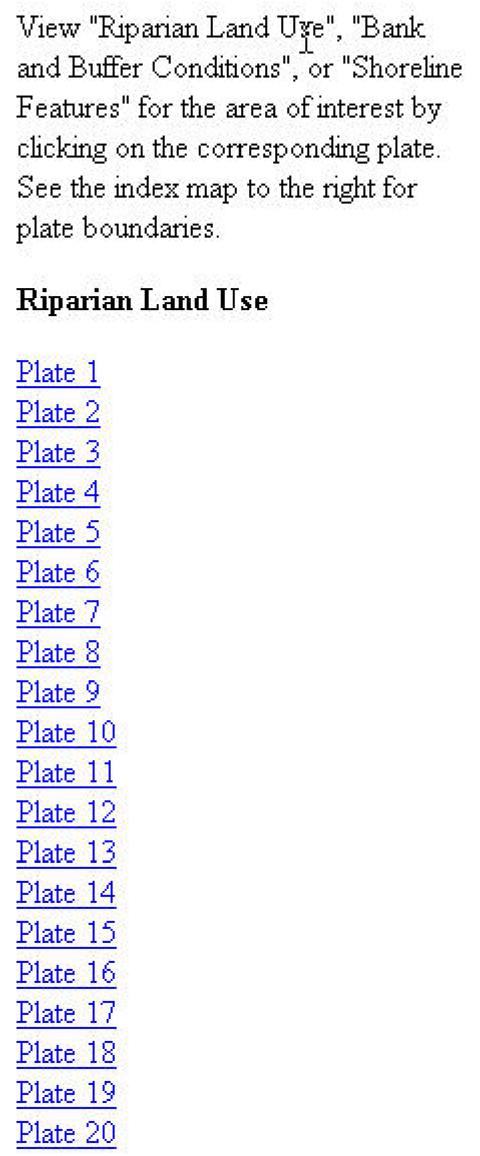
Figure 1. Shoreline Inventory Website

Figure 2. Map index for Lynnhaven Watershed



Once you determine which plate you want, the scroll down menu on the left has links to the four part series for each plate (Figure 3).   At the top of the scroll bar Riparian Land Use is first. You can scroll down to see links to maps illustrating Bank conditions, Shoreline Features, and Natural Buffers. The content and details of the four part plate series was described in detail in Chapter 2. The actual map will come up when you click on the plate number. For example, Figure 4 is the riparian land use map for plate 1. Figure 5 is the map illustrating Bank Conditions for plate 1, and Figure 6 shows all the shoreline features for that same area. Finally, the presence of natural buffers such as beaches and marshes are shown in Figure 7. You may open all four plates for the series, but can view only one at a time in most browsers. Tools for zooming and panning should be on the tool bar.   The maps can be printed at full resolution up to 11x17 color. Color printers are necessary. Summary statistics for all data are reported in tables accessed through the “Tables” button on the inventory project page.

The link to the GIS data is found on the project page again. Files are compressed and easily downloaded. The metadata is a separate link that can also be downloaded. Users are encouraged to read the metadata carefully as well as all other information in the disclaimer.


View "Riparian Land Use", "Bank and Buffer Conditions", or "Shoreline Features" for the area of interest by clicking on the corresponding plate. See the index map to the right for plate boundaries.

Riparian Land Use

Plate 1
Plate 2
Plate 3
Plate 4
Plate 5
Plate 6
Plate 7
Plate 8
Plate 9
Plate 10
Plate 11
Plate 12
Plate 13
Plate 14
Plate 15
Plate 16
Plate 17
Plate 18
Plate 19
Plate 20

Figure 3. Scroll down menu for plates

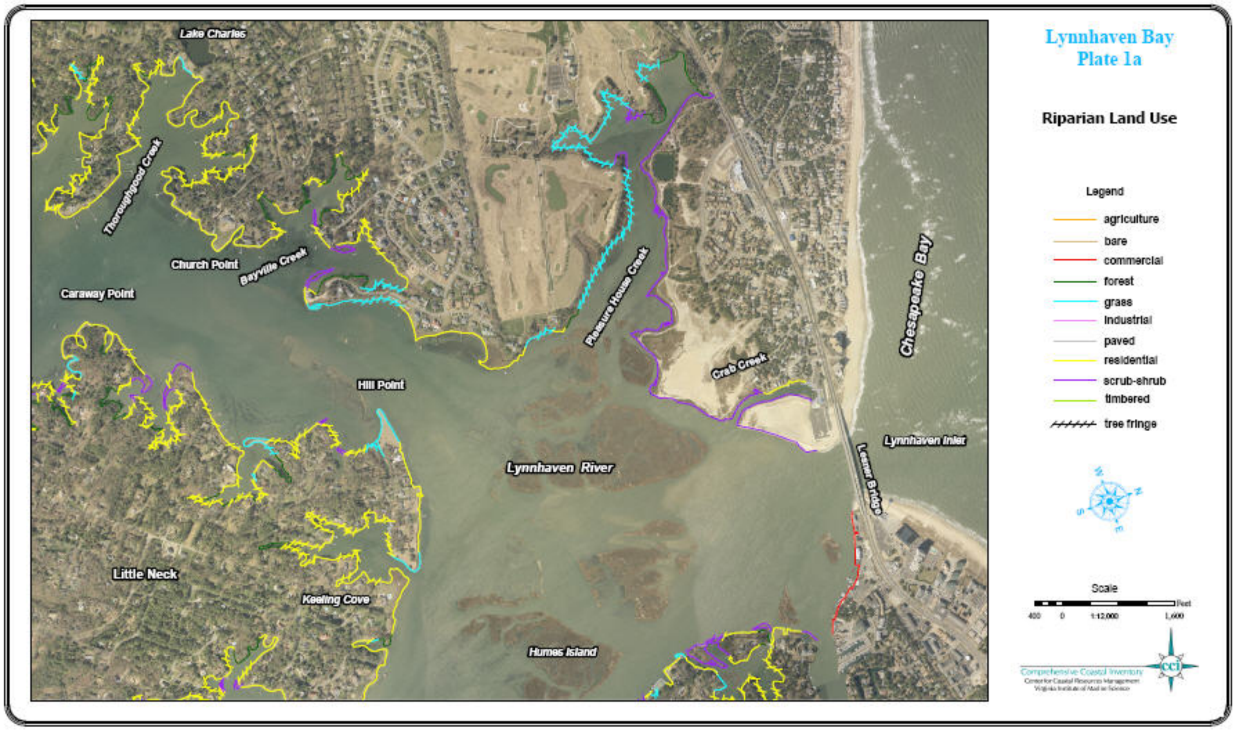


Figure 4. Sample riparian land use map for the Lynnhaven River

Figure 5. Map illustrating bank conditions for plate 1 in the Lynnhaven River

Figure 6. Map illustrating shoreline features for plate 1 on the Lynnhaven River

Figure 7. Map illustrating presence of natural buffers for plate 1 on the Lynnhaven River

Glossary of Shoreline Features Defined

Agricultural - Land use defined as agricultural includes farm tracts that are cultivated and crop producing. This designation is not applicable for pastureland.

Bare - Land use defined as bare includes areas void of any vegetation or obvious land use. Bare areas include those that have been cleared for construction.

Beaches - Beaches are sandy shores that are sub aerial during mean high water. These features can be thick and persistent, or very thin lenses of sand.

Boathouse - A boathouse is considered any covered structure alongside a dock or pier built to cover a boat. They include true "houses" for boats with roof and siding, as well as awnings that offer only overhead protection. Since nearly all boathouses have adjoining piers, piers are not surveyed separately, but are assumed. Boathouses may be difficult to see in aerial photography. On the maps they are denoted with a blue triangle.

Boat Ramp - Boat ramps provide vessels access to the waterway. They are usually constructed of concrete, but wood and gravel ramps are also found. Point identification of boat ramps does not discriminate based on type, size, material, or quality of the launch. Access at these sites is not guaranteed, as many may be located on private property. The location of these ramps was determined from static six second GPS observations. Private ramps are illustrated as purple squares on the maps. These include ramps on private residential property as well as those associated with commercial property. Public launch sites are illustrated in orange.

Breakwaters - Breakwaters are structures that sit parallel to the shore, and generally occur in a series along the shore. Their purpose is to attenuate and deflect incoming wave energy, protecting the fast land behind the structure. In doing so, a beach may naturally accrete behind the structures if sediment is available. A beach nourishment program is frequently part of the construction plan.

The position of the breakwater offshore, the number of breakwaters in a series, and their length depends on the size of the beach that must be maintained for shoreline protection. Most breakwater systems sit with the top at or near MHW and are partially exposed during low water. Breakwaters can be composed of a variety of materials. Large rock breakwaters, or breakwaters constructed of gabion baskets filled with smaller stone are popular today. Breakwaters are not easily observed from aerial imagery. However, the symmetrical cuspate sand bodies that may accumulate behind the structures can be. In this survey, individual breakwaters are not mapped. The first and last breakwater in the series is surveyed as a ten-second static GPS observation. The system is delineated on the maps as a line paralleling the linear extent of the breakwater series along the shore.

Bulkhead - Bulkheads are traditionally treated wood or steel "walls" constructed to offer protection from wave attack. More recently, plastics are being used in the construction. Bulkheads are vertical structures built slightly seaward of the problem area and backfilled with suitable fill material. They function like a retaining wall, as they are designed to retain upland soil, and prevent erosion of the bank from impinging waves. The recent proliferation of vertical concrete cylinders, stacked side by side along an eroding stretch of shore offer similar level of protection as bulkheads, and include some of the same considerations for placement and success. These structures are also included in the bulkhead inventory.

Bulkheads are found in all types of environments, but they perform best in low to moderate energy conditions. Under high-energy situations, the erosive power of reflective waves off bulkheads can scour material from the base, and cause eventual failure of the structure.

Bulkheads are common along residential and commercially developed shores. From aerial photography, long stretches of bulkheaded shoreline may be observed as an unnaturally straight or angular coast. In this inventory, they are mapped using kinematic GPS techniques. The data are displayed as linear features on the maps.

Commercial - Commercial zones include small commercial operations as well as parks or campgrounds. These operations are not necessarily water dependent businesses.

Dock/Pier - In this survey, a dock or pier is a structure, generally constructed of wood, which is built perpendicular or parallel to the shore. These are typical on private property, particularly residential areas. They provide access to the water, usually for recreational purposes. Docks and piers are mapped as point features on the shore. Pier length is not surveyed. In the map compositions, docks are denoted by a small green dot. Depending on resolution, docks can be observed in aerial imagery, and may be seen in the maps if the structure was built prior to 1994, when the photography was taken.

Forest Fringe – When the dominant land use on a parcel is something other than forest cover, but the parcel retains a fringe of tree cover along the shoreline.

Forest Land Use - Forest cover includes deciduous, evergreen, and mixed forest stands greater than 18 feet high. The riparian zone is classified as forested if the tree stand extends at least 33 feet inland of the seaward limit of the riparian zone.

Grass - Grasslands include large unmanaged fields, managed grasslands adjacent to large estates, agriculture tracts reserved for pasture, and grazing.

Groinfield - Groins are low profile structures that sit perpendicular to the shore. They are generally positioned at, or slightly above, the mean low water line. They can be constructed of rock, timber, or concrete. They are frequently set in a series known as a groinfield, which may extend along a stretch of shoreline for some distance.

The purpose of a groin is to trap sediment moving along shore in the littoral current. Sediment is deposited on the up drift side of the structure and can, when sufficient sediment is available in the system, accrete a small beach area. Some fields are nourished immediately after construction with suitable beach fill material. This approach does not deplete the longshore sediment supply, and offers immediate protection to the fast land behind the system.

For groins to be effective there needs to be a regular supply of sediment in the littoral system. In sediment starved areas, groin fields will not be particularly effective. In addition they can accelerate erosion on the down drift side of the groin. The design of "low profile" groins was intended to allow some sediment to pass over the structure during intermediate and high tide stages, reducing the risk of down drift erosion.

From aerial imagery, most groins cannot be observed. However, effective groin fields appear as asymmetrical cusps where sediment has accumulated on the up drift side of the groin. The direction of net sediment drift is also evident.

This inventory does not delineate individual groins. In the field, the first and last groin of a series is surveyed. We assume those in between are evenly spaced. On the map composition, the groin field is designated as a linear feature extending along the shore.

Industrial - Industrial operations are larger commercial businesses.

Marina - Marinas are denoted as line features in this survey. They are a collection of docks and wharfs that can extend along an appreciable length of shore. Frequently they are associated with extensive bulkheading. Structures associated with a marina are not identified individually. This means any docks, wharfs, and bulkheads would not be delineated separately. Marinas are generally commercial operations. Community docks offering slips and launches for community residents are becoming more popular. They are usually smaller in scale than a commercial operation. To distinguish these facilities from commercial marinas, the riparian land use map (Plate A) will denote the use of the land at the site as residential for a community facility, rather than commercial. Also the inventory estimates the number of slips and categorizes marinas as those with more than 50 slips and those with less than 50 slips.

Marsh Toe Revetment – generally a stone structure (see rip rap) placed at the seaward edge of an existing eroding marsh.

Marshes - Marshes can be extensive, embayed, or fringe marshes. Extensive marshes constitute large marsh complexes typical of wildlife areas. Embayed marshes characterize headwaters of streams, and fringe marshes represent narrow strips of vegetation found all along the shoreline. The vegetation in all cases must be relatively well established, although not necessarily healthy.

Miscellaneous - Miscellaneous point features represent short isolated segments along the shore where material has been dumped to protect a section of shore undergoing chronic erosion. Longer sections of shore are illustrated as line features. They can include tires, bricks, broken concrete rubble, and railroad ties as examples.

Paved - Paved areas represent roads which run along the shore and generally are located at the top of the banks. Paved also includes parking areas such as parking at boat landing, or commercial facilities.

Phragmites australis - a non-native, invasive wetland plant known to thrive in areas that have experienced disturbance. The plant is prolific and is known to out complete native species.

Various types of eradication methods have been used to stop the growth of this plant.

Residential - Residential zones include rural and suburban size plots, as well as multi-family dwellings.

Riprap - Generally composed of large rock to withstand wave energy, riprap revetments are constructed along shores to protect eroding fast land. Revetments today are preferred to bulkhead construction. They reduce wave reflection that causes scouring at the base of the structure, and are known to provide some habitat for aquatic and terrestrial species. Most revetments are constructed with a fine mesh filter cloth placed between the ground and the rock. The filter cloth permits water to permeate through, but prevents sediment behind the cloth from being removed, and causing the rock to settle. Revetments can be massive structures, extending along extensive stretches of shore, and up graded banks. When a bulkhead fails, riprap is often placed at the base for protection, rather than a bulkhead replacement. Riprap is also used to protect the edge of an eroding marsh. This use is known as toe protection. This inventory does not distinguish among the various types of revetments.

Riprap revetments are popular along residential waterfront as a mechanism for stabilizing banks. Along commercial or industrial waterfront development such as marinas, bulkheads are still more common since they provide a facility along which a vessel can dock securely.

Riprap is mapped as a linear feature using kinematic GPS data collection techniques. The maps illustrate riprap as a linear feature along the shore.

Scrub-shrub - Scrub-shrub zones include trees less than 18 feet high, and is usually dominated by shrubs and bushy plants.

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