The Virginia Wetlands Report

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A GIS Approach for Targeting Potential Wetlands Mitigation or Restoration Sites

By Marcia Berman and Tamia Rudnicky

Introduction

In the last ten years, resource managers and planners have seen a significant increase in the restoration of habitat for the preservation of living resources. The breadth of restoration activities is diverse, and includes riparian forests, aquatic reefs, oyster grounds, submerged aquatic vegetation, islands, and wetlands. Most activities enhance habitat for living resources, but also assume important roles to improve water quality, flood control, bank stabilization, and erosion protection from wave energy. Projects like these are now being undertaken within the Chesapeake Bay Watershed with considerable support from the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), U.S. Army Corps of Engineers (USACE), and state partners.

Wetland restoration, in particular, is very active within the Chesapeake Bay watershed. Among other things, it fosters the no net loss goals established by the agencies, and reinforces the Chesapeake Bay Executive Council directive calling for "... a net resource gain as a long term goal for wetland restoration ..." (Chesapeake Bay Executive Committee, 1997). Under this directive, states within the Chesapeake Bay are asked to submit a strategy for achieving this goal.

Wetland mitigation may be required under the Clean Water Act as compensation for wetlands lost due to development. There has been great debate regarding site selection, restoration of functions and values, monitoring, and criteria for evaluating success. These debates will undoubtedly continue as policy makers, environmentalists, and developers strive to achieve reasonable compromise.

The Comprehensive Coastal Inventory Program (CCI) at VIMS is engaged in a project which targets sites that may be considered as potential restoration or mitigation sites for wetlands. The term "restoration" is used loosely here since no component analysis of this project examines historic wetlands position.

Restoration is becoming more prevalent as a form of mitigation for wetlands lost due to human disturbance. Through much debate, the general consensus now favors restoration over creation as a mitigation option since the opportunity for success is higher (National Research Council, 1992). While restoration by definition seeks to restore functions and aquatic ecosystems to their previous state, restoration as compensation for lost wetlands may be designed to restore a particular function lost to a watershed by human disturbance. To that end, the placement of the restoration activity can be important, and should be considered along with the traditional financial and engineering concerns associated with land acquisition and site design. Site selection for wetland restoration has typically concerned itself more with logistics and finances than the environment.

The project described here is a pilot to develop a mechanism to improve how sites are selected for restoration or mitigation of wetlands. The project

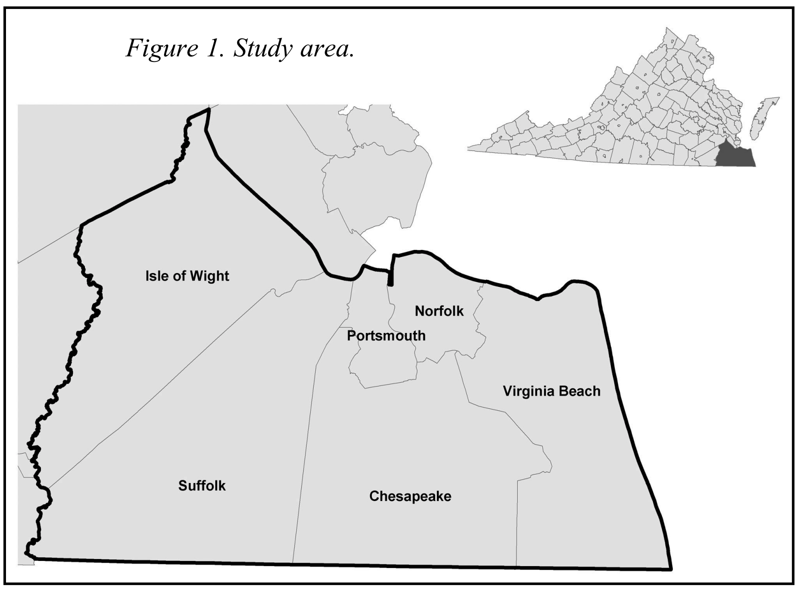

Figure 1. Study area.

is also GIS based and depends upon available GIS data to target sites.

A series of "rules" and "queries" have been developed around available GIS data. GIS models were written to analyze for protocols developed. The project goal is to develop a series of reference maps to be used by managers and developers in site selection. Maps will be restricted to the boundaries of the pilot project area located in the southern region of Virginia's Tidewater area (Figure 1, previous page). The cities and localities within the pilot area are listed in Table 1. The model, however, can be run for any area where selected GIS layers are available.

Table 1. Localities within the study area value

Isle of Wight County
City of Suffolk
City of Portsmouth
City of Norfolk
City of Chesapeake
City of Virginia Beach

Approach

The primary protocols for the model development were designed around available GIS data. Table 2 lists the principal data layers used in the targeting model. Not available to support this effort was perhaps the most desirable GIS coverage; prior converted wetlands (PCWs). A coverage delineating PCW, or sites where wetlands were converted to some other land use, would have enhanced the quality of the model for siting restoration locations. The project did not allow for the development of this coverage.

Instead, the protocol uses those data defined in Table 2 along with some basic rules to query for other important components of the landscape. This model is very dependent upon hydric soils data, and the targeting philosophy is predicated on the logistical ability to convert some existing land cover or use to a wetland. Therefore, heavily developed areas are not considered a potential site for restoration or mitigation, despite the possible presence of other physical attributes. Additional generalizations call for utilization of polygons greater than 0.25 acres only, and assume at this time that all hydric soils types are conducive for wetland growth. Future analysis may refine the target sites based on hydric soil type, which is known.

The modeled protocol is a hierarchical technique, where each query builds on the previous query and subsequently refines or improves the targeting. In doing so, higher order queries result in better sites for selection. Developing the model in this fashion also allows targeting to occur at simplified levels of prediction in other study areas when some GIS coverages are not available.

The model has 4 levels:

Level 1 defines all hydric soil polygons with hydrologic connectivity. The GIS query combines hydric soil and stream data, and searches for hydric soil polygons with intersecting stream arcs. Technically these sites, while upland areas, have some basic characteristics of a wetland, and could potentially be modified using engineering techniques. Some of these sites are likely PCW sites. Some GIS buffer algorithms are written to account for slight discrepancies when combining data of different accuracies and resolutions. Reasonably sized buffers (~2 meters) may be placed around stream networks to improve logical alignment with hydric soil polygons. In some cases this buffering forces the intersection between the hydric soil polygon and the hydrology. For all cases this forcing function is assumed to represent real world conditions.

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GIS Data Layer	Data Source
Hydrology	U.S. Geological Survey (DLG)
Wetlands	U.S. Fish and Wildlife Service (NWI)
Hydric soils	U.S. Dept. of Agriculture (SSURGO) Virginia Tech (VIRGIS)
Land use/Land cover	U.S. Geological Survey/Environmental Protection Agency (National Land Cover Dataset - NLCD)
Conservation areas/Special habitat sites	VA Department Conservation and Recreation, Div. of Natural Heritage

Table 2. GIS data available for model development.

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Wetland Denizens

Diamondback Terrapin

Malaclemys terrapin

by Walter I. Priest, III

When fishing or boating during the summer, have you ever noticed small dark shapes on the water that periodically appear and disappear? Well, they are diamondback terrapins, the only reptile restricted to brackish and saline estuaries. They are commonly found in and around *Spartina* marshes where they are frequently seen sunning themselves on exposed peat banks along the edge of the marsh. There are a number of subspecies of terrapins, and they are found from southern New England to Gulf of Mexico. In days gone by, they were the prime ingredient in turtle soup, which was considered an epicure's delight. They were in such demand that they were overfished to the point that their population in Chesapeake Bay became seriously depleted. Protective measures and changes in taste have allowed populations to recover.

Diamondback terrapins range in size from 4 – 5.5" for males and 6 – 9" for females. The carapace or shell is dark gray, brown or black with the individual plates or scutes on the carapace displaying a geometric pattern of concentric rings. The rings are worn smooth in older individuals. The plastron or underside plate is a lighter yellowish or greenish color. The skin is usually gray with black dots or flecks or sometimes uniformly dark.

Diamondback terrapin at home on the marsh surface with mud snails and cordgrass.

Egg laying usually begins the second week in June and continues until the third week in July. Nests are usually excavated in high sandy areas along marshes, upper portions of beaches and sand dunes where the nests are protected from flooding. Nests are excavated through the dry surface material into the wet subsoil. The eggs are pinkish-white symmetrical and approximately an inch in diameter. Clutch size averages 10 eggs with a range of 4 –18. Females can produce multiple clutches in a season producing 35 or more eggs per year. Hatching occurs in approximately 70 – 80 days depending on the exposure and temperature of the nest. Some late season nests can overwinter and hatch the following spring. Females start laying eggs by the time they are five years old , peak egg production occurs around 25 and can continue until 40 years of age.

Diamondback terrapin nest exposed by erosion of sand dune sediments.

Eggs and hatchlings are preyed upon by a number of predators including gulls, herons, muskrats and raccoons. Diamondback terrapins either hibernate or become dormant for extended periods buried in the mud of creek bottoms during the winter.

Terrapins are carnivores feeding on most anything they encounter including mollusks, snails, crabs, worms and sometimes carrion.

Adult diamondback terrapins have few predators other than man. They are often attracted to crab pots where they can become trapped and drown. One day last spring on Allen's Island in the York River, I came across a derelict "ghost pot" that had fourteen terrapins trapped inside of it. I had found the pot too late for half of the trapped turtles. So the next time you run across an abandoned crab pot, pull it out of the water and dispose of it. The diamondback terrapins—as well as other residents of Chesapeake Bay—will thank you for your efforts.

Bay Managers Eye Recently Permitted SAV Losses

By Lyle Varnell, VIMS and Jay Woodward, VMRC

The importance of submerged aquatic vegetation (SAV) to the Chesapeake Bay's living resources has been well documented through scientific research activities. Eelgrass *(Zostera marina)*, widgeon grass *(Ruppia maritima)* and the approximately two dozen other species of underwater grasses found in the Bay are important nursery and feeding grounds for many commercially and recreationally important species, as well as lower members of the estuarine food chain. SAV's contributions to healthy coastal ecosystems have been recognized in federal and state environmental regulatory programs for many years. The recent reauthorization of the Chesapeake Bay Program commitments (through the Chesapeake 2000 Agreement recently signed by the Governors of Virginia, Maryland, Pennsylvania, The Chairman of the Chesapeake Bay Commission, the United States Environmental Protection Agency Administrator, and the Mayor of the District of Columbia) calls for an increase in SAV from the current levels of approximately 69,126 acres to 114,000 acres Bay wide, and by 2002 to implement a strategy to accelerate protection and restoration of SAV beds in areas of critical importance to the Bay's living resources. Additionally, the 1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act (MSFMCA) mandated the National Marine Fisheries Service (NMFS), regional fishery management councils and other pertinent federal agencies to identify and delineate important marine and estuarine fishery habitats, known as "essential fish habitat" or EFH. SAV is included in the Essential Fish Habitat designation for a number of important estuarine species.

Two dredging projects in Maryland, recently authorized by the U.S. Army Corps of Engineers and the Maryland Department of the Environment, have brought to light the realities of economic development and related difficulties involved with the protection and restoration of SAV. Forty-two property owners in Baltimore and Anne Arundel counties received permission to dredge through approximately 2.4 acres of SAV over the objection of the U.S. Environmental Protection Agency. In response, the Chesapeake Bay Program has formed a special task force made up of representatives of local, state, and federal agencies along with regulators, academia, and non-government environmental organizations to address issues that arose during the public interest review process for these projects. The primary issues that have arisen during this process involve multiple interpretation of imprecise definitions for key terms such as "maintenance" dredging, "presence/absence" of SAV, and "right to riparian access" for property owners.

The issue of permitted SAV losses is currently confined to Maryland. In Virginia, the Marine Resources Commission (VMRC) and VIMS critically review all proposed dredging projects with respect to direct and potential indirect impacts to SAV and other shallow water habitats. Also, Maryland and Virginia define maintenance dredging projects differently which results in more projects that qualify as maintenance dredging in Maryland. Over the last decade, direct impacts to SAV from either new or maintenance dredging in Virginia have been minimal. However, as coastal populations expand and the desire for access to the Chesapeake Bay continue to increase, the pressures on SAV resources will also increase.

The results of the current Chesapeake Bay Program Task Force effort will help guide Virginia's management of SAV resources in the future. Additionally, VMRC's Habitat Management Advisory Committee (HMAC) and VIMS began a proactive effort last year to develop guidelines for SAV transplanting, which were approved by the Commission in October of 2000. The HMAC will soon begin discussions on requiring compensatory mitigation for permitted, unavoidable direct impacts to SAV.

The results of the Chesapeake Bay Program Task Force and HMAC efforts will be outlined in a future VIMS Technical Report and will be posted on the VIMS/Center for Coastal Resources Management (CCRM) web page . Please visit the VIMS/SAV web page at http://www.vims.edu/bio/sav/index.html for more specific information on the ecology of underwater grasses.

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Level 2 builds off Level 1. Using NWI data, this iteration searches for hydric soil polygons that meet Level 1 criteria, and are adjacent to or coincident with existing wetlands. Both tidal and non-tidal vegetated wetlands are considered. The presumption here is that the placement of a new wetland adjacent to an existing wetland may enhance the value of the existing site, may be restorative (PCW), and may have a greater chance of success.

Level 3 considers the current land use within the hydric soil polygon. The analysis actually looks at all hydric soil polygons that have hydrologic connectivity (from Level 1), and then those adjacent to wetlands (Level 2). Land use data from the National Land Cover Dataset (NLCD) is simplified into six major categories: forest, agriculture, developed, wetlands, bare/barren, water. With respect to the hydric soil polygons, the protocol searches only for those that are either agriculture or forested. These are realistically the only places on the landscape with a high likelihood for conversion. Al-

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Through the Years in Virginia's Wetlands: Days in the Field

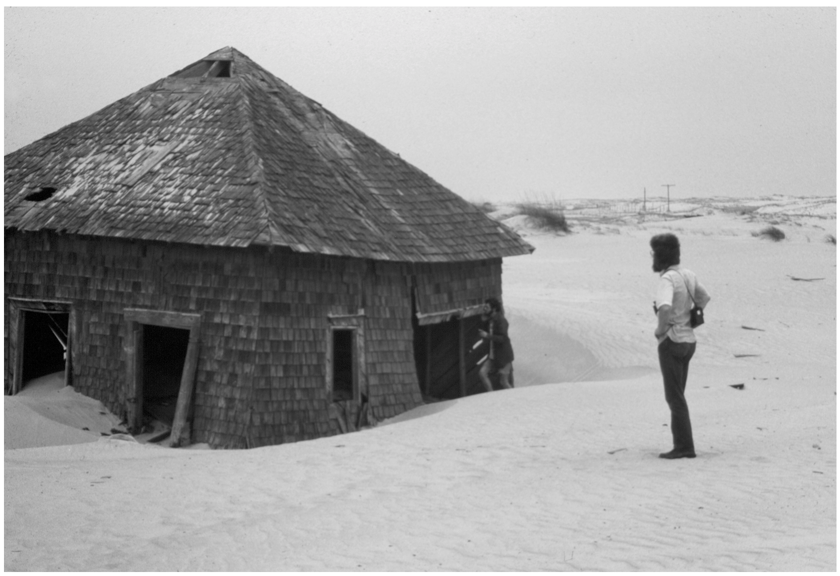
Gene M. Silberhorn, Ph.D.

Prologue

At this point in time, it is difficult to choose which field trip experiences to write about that would intrigue the reader. Time fogs my memory of many of them to relate interesting details of events and individuals. Old photographs help; student theses capture dates, excruciating detailed data and help bring back interesting happenings in the field that are not related in the scientific text. With that background in mind, I sit at my keyboard with stacks of old 35mm slides wrapped in deteriorating rubber bands and several student theses with whom I spent many pleasurable days in the field. I am not responsible for the great photography, but I did archive many slides for no apparent reason years ago and find them highly interesting and valuable today.

False Cape, Back Bay and Currituck Spit

Harold (Hank) Hennigar's 1979 thesis "Historical Evolution of Sand Dunes on Currituck Spit, Virginia/ North Carolina," is a great starting point for field adventures that Hank and I encountered mainly in the then relatively newly established False Cape State Park (FCSP) located between Back Bay National Wildlife Refuge and the North Carolina border. Today there is no vehicular traffic allowed into the park. Hiking, cycling, and tram are the only access through Back Bay National Wildlife Refuge which is the land connector to Virginia Beach (Sandbridge). False Cape is named after a definite bulge or projection of the Atlantic shoreline out into the ocean. Historically, a number of vessels approaching at night from the south, mistaking False Cape for Cape Henry, would turn to port and wreck in the shoals before discovering their error. Several buildings in now abandoned Wash Woods Village (the site now preserved in FCSP) were built of wooden shipwrecks. The only evidence of Wash Woods Village today is the brick foundation of the church, the wooden cedar shake church steeple, a graveyard and magnificent old live oaks. The village was pretty well leveled by the hurricane of 1933 which also did a lot of damage in tidewater Virginia and elsewhere along the coast. This devastating event also leveled much of the dunes and maritime forest in the FCSP compartment of Currituck Spit. Aerial photographs from 1937 documented the impact from 4 years earlier but at the same time reveal the beginnings of dune development, as described in Hank's thesis.



Exploring one of the early beach structures at False Cape.

My part of Hank's adventure came as one of his thesis committee members and my background in coastal vegetation. Dune vegetation plays a significant role in dune formation, particularly parabolic dune development. Without going into detail, parabolic dunes are crescent shaped dunes that have formed through time under the influence of prevailing winds and vegetation. These dunes are not common on maritime coasts and many of them have been bulldozed in the process of coastal development. Hank's thesis tells an extremely well documented story about parabolic dune formation in the FCSP sector. This section of Currituck Spit now has what is likely the most pristine parabolic dune field on the East Coast thanks to their protection in FCSP. Hank brought me along in the field to identify the existing vegetation and in the lab to interpret vegetation types on archival aerial imagery.

At the time of his investigation, the Park was virtually undeveloped. There was only one ranger (Bill Taylor) who lived with his wife in one the abandoned hunting cabins on Back Bay in the middle of the park. The couple was always happy for our visits and were a wealth of local knowledge which they shared with us. Hank and I would bunk in a nearby cabin if extended field work was needed. We traveled around the area in a 1950's vintage open Jeep bought surplus by VIMS. We would venture sometimes as far south as Corolla, NC, which at that time was a tiny fishing village accessible only via boat or jeep trails through the dunes, beach and maritime woods. Our only landmark from a distance was the nearby brick Currituck Lighthouse. How different from today. The Jeep was also used by VIMS folks including Andrew (Andy) Gutman (VIMS, MA 1978) who had a similar intriguing thesis topic "The In-

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teraction of Eolian Sand Transport, Vegetation and Dune Geomorphology, Currituck Spit, Virginia/North Carolina." In the early years, the park was littered with mostly abandoned beach shacks and house trailers on flimsy pilings, buried junk vehicles and derelict turn-of- the -century hunt club structures. Most interesting of all, however, were the old shipwrecks (mainly wooden frames) uncovered by shifting beach sand and dunes. The Environmental Education Center and natural history museum and lab in an old boat house at FCSP are showcases for visitors. The Center is a well built, rustic hunting lodge from the 1950's that now accommodates over 20 guests by appointment.

In addition to common and often abundant beach and dune plants such as American beach grass, running dune grass and seaside goldenrod, the False Cape/Back Bay maritime environment is home to a number of plant species that are near their northern or southern natural distribution limits. Notable among these dune plants is beach heather (*Hudsonia tomentosa),* a northern herb whose southern populations extend just a few miles into North Carolina on Currituck Spit. A well known dune grass, seaoats (*Uniola paniculata)* is a southern species that is abundant on the primary dunes in the FCSP/Back Bay area, but rare on the dunes of Eastern Shore. A dune shrub *Iva imbricata*, a close relative of marsh elder *(Iva frutescens)* a halophytic saltmarsh shrub, is a southern species that is found just a few miles north of the North Carolina border in FCSP.


Crescent-shaped parabolic dune at False Cape State Park.

The usually damp dune swales in FCSP and Back Bay also are home to the insectivorous sundews (*Drosera intermedia)* and the rare *(D. rotundifolia).* This maritime habitat is a treasure trove of rare and unique plants. One of the main adverse impacts to this unusual floral community is the rooting activities of wild pigs that likely escaped from pig lots years ago in the Wash Wood community. Large areas in FCSP/Back Bay appear as plowed fields after the creatures root in mass for roots and tubers. Hunters are allowed to bag them in October (while the Park is closed to the public) in order to attempt to control their numbers. They are quite secretive and are seen or heard mainly at night or when piglets are born in early spring. Their black, hairy backs are sometimes seen at a distance foraging in the marsh grass flats.

The old Jeep, alas, broke down (blown head gasket) on our last field trip (1978). To this day, I do not know what happened to it. Most of the abandoned shacks, trailers, vehicles and junk have been cleared away. However, shifting dunes often reveal the discards of the recent and distant past. Maybe the old Jeep will turn up someday as though reappearing out of a sand time-capsule.

Over the years, I have revisited this wonderful, wild place many times on class field trips, student research projects (Heather Jones, 1992 MA/W&M "A Vegetational Analysis of Interdunal Swale Communities of False Cape State Park, Currituck Spit, Virginia," overnighters at the EEC with my wife, friends and colleagues and more recently on a solitary bike trip from Sandbridge on a sunny October day. On that trip there were two unexpected bonuses encountered on the trip; a stubborn wild mare that was reluctant to let me pass on the narrow trial through a stand of live oaks and a beautiful legless glass lizard *(Ophisaurus attenuatus)* glistening in competition among jewel-like sundews in an open dune swale.

Editor's Note: This is the second installment in a series of career reminiscences written by Professor Emeritus Gene M. Silberhorn upon his retirement from the Virginia Institute of Marine Science, School of Marine Science, College of William and Mary. Dr. Silberhorn came to VIMS in 1972 and has distinguished himself in the field of wetlands and coastal botany. He has published several books and numerous scientific articles over his career as well as mentoring students and advising state officials regarding wetland policy and management. His first memoir appeared in the newsletter prior to this one (Vol.16, No. 2). Look for Gene to take us on another trip back in time next year.

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though technically possible, it is unlikely that one wetland would be converted to a different type of wetland as part of a mitigation or restoration plan. It is also unlikely that existing areas of residential, commercial, or industrial development would make plausible mitigation or restoration sites. Therefore, forested and agricultural areas present the best options.

In the study area, 26% and 28% of the landscape, respectively is forested or agricultural. Therefore, there is a significant amount of available land area within this landscape; which has traditionally been considered highly urbanized. In fact only 11% of the total area including surface water is developed (total area ~ 1 million acres). The acreage of land within the forested and agricultural areas which have hydric soil properties is actually less. The final Level 3 analysis indicates there are 54,527 acres of forested upland with hydric soil properties that are adjacent to and coincident with existing wetlands. There are 97,068 acres of land now engaged in some form of agriculture that also share these characteristics. It is this later set of polygons that present the highest likelihood for conversion based on the physical and landscape criteria integrated thus far.

Level 4 in the analysis considers land characteristics, not distinguished in traditional land use/land cover (lu/lc) datasets, that are more reflective of environmental planning and zoning practices. This step integrates conservation easements, special area management designations, or any proposed preservation corridors. Hydric soil polygons which meet all requirements for hydrologic connectivity, wetland adjacency, and land use (Level 3) are reevaluated based on their proximity to existing special habitat or conservation areas. Those polygons which are adjacent to lands with some special area designation are elevated in status as a preferred restoration or mitigation site.

Based on the hierarchical approach described above, some final decision rules propose to rank the polygons at each level. The ranking is reported in Table 3. Table 3 also reports results of the final model run for the entire study area using these criteria. A sample map (Figure 2, page 8) illustrates available sites based on the ranking system. This is a preliminary result. A field exercise is planned where random sites from each rank will be visited for verification. Final project maps will also distinguish available sites on the basis of size classes. This will allow the site selection process to choose from a selection of sites which meet either a mitigation size requirement, or the desired outcome of a proposed restoration project.

The final project analysis combines the modeling activity developed here with an earlier GIS model developed by the Chesapeake Bay Program (Chesapeake Bay Program, 1999). The Wetlands Initiative used GIS techniques to evaluate the functions that wetlands perform based on their position in the landscape. Five functions were modeled: habitat, water quality, erosion control, flood control, sediment retention. Designation of functionality was based on wetland type and the surrounding landuse. An attempt will be made to apply the Wetlands Initiative model to the site selection process developed here. In doing so, proposed wetland restoration sites are evaluated for their probability of performing these five functions, assuming wetland creation is successful. This exercise is particularly valuable if the restoration effort is trying to restore a specific function. The evaluation will provide some guidance for the selection of sites that have the ability to perform these functions based on their landscape position. All hydric soil polygons ranked good-excellent will be run through the model. Initial model runs will assume that the wetland created is a nontidal forested wetland. This is a likely assumption in this landscape.

Conclusions

The GIS model is a unique approach for targeting locations for on the ground wetland mitigation and restora-

Selection Rank	Rules (as they apply to hydric soils)	Polygon #	Total Acreage	Range (acres)
Potential	hydrologic connectivity	4,544	226,837	25-11,880
Moderate	hydrologic connectivity, adjacent to or coincident with wetlands	2,766	196,069	25-11,880
Good	hydrologic connectivity, adjacent to or coincident with wetlands, current lu/lc = forested	2,336	54,527	.25-2,849
High	hydrologic connectivity, adjacent to or coincident with wetlands, current lu/lc = agricultural	2,058	97,068	.25-5,945
High	hydrologic connectivity, adjacent to or coincident with wetlands, current lu/lc = forested, adjacent to special habitat area	132	1,736	.25-216
Excellent	hydrologic connectivity, adjacent to or coincident with wetlands, current lu/lc = agricultural, adjacent to special habitat area	109	7,430	.25- 3,107

Table 3. Selection criteria for wetland restoration/mitigation targeting.

Calendar *of Upcoming Events*

January 6-9, 2002	*Phragmites australis:* A Sheep in Wolf's Clothing? Vineland, NJ Contact Dr. Michael P. Weinstein, New Jersey Marine Sciences Consortium, Bldg #22, Fort Hancock, NJ 07732. Ph. 732-872-1300, Ext. 21. email: mweinstein@njmsc.org
Feb. 27-Mar. 1, 2002	5th National Mitigation Banking Conference. Washington, D.C. Contact: terrinst@aol.com Sponsor is the Terrene Institute, (703)584-5473. See program at, http://www.terrene.org and click on National Mitigation Banking Conference.
March 18-22, 2002	Sixth Marine Estuarine Shallow Water Science and Management Conference. Atlantic City, NJ. Contact Ralph Spagnolo, (215)814-2718, email: spagnolo.ralph@epa.gov
	VIMS Short Courses:
Dec. 13&14, 2001	**Winter Botany.** Contact Bill Roberts at; (804)684-7395 or email: wlr@vims.edu

tion projects. At this time, site selection is based only on available GIS data. The selection criteria does not consider topography, parcel geometry, land value, ownership, or probability for acquisition or availability. It is understood that these considerations will have to be evaluated on a case by case basis. The approach does, however, search the desired landscape for sites which meet (and do not meet) certain desirable characteristics. In doing so, the model potentially saves time and effort in the planning phase.

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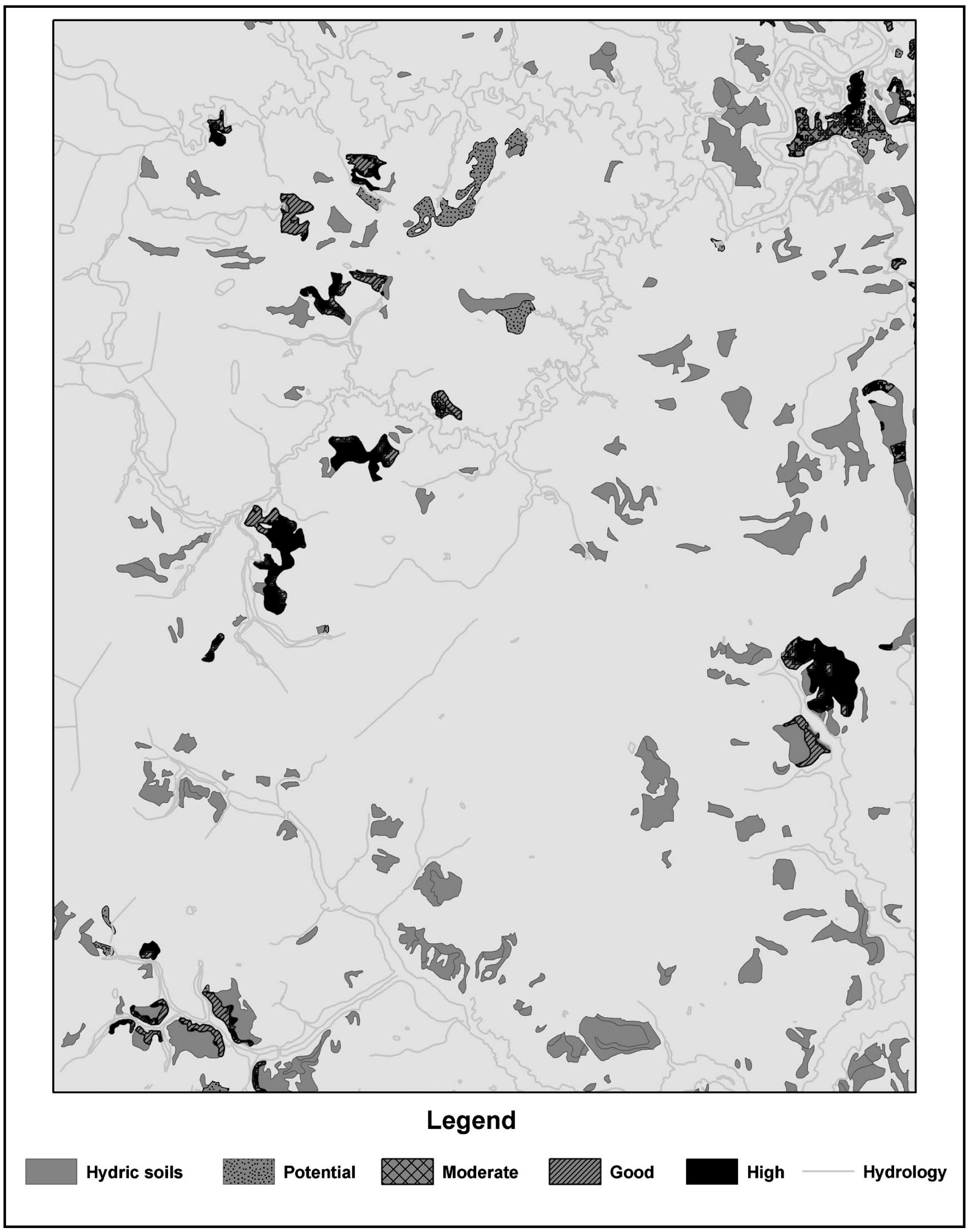

Figure 2. Hydric Soils Suitability Index for Wetland Restoration