MARINA SITE SUITABILITY TOOL

Final Project Report

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Executive Summary

In coordination with the Department of Conservation and Recreation, the Department of Environmental Quality, the Chesapeake Bay Local Assistance Department and the Virginia Marine Resources Commission (VMRC), the Center for Coastal Resources Management at the Virginia Institute of Marine Science (VIMS) was contracted to develop a tool for local governments that would assist in the decision-making process for marina development. In particular, the agencies wanted to develop a visual representation of the VMRC *Criteria for the Siting of Marinas or Community Facilities for Boat Mooring*. This was accomplished by gathering available data sets and developing geographic information system (GIS) data layers that can be used to determine the suitability of a shoreline for marina development.

Using shoreline areas demarcated in increments of 600 m (0.4 mile) longshore, this GIS modeling effort results in a mapping scheme showing color-coded segments for habitat, design, and water quality criteria. A summary map was also developed. The summary map should be the most appropriate to use in decision-making as it contains all information from the other three maps. It is anticipated that local and state agencies will utilize this tool when developing land use plans, reviewing permits, siting public access points, and considering options for economic development.

Introduction

The pressure to develop shoreline in the coastal plain of Virginia continues to increase. Concomitant with shoreline development is increasing demand for more or expanded marina facilities. Additionally, government policies and initiatives promote expanded public access to waters for recreational and commercial purposes. The demand for additional boat storage facilities will continue to increase as more people move to the coastal plain and join the recreational boating community.

As marina developers, or those expanding or purchasing old marinas with the intention to expand, acquire a parcel of land the issues of economic and environmental impacts are paramount to a project moving forward. If the area is environmentally sensitive then a protracted and expensive permitting process may ensue which can be resource intensive for both the applicant and the locality.

All local governments have designated shore land uses through zoning ordinances. These designations reflect the counties desired uses for waterfront property and may conflict with a property owner's desire to develop the land in a particular manner.

The Commonwealth of Virginia, through the Virginia Marine Resources Commission, developed detailed criteria for siting of marina facilities (VMRC, 1993) (Table 1). This project uses these VMRC marina siting criteria to develop a map portfolio of marina siting suitability for the tidal shoreline of Virginia. The siting criteria were divided into three categories: criteria mostly related to marina design, criteria mostly related to water quality considerations, and criteria mostly related to habitat considerations. Geographic Information System (GIS) algorithms were developed to model the VMRC criteria (Table 1) and create indices of suitability related to marina siting. The indices were summed within each category (design, water quality, and habitat) to identify areas as desirable, desirable with limitations, and undesirable for the location of a marina. A final summary incorporating all three categories was also created.

This project provides guidance for the location of marinas, which will help potential marina developers, state and natural resource agencies, regional planning districts, local

planning departments and community boards. Marina developers will have the ability to better locate areas for potential marina construction while state and local agencies will have information that will allow them to direct marina development to specific areas and away from sensitive natural resources. The potential economic and environmental benefits are broad. There is increased certainty that permit decisions will be positive through advanced identification of compatible land uses, sensitive resource areas, and maintaining the health of economically important natural resources. The process reduces the potential for loss of investment capital through improper siting and project delays; and enhances the state's and localities' ability to focus limited project review resources on the most environmentally sensitive areas.

By providing both the developer and the regulator with marina suitability maps of the shoreline, this tool will enhance comprehensive community development planning for both the developer and the manager. In doing so, this tool supports additional protection of coastal resources.

Protocol Introduction

The Center for Coastal Resources Management (CCRM) developed this tool using available GIS data, government specified criteria and scientific information to identify appropriate sites for future marinas. The marina siting criteria outlined in Table 1 is recommended by the Virginia Marine Resources Commission (VMRC) and was the basis for this project. A team of experts including planners, regulators, environmental managers, scientists, and GIS specialists collaborated on a protocol that became the basis for a series of GIS algorithms that would model the marina siting criteria.

The protocol assigns individual criteria to one or more of three major categories: **habitat, water quality,** and **design**. A criterion is numerically ranked to reflect relative importance in contributing to the value of the category. For each category, these individual ratings are combined to produce a ranking for the category. A final ranking combines points for each category.

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Table 1. Virginia Marine Resources Commission marina siting criteria checklist.

Criteria	Undesirable	Desirable	
Water depth	Less than 3 ft. MLW	Greater than 3 ft. MLW	v
Salinity	Suitable for shellfish growth	Unsuitable for shellfish growth	
Water quality	Approved, conditionally approved or seasonally approved or shellfish harvesting	Closed for direct marketing of shellfish. Little or no potential for future productivity	v
Designated shellfish grounds	Private leases or public oyster ground in proximity	No private leases or public ground within affected area. No potential for future productivity	v
Maximum wave height	Greater than 1 ft.	Less than 1 ft.	v
Current	Greater than 1 knot	Less than 1 knot	
Dredging	Requires frequent dredging	Does not require frequent maintenance	v
Flushing rate (Tidal exchange)	Inadequate to maintain water quality	Adequate to maintain water quality	
Proximity to natural or improved channel	Greater than 50 ft. to navigable water depths	Less than 50 ft. to navigable channel	v
Threatened or Endangered species	Present as defined in existing regulations, or project has potential to affect habitat	Absent; project will not affect	v
Adjacent wetlands	Cannot maintain suitable buffer	Suitable buffer to be maintained	v
Navigation and safety	Water body difficult to navigate or presently overcrowded conditions exist	Navigation not impeded	v
Existing use of site	Presently used for skiing, crabbing, fishing, swimming or other potentially conflicting uses	Not presently used for skiing, fishing, swimming or other recreational use	v
Submerged aquatic vegetation	Present	Absent	v
Shoreline Stabilization	Bulkheading required	Shoreline protected by natural or planted vegetation or riprap	
Erosion control structures	Groins and/or jetties necessary	No artificial structures needed	
Finfish habitat usage	Important spawning and nursery area	Unimportant area for spawning or nursery for any commercially or recreationally valuable species	v

v = Criterion used with GIS coverage to develop indices. (After VMRC, 1993)

For example, in the category "habitat" the presence or absence of the following criteria are considered: sav, wetlands, threatened and endangered species, shellfish grounds, and riparian forest. The ranking system assigns points based on a set of defined rules for each criterion. This is discussed further in the following section.

Each shore segment is evaluated for each of the three major categories. A cumulative assessment combines the three groups to complete the evaluation for a site. Three possible levels of suitability can be assigned for a site: high (desirable), moderate (desirable with limitations), low (undesirable). The suitability levels are intended for general guidance related to marine environmental concerns. Additional issues involving local community planning (i.e. local zoning) are not reflected in this project.

GIS Protocol

The protocol developed by the technical advisory team worked through the original VMRC criteria (Table 1) and determined which of these could be modeled using GIS. Availability of GIS data was a key factor. In the absence of GIS data, surrogate data sources were considered. Seventeen original criteria are listed in the Siting Criteria Checklist (Table 1). Thirteen were modeled, including those for which surrogates have been defined (Table 2). Four criteria could not be modeled due to absence of available data. An additional criteria was added to evaluate riparian land use; a concern for local planners. Each of these can be related to one or more of the three major categories: habitat, water quality, and design. Appendix 1 reports this breakdown.

A set of GIS rules was required to model the requirements for each criterion. In some cases, only presence or absence of a feature was necessary. The last stage of the protocol development included the design of an evaluation scheme, which assigned points to value the contribution that a particular criterion made in siting future marina construction. The point system is reported in Appendix 1. The higher the point value assigned, the more suitable a site is for marina development. The suitability index of high, medium, and low is based on a 33.3% point spread for any criterion. Therefore if the total number of potential points is 15 and a site ranks 5 then the ranking for that criterion would be "low". If the ranking was 13,

the site would score a "high" for that criterion. Two criterion, threatened or endangered species and designated shellfish grounds, were automatically ranked as low if an endangered species or public oyster ground were identified within the sample area. This modification was incorporated into the ranking system to recognize the increased regulatory scrutiny associated with having either of these two items on site.

All evaluations were made on landscape units (segments) which were 600m alongshore, 30m inland, and 200 m seaward of the shoreline (Figure 1). This unit of measurement satisfied several issues of concern. The inland width was sufficiently wide to capture riparian land use, and the longshore length could analyze for even small, community level marina construction. The seaward limit could reasonably address water depth, and intertidal habitat communities which may persist and be impacted by pier construction or
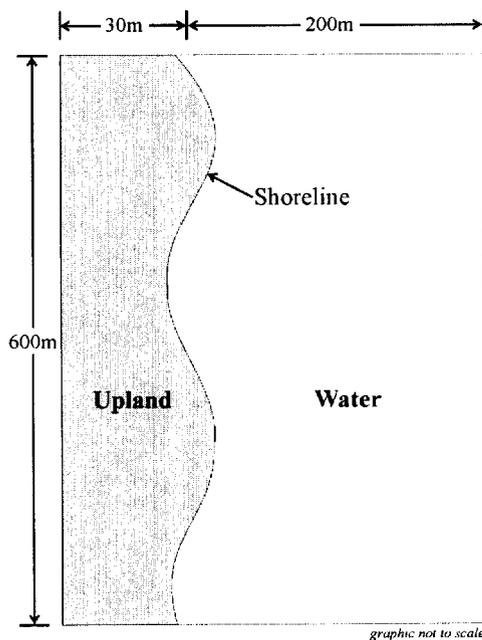

Figure 1. Shoreline analyzed in 600 meter by 230 meter blocks

Table 2. Original vs. Modeled Criteria for Marina Siting

Original Criteria (from Table 1)	Modeled Criteria
Water Depth	2 meter contour
Salinity	Shellfish grounds
Water Quality	Shellfish Condemnation Zones
Designated shellfish grounds	Public or private oyster grounds
Maximum wave height	Fetch distance from shoreline
Dredging	Distance to the 2m contour
Proximity to Natural Channel	Distance to the 2m contour
Threatened or Endangered Species	Rare, threatened, or endangered species habitat
Adjacent Wetlands	Tidal marsh inventory
Navigation and Safety	Distance to 2m contour is > 50% creek width
Existing Use of Site	Considers aquaculture, oyster reefs, public beaches, mud flats
Submerged Aquatic Vegetation	Submerged aquatic vegetation
Finfish Habitat	Assumes SAV and Wetlands

Not Modeled: Current velocity, flushing rate, shoreline stabilization, and erosion control
Added criteria: Riparian land use to consider local planning and development needs.

dredging activity.

The algorithms written to model the protocols were prepared using the Environmental Systems Research Institute's (ESRI) Arc Macro Language (aml) for use with the ArcInfo® Geographic Information System software. ArcInfo was run in a unix computing environment.

Model Output

After processing all the GIS data and ranking conditions for each criterion, the analysis generates four GIS coverages. They represent the following: marina suitability evaluation based on water quality parameters, marina suitability evaluation based on habitat parameters, marina suitability evaluation based on design parameters, and a summary coverage which represents a combined assessment of all three parameters. It is the latter that ultimately

describes a location as suitable for marina construction based on the MRC criteria. All four coverages are ranked as 1) high: desirable; 2) moderate: desirable with limitations; 3) low: undesirable.

Products

Products for this project are delivered in digital formats only. They are available to the general public via the internet, and selected agencies and localities on CD. A website has been developed to link clients to maps and GIS data. Maps illustrate the distribution of suitability within the tidal waters of Virginia. The region is divided into a series of plates. A user clicks on the category (habitat, water quality, design, or summary) they wish to view and then selects the area of interest from an index map. The maps are in color and can be downloaded. It is the "Summary" map which provides the final ranking based on a cumulative evaluation of the three main categories. Viewing the individual categories, however, allows a user to see which categories may have forced a particular region to have an overall "desirable", "desirable with limitations", or "undesirable" ranking.

The final four GIS coverages can also be downloaded from the website. These are posted as ArcInfo export files and shape files. The projection is Universal Transverse Mercator zone 18 (UTM), and uses the North American Datum of 1983 (NAD83). From attribute tables, a GIS user can view the actual rankings for individual criteria, and therefore know the impact a specific criterion has on rankings. Documentation for the GIS data is contained within the metadata file available at the same site. The project home page is located at this url: **http://www.vims.edu/ccrm/marinasiting.htm**.

Basic Steps

The amount of information that can be extracted from the products depends on user's knowledge, experience and capabilities. GIS users can extract more information than non-GIS users. Here are some basic steps to follow when using this tool for the first time.

1) From the website or CD open the Summary Map Index. This map illustrates the tidal portion of Virginia and divides the region into 28 plates. Click on the plate which encompasses your area of interest. This will take you to the final suitability rankings for that area.

2) The plate map will be titled, " Marina Suitability Evaluation Based on Design, Habitat, and Water Quality Parameters". The title indicates it includes all criteria in the three major categories. The map has a series of uniform color coded rectangles along the shore. Each rectangle represents the landscape unit discussed previously (Figure 1). The color represents the final ranking assigned to that unit. Purple indicates a site highly desirable for development of a marina. Orange indicates the site is desirable, but there may be some factors which present some limitations. If the unit is yellow, the site has low suitability and is therefore undesirable. Ideally, contiguous units of purple represent sites best suited for marina development. The number of landscape units required would depend on the size of the proposed marina. A small community marina may only require one landscape unit. A large full service marina may require several.

3) Also provided are the three maps that illustrate the evaluation for each major category. These can be viewed by opening either Design, Habitat, or Water Quality Indices. They are viewed just like the Summary Map. Click the plate on the index map to view the results for the area of interest. Here you can see whether a category (i.e. the cumulative assessment of all criteria within that category) played a significant role in determining the overall suitability of a site. For example, if the shoreline segments selected have an overall "low" suitability for marina development, and the same segments rank "low" for Habitat, "moderate" for Design, and "moderate" for Water Quality, conditions related to habitat are most likely causing the site to have an overall evaluation of undesirable for marina development.

4) More specifics related to each category can be viewed if the GIS data can be accessed through either ArcView or ArcInfo. For example, in ArcView, select a segment in a

particular theme and look at the attribute table associated with the segment. Here you will be able to see all the individual criteria and their rank for each category. If you compare the designated ranking with the potential point spread reported in Appendix 1, the significance of a particular criterion to the decision process can be ascertained.

Acknowledgments

References

Virginia Marine Resources Commission. 1993. Subaqueous Guidelines. Virginia Marine Resources Commission, Newport News, Virginia, 34pp.

Appendix 1. Marina Siting Criteria and Applied GIS Protocol

Category	Criteria	GIS Data	RULE	Ranking
Habitat	shellfish grounds	public oyster leases private oyster leases	presence/absence presence/absence	p = 0; a = 5 p = 0; a = 5
Habitat	threatened and endangered sp.	natural heritage info	presence/absence	p = 0; a = 5
Habitat	SAV	SAV distribution	shore to 2m contour >2m absent	yes = 0 yes = 1 yes = 5
Habitat	Wetlands	VIMS TMI	presence/absence	tidal fresh = 0 Group 1 = 1 Group 2 = 2 Group 3 = 3 Group 4 = 4 Group 5 = 4 absent = 6
Habitat	Riparian Forest	MRLC dataset	presence/absence	100-80.1% = 0 80-60.1% = 1 60-40.1% = 2 40-20.1% = 3 20-1.0% = 4 < 1% = 5
Water Quality	Shellfish condemnation zones	condemnation zone	opened/closed	open = 0 seasonally cond. = 4 permanently cond. = 5

Category	Criteria	GIS Data	RULE	Ranking
Water Quality	Dredging	2m contour	distance 2m contour	>200m = 0 200-150.1m = 1 150-100.1m = 2 100-50.1m = 3 50-10 m = 4 < 10 m = 5
Water Quality	Wetlands	Tidal Marsh Inventory	see Habitat	
Water Quality	Riparian Forest	MRLC dataset	see Habitat	
Design	Dredging	2m contour	see Water Quality	
Design	Wave Height	Exposure	distance from shore to shore	<2km=5 >2km=0
Design	Proximity to Channel	bathymetry	distance 2m contour	> 15 m = 0 < 15 m = 5
Design	Navigation and Safety	bathymetry	distance 2m contour is > 50% creek width	yes = 0 no = 5
Design	Existing Uses	aquaculture sites	cumulative presence/absence restored Oyster Reefs public Beaches mud flats	1 or less = 0 >1 = 5

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