A Critique of Existing Methodologies for Developing Shoreline Recommendations for Local Governments

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Center for Coastal Resources Management

Virginia Institute of Marine Science

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This project was funded in part by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA08NOS4190466, FY 2008, Task 2.03, of the United States Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.

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Executive Summary

The purpose of this study is to define a methodology for making shoreline management recommendations to local governments. Two methods were intensely reviewed for consideration as a state-wide preferred approach to delivering information to assist local governments. One approach is field intensive while the other uses best available data and an automated geo-spatial model to reach the desired output.

A study approach developed by the Shoreline Studies Program (SPP) at the Virginia Institute of Marine Science (VIMS) relies on field data, field reconnaissance and laboratory reviews to map the recommended shoreline strategies for erosion control. The SPP approach includes a historical analysis of shoreline trends, detailed design schematics for structural control, and other ancillary parameters. The approach developed by the Center for Coastal Resources Management (CCRM) uses GIS to map recommended shoreline strategies for erosion control based on a geospatial decision support tool they developed known as the Shoreline Management Model (SMM). The model uses available field data (Shoreline Inventory) , external GIS data (e.g. bathymetry) and models to determine preferred strategies.

Three pilot areas (Mathews County, Occahannock Creek, and Lower Machodoc Creek) were selected to conduct comparisons of accuracies, both independent and combined, time and effort, content and product output. Further input was gathered from a large audience of stakeholders who gathered at VIMS for a semi-annual Tidal Wetlands Workshop in November, 2010. This audience represented a fairly robust sample of the intended target audience for these products. The audience participated in a number of voting and prioritization exercises to arrive at 1) content material held most valuable, and 2) the format for product delivery. The results have been compiled in this report.

Following a review of all results it was determined that both methodologies contribute important elements to a county-wide Shoreline Management Plan. Therefore a hybrid has been recommended. The CCRM geospatial model provides comparable output for recommended erosion control strategies at significantly less time and effort than the SSP approach and should be the accepted method for delivering recommended erosion control strategies to local governments on a site by site basis. The CCRM model, however, does not develop cross sectional structure design and estimates. This information should continue to be provided for areas where the model recommends structural control. Shoreline Evolution Reports, developed by SPP and report on trends in shoreline change over time should also be included in a Shoreline Management Plan. The analysis of shoreline trends can include a wave climate assessment and characterization of underlying geology and geomorphology where available.

Shoreline Management Plans should be delivered to localities via an internet accessible website. Reported information in both map and digital data is recommended at this time. Depicting data within the framework of an interactive “Google” type interface should be considered for the future.

Acknowledgment

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A Critique of Existing Methodologies for Developing Shoreline Recommendations for Local Governments

1.0 Project Objectives

The purpose of this study is to define a methodology for making shoreline management recommendations to local governments. There are two methods currently being considered for adoption as a state-wide preferred approach to delivering information to assist local governments. One approach is field intensive while the other uses best available data and an automated geo-spatial model to reach the desired output. The final recommendation generated from this study may be one of these methodologies, but a hybrid option is also possible.

1.1 Study Approach

To arrive at the determination, a practical review of the two methods was undertaken. This review included a comparison of accuracies, both independent and combined. To the extent possible an assessment of effort to derive products was produced. Not only did this include time but also content. To arrive at these data necessary for a comparison of approaches 3 pilot areas were used: Mathews County, Occahannock Creek on the Eastern Shore, and Lower Machodoc Creek on the Northern Neck. For these areas, both methods were applied to compare the outputs.

To determine value of content material to the user audience, 52 (52) diverse members of the anticipated user community were surveyed and queried as part of a hands-on workshop hosted by the Center for Coastal Resources Management at the Virginia Institute of Marine Science.

The results are reported in two sections. Section 2.0 discusses the comparison of the two methods directly including accuracy, time and effort. Section 3.0 discusses the results of the user audience input on content and format. The recommended strategy for providing guidance to local governments is presented in section 4.0.

2.0 Summary of Methodologies

2.1 Shoreline Management Plan by the Shoreline Studies Program (SSP)

The Shoreline Management Plan offers management strategies for sections of inhabited, unaltered, eroding shoreline. This work relies on field data collected as part of the Virginia Shoreline Inventory Series as well as extensive subsequent field work to assess site specific conditions for determining appropriate methods to counter the erosion problem on site. The secondary field crew of two verifies conditions on site including state of erosion, fetch, nearshore bathymetry, upland slope, and the presence of vegetation. Each site is documented with a digital photograph and the geographic coordinates are collected with a GPS unit. A management recommendation is made for the site and this information is transferred into GIS using ArcMap9.2. Typical cross-sections with generalized cost

estimates are generated for recommendations that include structural alternatives. Management options range from vegetation management to structural erosion control and are reported at the scale of individual property levels.

The Shoreline Management Plans developed under this program also includes details that pertain to historic geology, shoreline evolution, and wave climate. The program combines this background information with the shoreline management recommendations which are delivered in both tabular and map format.

2.2 Geospatial Shoreline Management Model by the Center for Coastal Resources Management (CCRM)

The automated Geospatial Shoreline Management Model (SMM) uses GIS and available spatial data to delineate a preferred alternative to counter shoreline erosion. The model seeks to support integrated guidance at the management level and therefore assumes that there is an existing or perceived erosion problem on site. The model defines a suite of variables to classify shorelines suitable for soft shoreline control, but understands that the preferred option can include structure where necessary. The variables used in the model include fetch, nearshore bathymetry, bank condition, marsh presence, beach presence, and tree canopy presence. The SMM is a logic model that follows a Decision Tree support system developed by CCRM to arrive at its recommendation. The model was written in ArcMap, ArcGIS version 9.3.1.

The Virginia Shoreline Inventory Series is the source for the majority of the data inputs which contains information on bank height, bank erosion, and presence of beach, marsh, and forest cover. Additional GIS based data and models are used to characterize other attributes such as fetch and nearshore bathymetry. Parameters are classified into groups based on the limits established by the Decision Tree and logical paths along the tree are followed using algorithms written for the ArcGIS Model Builder.

The model outputs 11 different treatment options that range from “Do Nothing” to revetment construction with a focus on living shoreline hybrid options. The model reports information at the scale of individual property levels. No field work is required beyond that which is necessary to collect the VA Shoreline Inventory data. Data are delivered in map and GIS format.

2.3 – Comparison of Both Methodologies

Outputs from both methodologies where compared at different levels. Geospatial and analytical analyses were conducted to compare the coverage and agreement of recommendations provided by both approaches. Original data sets needed to be edited (i.e. referenced to the same base shoreline) in order to make them comparables for the analysis. Different geospatial tools included in ArcGIS (e.g. buffer, identity, among others) were used to derive a common shoreline. After the final editing, total

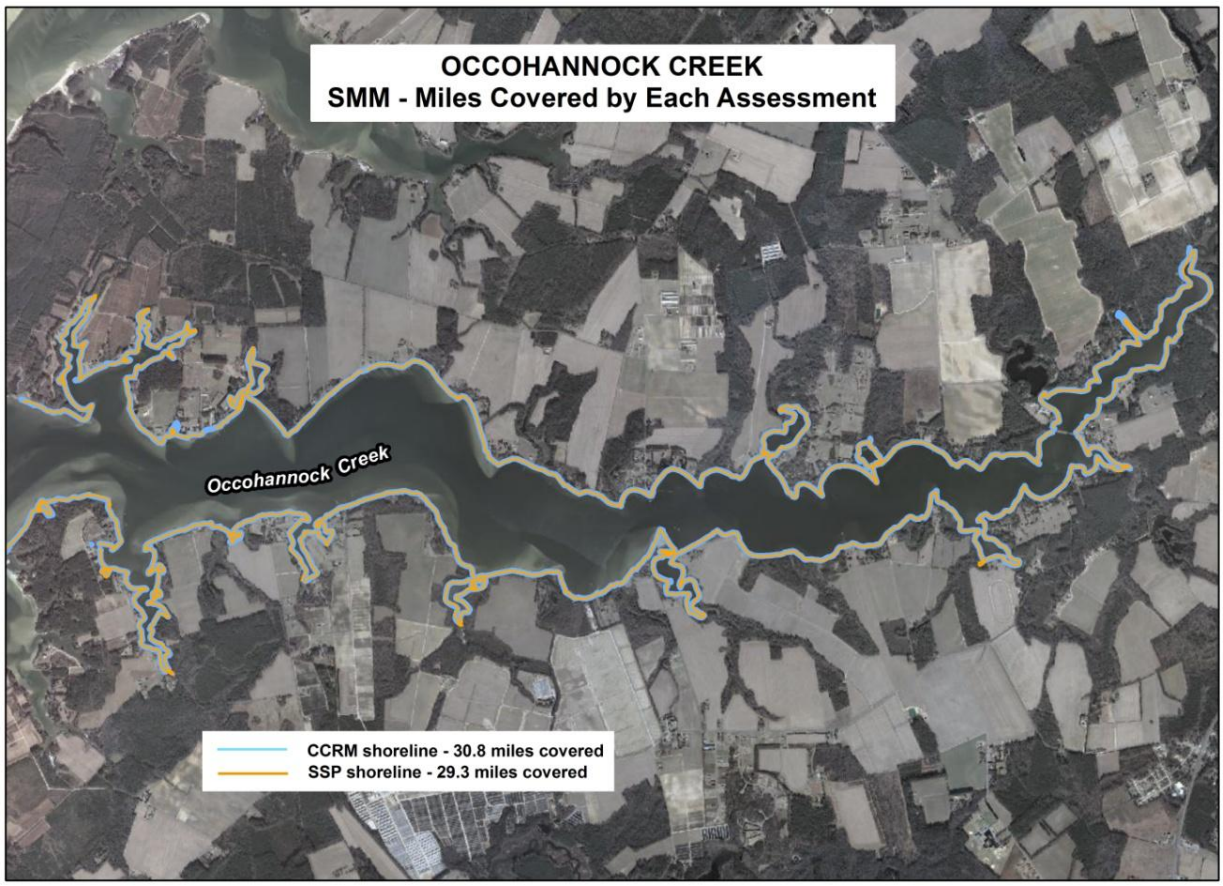
mileage of shoreline assessed by each methodology was computed for the three pilot areas. Subsequently, recommendations provided by the two approaches were compared along the shoreline.

The classifications of recommendations used for each of the three pilot areas are different. For that reason, a generalized classification of recommendations was made, so comparable outputs can be identified. The individual classifications and the final general classification of recommendations are shown in the following table.

SHORELINE STUDIES *(Mathews County and Occohannock Creek)*	**Northern Neck Planning District Commission** *(Lower Machodoc Creek)*	**CCRM - Comparable Recommendation**
Beach Fill		Beach Nourishment
Breakwaters		Breakwaters
Breakwaters with Beach Fill		Breakwaters
Small Low Sill		Marsh with Sill
Low Sill		Marsh with Sill
Low Sill with Beach Fill		Marsh with Sill plus Beach Nourishment
Medium Sill		Marsh with Sill
High Sill		Marsh with Sill
Revetment/Riprap		Revetment
Marsh Management		Vegetation Management
Not action needed		No action needed
NA (structure)		Currently defended
Low Sill; Spur and Beach Fill		not equivalent
Breakwater; Spur and Beach Fill		not equivalent
Sand with Groins		not equivalent
Spur		not equivalent
Spur with Low Sill		not equivalent
Spurs with Beach Fill		not equivalent
	Marsh Fringe with Breakwaters	Marsh with Sill
	Fringe Marsh Creation or Restoration	Vegetation Management only
	Beach Replenishment	Beach Nourishment
	Fringe Marsh Creation W/Coir Logs	Marsh with Biologs
	Marsh Fringe with Sills	Marsh with Sill
	Marsh Toe Revetment	Marsh with Sill
	Revetment	Revetment
	Breakwater Systems	Breakwaters
	Dune Grass	not equivalent
	Marsh Fringe with Groins	not equivalent
	Spurs	not equivalent
		Bank grading (RIPARIAN AND BANK ACTIONS)
		Upland management (UPLAND ACTIONS)

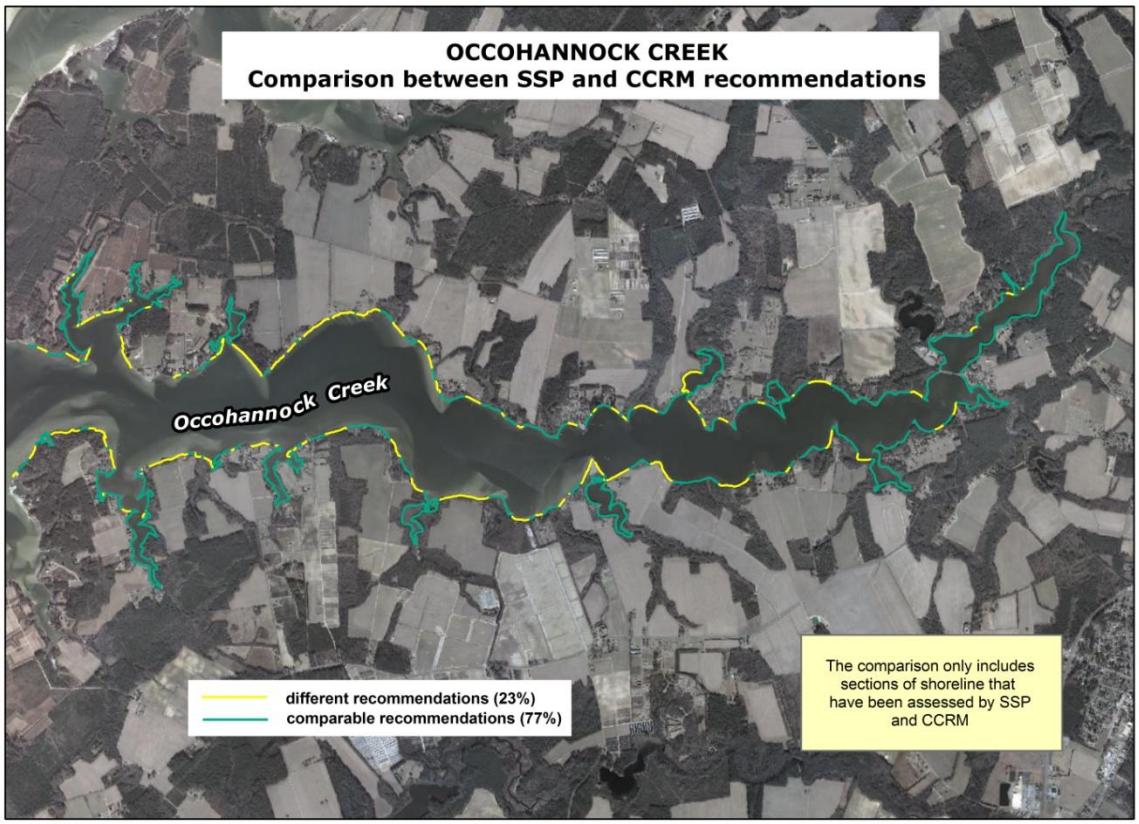
2.3.a– Occohannock Creek

A shapefile representing the 2002 shoreline from Virginia Base Mapping Program (VBMP) was used by SSP to develop the Shoreline Management Plan for Occohannock Creek. The Shoreline Management Model output derived from CCRM is referenced to the 2007 VBMP shoreline. Given that both outputs are based on different shorelines, editing of the two data sets was necessary in order to make them spatially comparable (common shoreline). After editing, the total amount of miles covered by each methodology was determined.



The comparison of the outputs (recommendations) generated by both approaches only included sections of the shoreline that have been assessed by the Geospatial Shoreline Management Model (SMM) of the Center for Coastal Resources Management (CCRM), and by the Shoreline Studies Program (SSP). Since the CCRM method generally covered more shoreline than the SSP method, editing the data was necessary to remove from the analysis areas with coverage provided only by CCRM. In addition, the features coded as "NA" (not available) in the SSP data set were excluded. Since the SSP method does not make recommendations for shoreline that already altered, those areas currently defended in the CCRM analysis had to be removed from the analysis, unless SSP provides any type of recommendation for that section. In that case, the "currently defended" coding was replaced by the output (recommendation) obtained with the CCRM model for 'Living Shoreline Model-Defended model'. This model makes the assumption that the shoreline structure has failed and evaluates the shoreline and makes treatment recommendations.

Both data sets were combined and saved as a separated file. A series of queries were run to identify where both methodologies recommend the same or different shoreline treatment. Total mileages of shoreline with comparable and different recommendations were calculated and percentages were obtained.



After obtaining the percentage of agreement and disagreement in the recommendations provided by each assessment, a frequency analysis was conducted to identify where the differences between the approaches were greatest. For this particular study area, the categories “vegetation management only” and “no action needed” were combined.

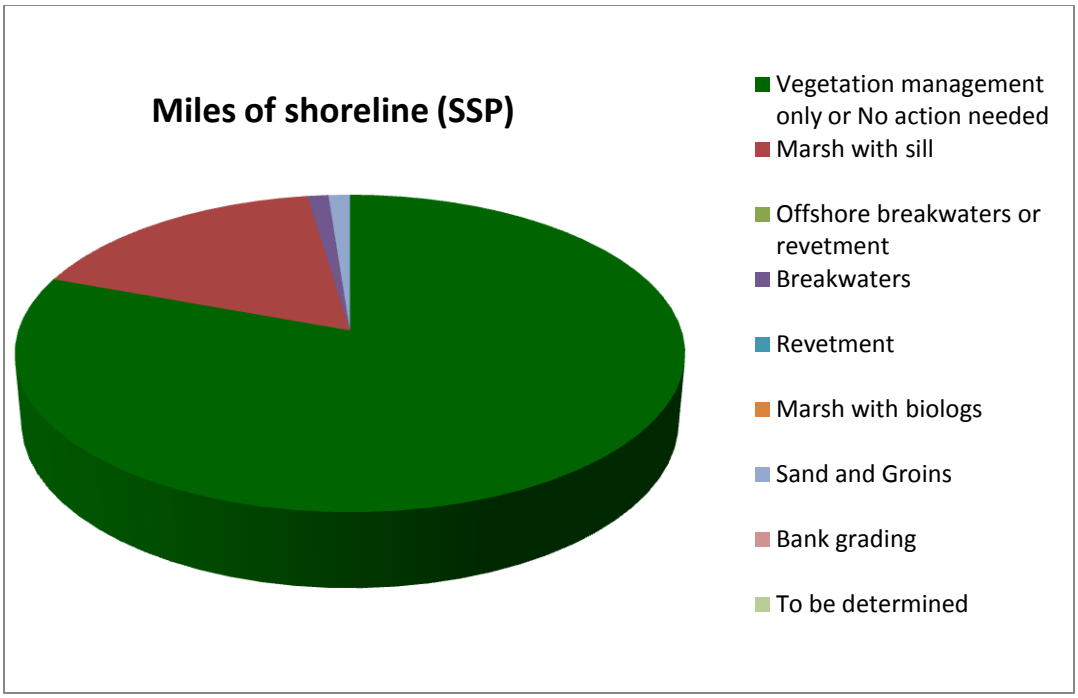
OCCOHANNOCK CREEK - Frequency Analysis

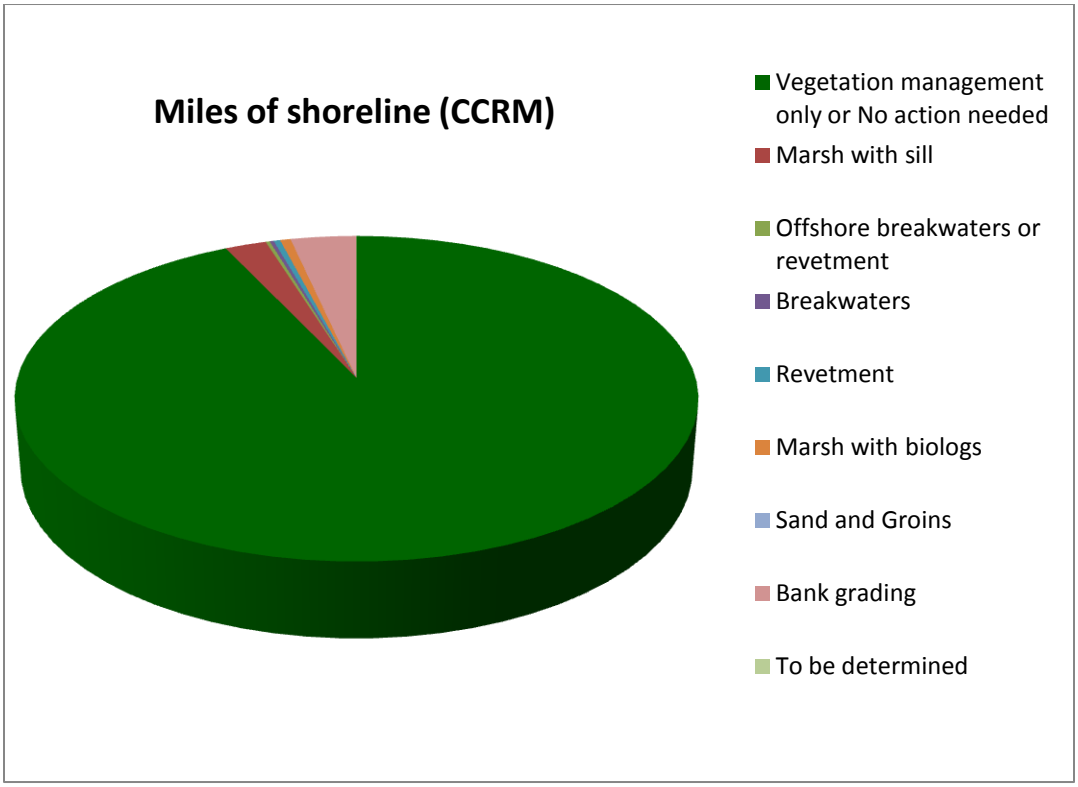
FREQUENCY	SSP assessment	CCRM model
1690	veg. mgt. only or NAN	veg. mgt. only or NAN
4	Breakwaters	Offshore breakwaters
18	Marsh with sill	Marsh with sill
3	Breakwaters	Bank grading
16	Breakwaters	veg. mgt. only or NAN
37	Marsh with sill	Bank grading
4	Marsh with sill	Offshore breakwaters or revetment
2	Marsh with sill	Revetment
291	Marsh with sill	veg. mgt. only or NAN
2	Sand and Groins	Marsh with biologs
4	Sand and Groins	Marsh with sill
9	Sand and Groins	veg. mgt. only or NAN
101	veg. mgt. only or NAN	Bank grading
3	veg. mgt. only or NAN	Marsh with biologs
42	veg. mgt. only or NAN	Marsh with sill
14	veg. mgt. only or NAN	Revetment
3	veg. mgt. only or NAN	TBD

veg. mgt. only = vegetation management only
NAN = no action needed
TBD = to be determined

OCCOHANNOCK CREEK – Length of the shoreline assigned with a particular recommendation:

Recommendation	Miles of shoreline (SSP)	Miles of shoreline (CCRM)
Vegetation management only or No action needed	23.619	27.225
Marsh with sill	4.990	0.648
Offshore breakwaters or revetment	0.000	0.063
Breakwaters	0.340	0.064
Revetment	0.000	0.102
Marsh with Biologs	0.000	0.164
Sand and Groins	0.348	0.000
Bank grading	0.000	1.027
To be determined	0.000	0.005


Miles of shoreline (SSP)
Vegetation management only or No action needed
Marsh with sill
Offshore breakwaters or revetment
Breakwaters
Revetment
Marsh with biologs
Sand and Groins
Bank grading
To be determined


Miles of shoreline (CCRM)
Vegetation management only or No action needed
Marsh with sill
Offshore breakwaters or revetment
Breakwaters
Revetment
Marsh with biologs
Sand and Groins
Bank grading
To be determined

2.3.b– Lower Machodoc Creek

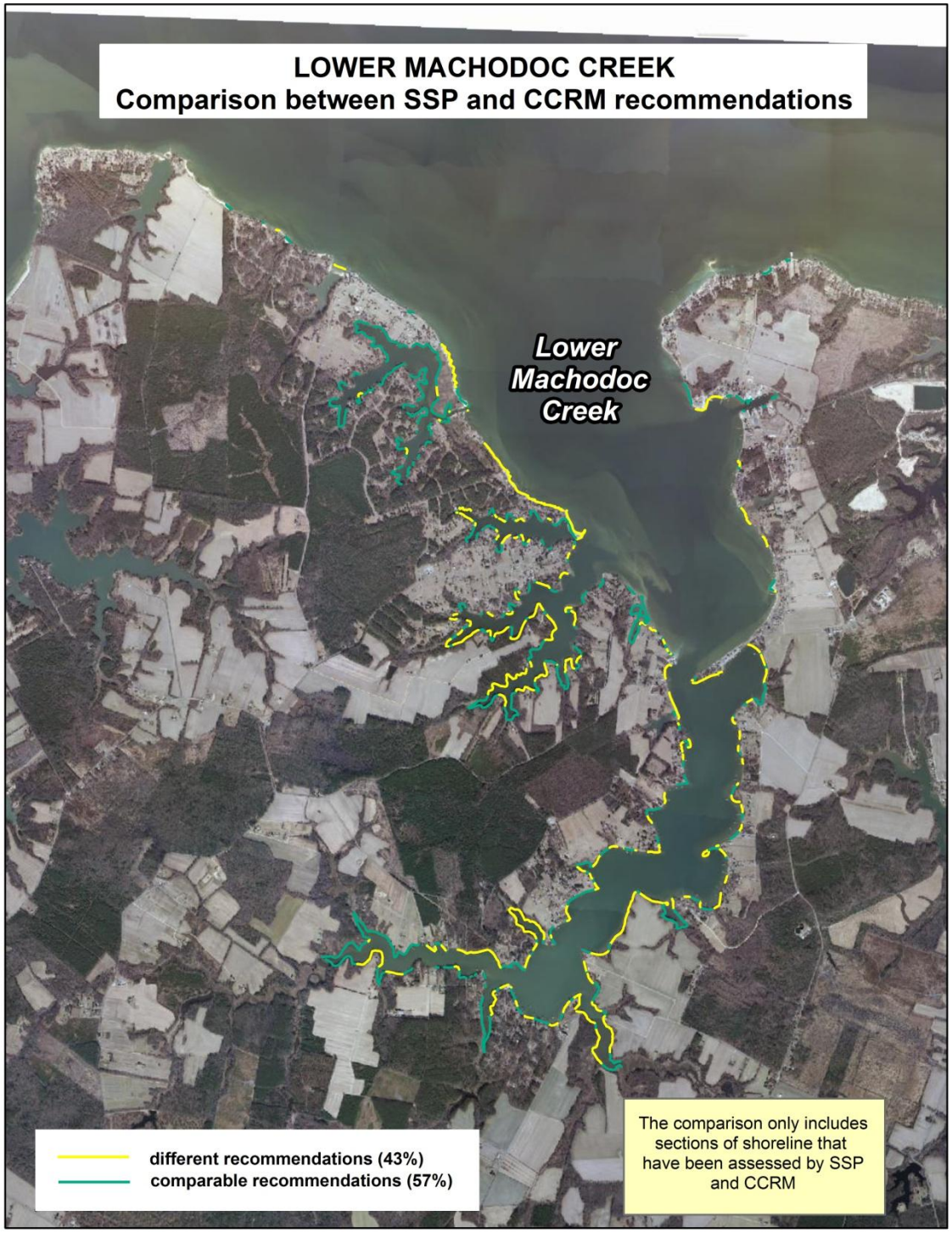
The total miles of shoreline covered by each methodology were first evaluated. Geoprocessing of both data sets was needed to combine them as an integrated shoreline to facilitate the analysis. The SMM developed by CCRM has greater coverage. This difference can be attributed to those segments that are currently defended, and hence, only evaluated by the CCRM model.

In the same manner applied for Occohannock Creek, the comparison of the recommendations generated by both approaches included only those shoreline miles that were assessed in both approaches. Sections of the shoreline covered only by CCRM were excluded for this part of the analysis. Sections of shoreline coded as “currently defended” by CCRM were not considered in the calculations unless SSP provides any type of recommendation for that section. In that case, the “currently defended” coding was replaced by the output (recommendation) obtained with the CCRM model for 'Living Shoreline Model-Defended model'.

The final file, which included the output of both data sets, was used to run a series of queries. This step identified where the methodologies recommend the similar or different shoreline treatments. Total mileages of shoreline with comparable and different recommendations were calculated and percentages were acquired.

Finally, a frequency analysis was conducted to identify the occurrences of the different recommendations suggested by SSP and CCRM. In addition, total miles of shoreline coded with the different recommendations were identified and computed in order to compare both approaches.


LOWER MACHODOC CREEK
Miles Covered by Each Assessment
Lower
Machodoc
Creek
CCRM shoreline - 34.9 miles covered
SSP shoreline - 22.6 miles covered
The extra segments of shoreline assessed by the CCRM model correspond to sections of shoreline that are currently defended


LOWER MACHODOC CREEK
Comparison between SSP and CCRM recommendations
Lower Machodoc Creek
different recommendations (43%)
comparable recommendations (57%)
The comparison only includes sections of shoreline that have been assessed by SSP and CCRM

LOWER MACHODOC CREEK - Frequency Analysis

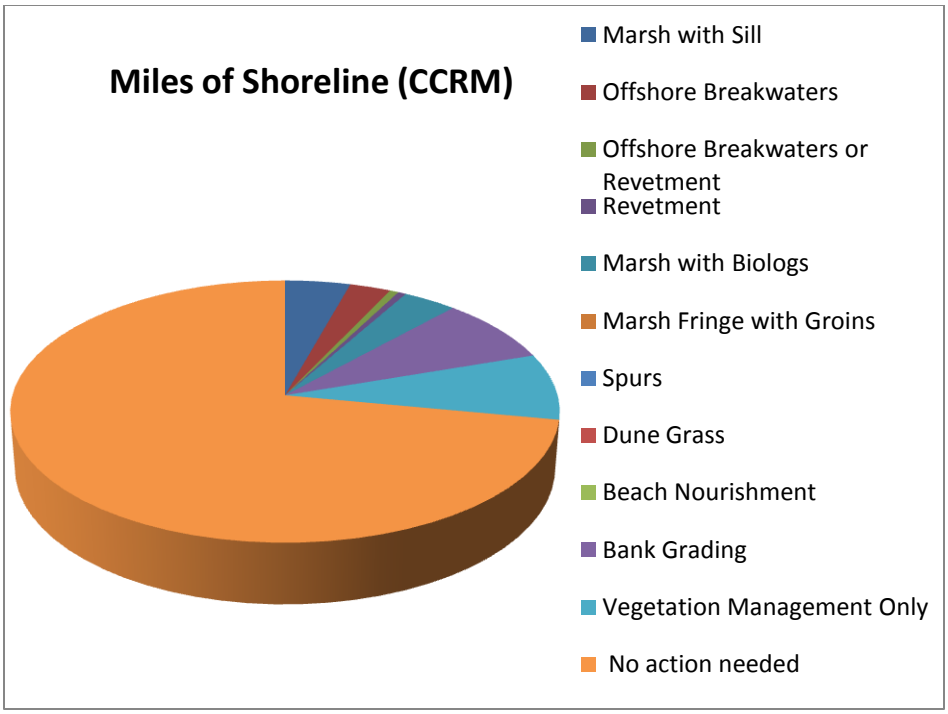
FREQUENCY	CCRM model	SSP (eq. Classification)
688	No action needed	No action needed
15	Marsh with sill	Marsh with sill
13	Vegetation management only	Vegetation Management Only
3	Offshore breakwaters	Offshore Breakwaters
1	Revetment	Revetments
3	Bank grading	Beach Nourishment
2	Bank grading	Marsh Fringe with Groins
17	Bank grading	Marsh with sill
97	Bank grading	No action needed
1	Bank grading	Revetments
30	Bank grading	Vegetation Management Only
5	Marsh with biologs	Marsh Fringe with Groins
14	Marsh with biologs	Marsh with sill
16	Marsh with biologs	No action needed
24	Marsh with biologs	Vegetation Management Only
7	Marsh with sill	Dune Grass
2	Marsh with sill	Marsh Fringe with Groins
18	Marsh with sill	No action needed
14	Marsh with sill	Offshore Breakwaters
1	Marsh with sill	Revetments
1	Marsh with sill	Spurs
20	Marsh with sill	Vegetation Management Only
24	No action needed	Beach Nourishment
1	No action needed	Dune Grass
16	No action needed	Marsh Fringe with Groins
3	No action needed	Marsh with biologs
16	No action needed	Marsh with sill
11	No action needed	Offshore Breakwaters
2	No action needed	Revetments
7	No action needed	Spurs
167	No action needed	Vegetation Management Only
3	Offshore breakwaters	Beach Nourishment
34	Offshore breakwaters	Dune Grass
1	Offshore breakwaters	Marsh with sill
1	Offshore breakwaters	No action needed
4	Offshore breakwaters	Revetments
5	Offshore breakwaters	Spurs

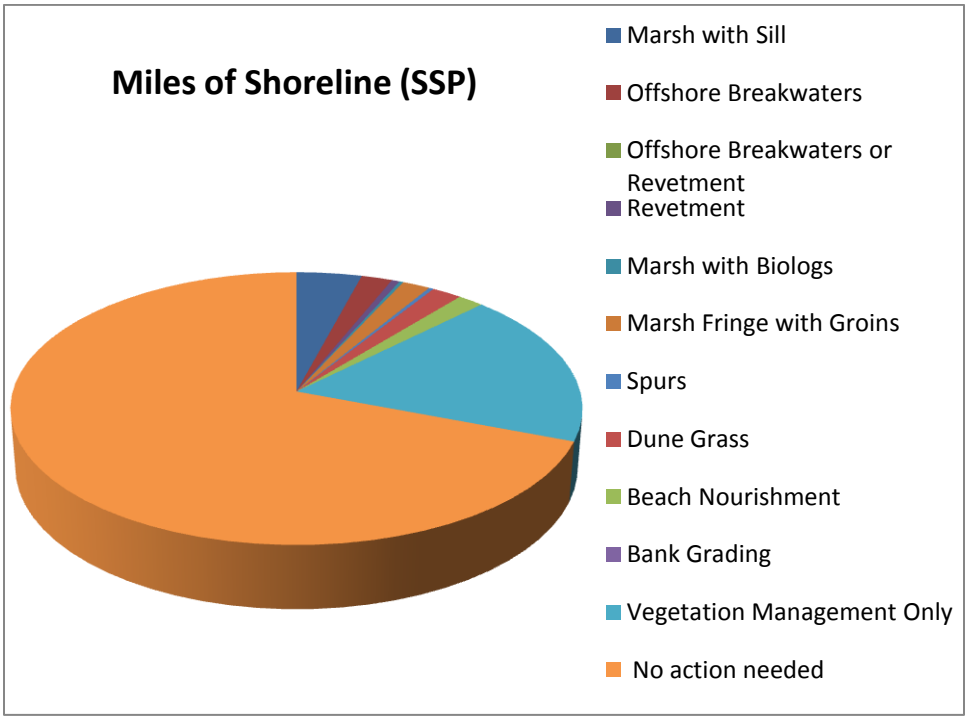
4	Offshore breakwaters or revetment	Marsh with sill
6	Revetment	Marsh with sill
2	Revetment	Vegetation Management Only
5	Vegetation management only	Marsh Fringe with Groins
11	Vegetation management only	Marsh with sill
82	Vegetation management only	No action needed

Those sections of the shoreline that were classified as "currently defended" by the CCRM model were replaced by the recommendations obtained with the CCRM model for "defended shoreline"

LOWER MACHODOC CREEK – Length of the shoreline assigned with a particular recommendation:

Recommendation	Miles of Shoreline (SSP)	Miles of Shoreline (CCRM)
Marsh with Sill	0.94	0.98
Offshore Breakwaters	0.45	0.62
Offshore Breakwaters or Revetment	0.00	0.13
Revetment	0.12	0.12
Marsh with Biologs	0.05	0.81
Marsh Fringe with Groins	0.40	0.00
Spurs	0.07	0.00
Dune Grass	0.44	0.00
Beach Nourishment	0.38	0.00
Bank Grading	0.00	1.82
Vegetation Management Only	4.13	1.85
No action needed	15.67	16.3


Miles of Shoreline (CCRM)
Marsh with Sill
Offshore Breakwaters
Offshore Breakwaters or Revetment
Revetment
Marsh with Biologs
Marsh Fringe with Groins
Spurs
Dune Grass
Beach Nourishment
Bank Grading
Vegetation Management Only
No action needed


Miles of Shoreline (SSP)
Marsh with Sill
Offshore Breakwaters
Offshore Breakwaters or Revetment
Revetment
Marsh with Biologs
Marsh Fringe with Groins
Spurs
Dune Grass
Beach Nourishment
Bank Grading
Vegetation Management Only
No action needed

2.3.c – Mathews County

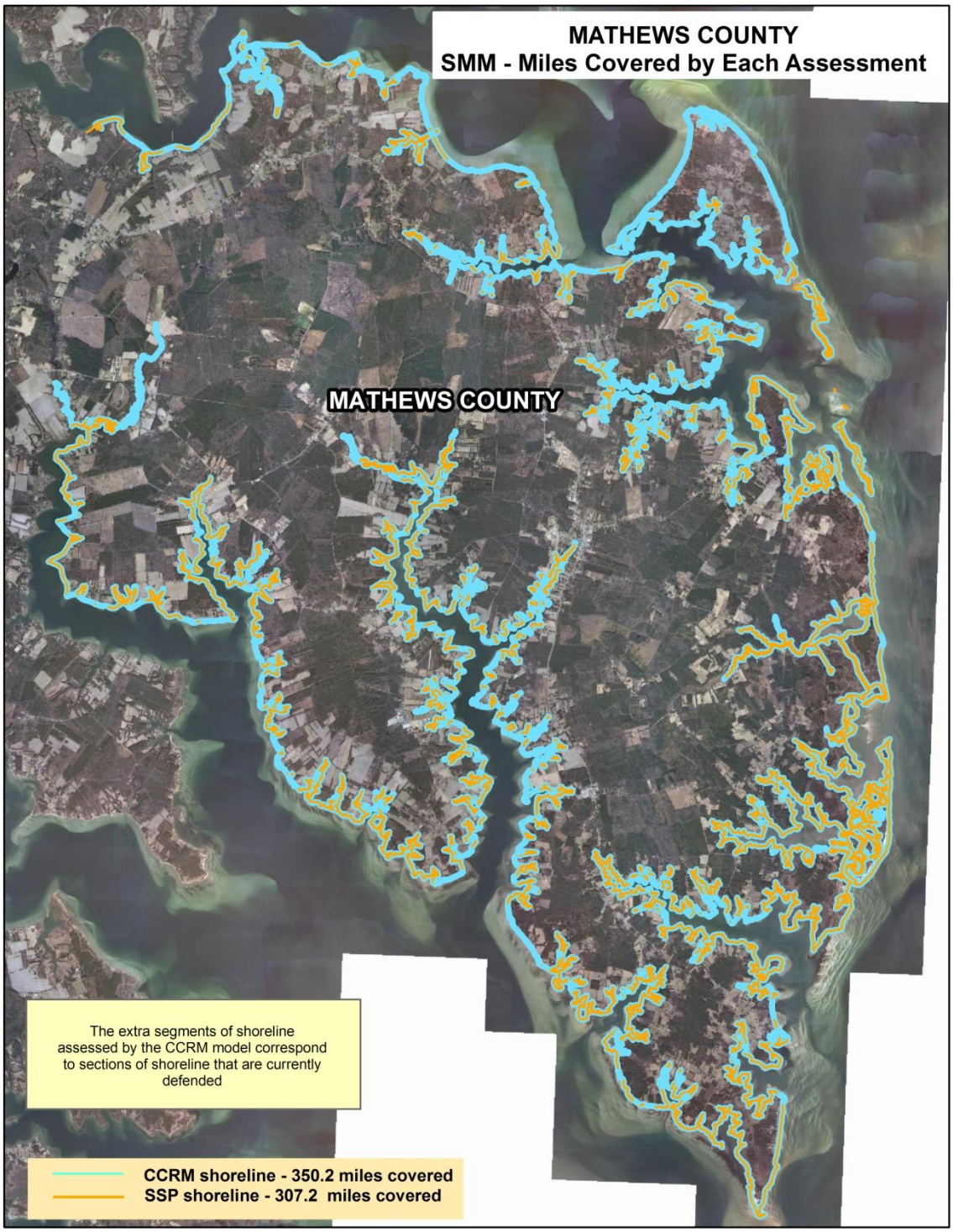
The 2007 Virginia Base Mapping Program (VBMP) shoreline was used by SSP. This shoreline was not created with a tidal datum, it was used as the base for the site recommendations and attributes because it was the most recent shoreline available. Using the 2007 images and the field notes, the site locations, and attributes were then transferred onto the 2007 shoreline. Once all the attributes were entered and calculated, spreadsheets were created. For this particular study area, SSP provided two different files with recommendations. One file contains the recommendations for the shorter fetch rivers and creeks, and the other one includes the recommendations for the Chesapeake Bay coast of Mathews.

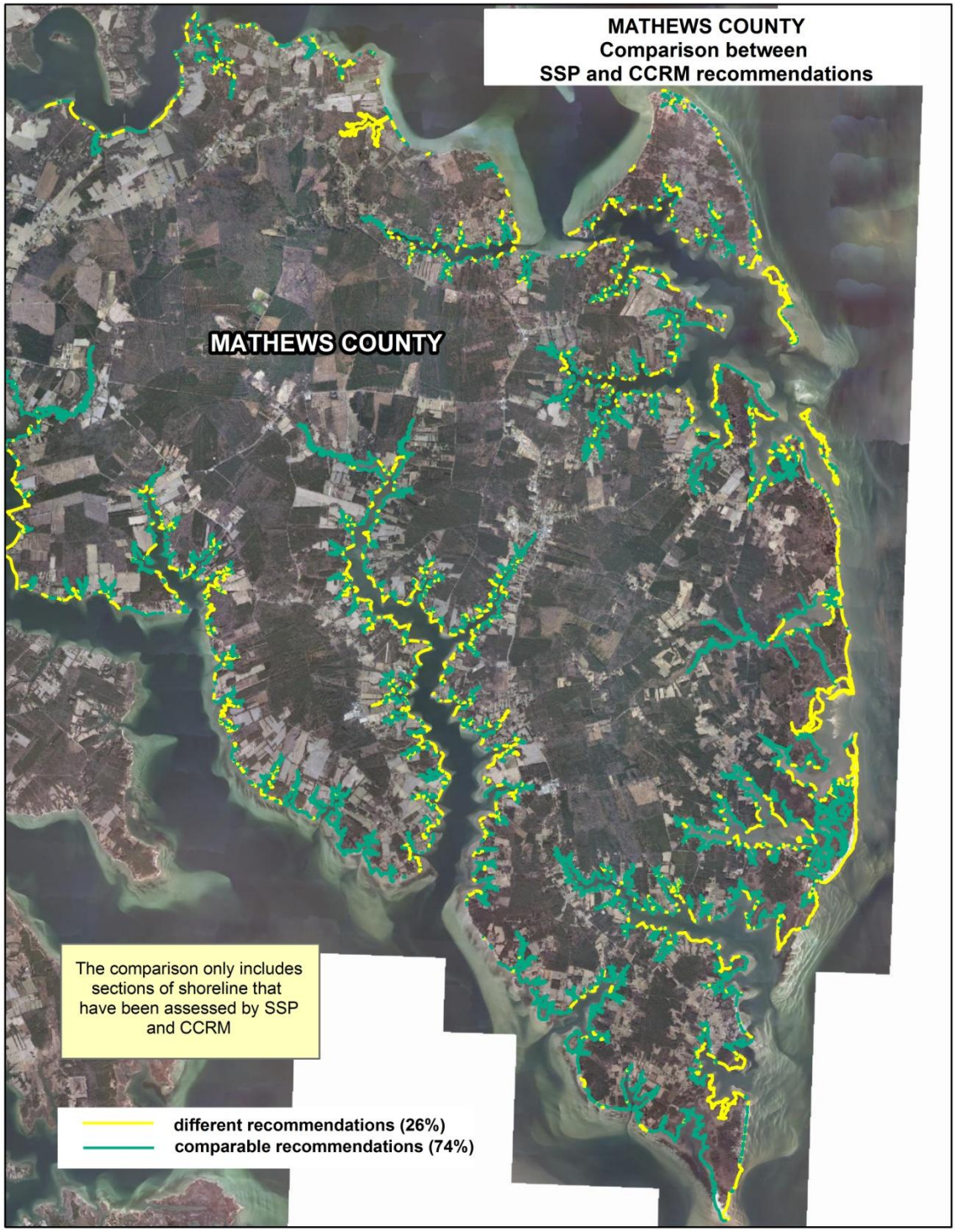
Initially, these files were combined using different geoprocessing tools (select, buffer, and identity), and subsequently, the combined file was integrated with the output from the CCRM model (referred also to the imagery collected as part of 2007 VBMP). Once again, the Geospatial SMM developed by CCRM has greater coverage. This difference can be attributed to those segments that are currently defended, and hence, only evaluated by the CCRM model.

Again, the comparison of recommendations generated by both approaches included only shoreline sections assessed by both approaches. Sections of the shoreline covered only by CCRM were excluded for this part of the analysis. Sections of shoreline coded as “currently defended” by CCRM were not included in the calculations unless SSP provides any type of recommendation for that section. In that case, the “currently defended” coding was replaced by the output (recommendation) obtained with the CCRM model for 'Living Shoreline Model-Defended model'.

The final file, which included the output of both data sets plus the output of the “defended shoreline” model were used to run a series of queries. This step defined where both methodologies recommend the same or different shoreline treatment. Total mileages of shoreline and percentages with comparable and different recommendations were computed.

Finally, a frequency analysis was conducted to identify where the differences between SSP and CCRM occur. In addition, total miles of shoreline coded with the different recommendations by both methods were identified and computed.


MATHEWS COUNTY
SMM - Miles Covered by Each Assessment
MATHEWS COUNTY
The extra segments of shoreline assessed by the CCRM model correspond to sections of shoreline that are currently defended
CCRM shoreline - 350.2 miles covered
SSP shoreline - 307.2 miles covered


MATHEWS COUNTY
Comparison between
SSP and CCRM recommendations
MATHEWS COUNTY
The comparison only includes sections of shoreline that have been assessed by SSP and CCRM
different recommendations (26%)
comparable recommendations (74%)

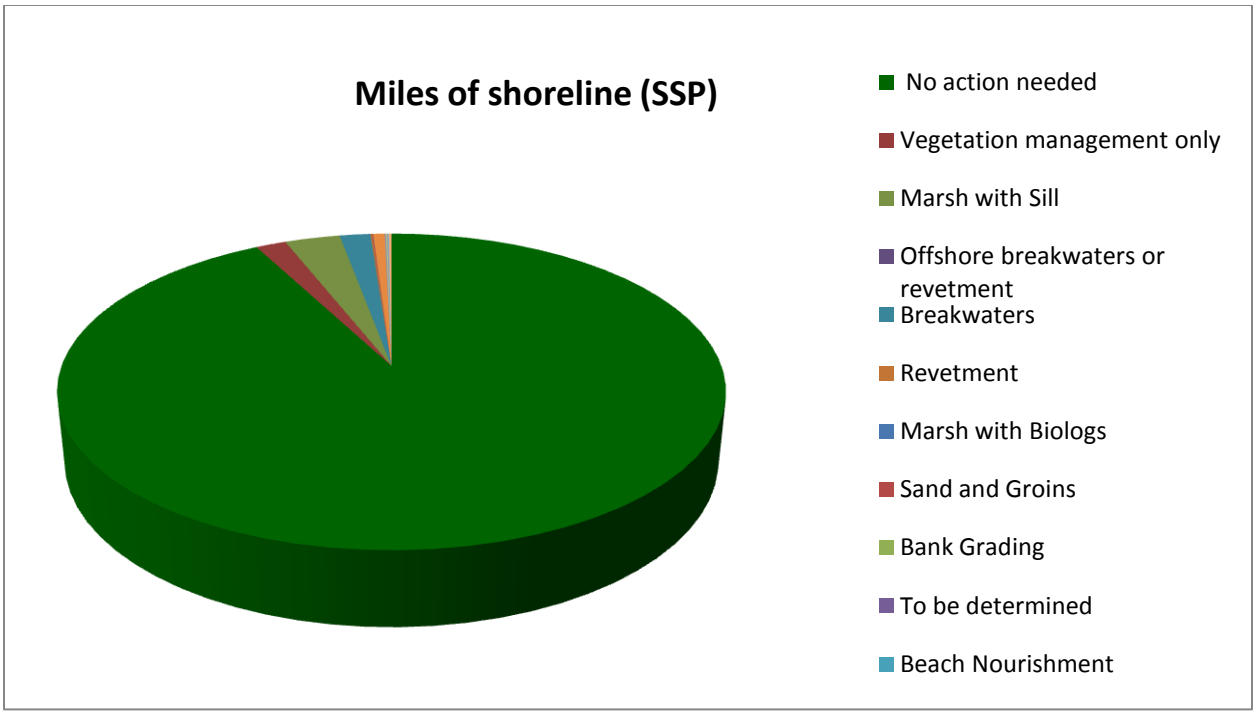
MATHEWS COUNTY - Frequency Analysis

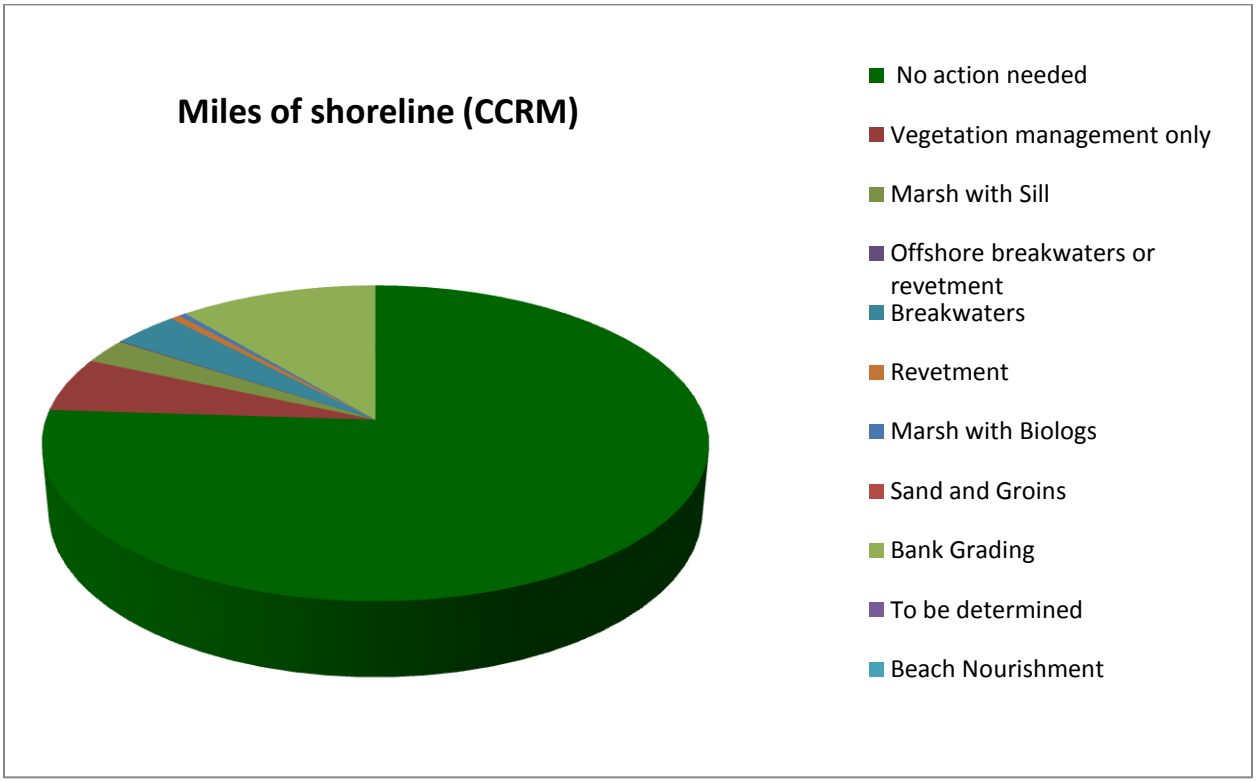
FREQUENCY	CCRM model	SSP assessment
10684	No action needed	No action needed
178	Offshore breakwaters	Breakwater
69	Marsh with sill	Marsh with sill
4	Vegetation management only	Vegetation management only
3	Revetment	Revetment
1	Offshore breakwaters or revetment	Breakwater
2	Marsh with sill	marsh with sill and beach nourishment
2	Offshore breakwaters	Breakwater, Spur and Beach Fill
1	Bank grading	Breakwater
7	Bank grading	Breakwater, Spur and Beach Fill
1687	Bank grading	No action needed
14	Bank grading	Sand with Groins
42	Bank grading	Sill
4	Bank grading	Spur
9	Bank grading	Spur with Low Sill
10	Bank grading	breakwater
233	Bank grading	marsh with sill
7	Bank grading	revetment
122	Bank grading	vegetation management only
2	Beach nourishment	marsh with sill
25	Marsh with biologs	No action needed
13	Marsh with biologs	marsh with sill
3	Marsh with biologs	revetment
28	Marsh with biologs	vegetation management only
82	Marsh with sill	Breakwater
1	Marsh with sill	Breakwater, Spur and Beach Fill
1	Marsh with sill	Low Sill; Spurs and Beach Fill
234	Marsh with sill	No action needed
41	Marsh with sill	Sill
8	Marsh with sill	Spur
1	Marsh with sill	Spurs with Beach Fill
1	Marsh with sill	beach nourishment
1	Marsh with sill	Breakwater
6	Marsh with sill	revetment
10	Marsh with sill	vegetation management only
17	No action needed	Breakwater
7	No action needed	Breakwater, Spur and Beach Fill

2	No action needed	Low Sill; Spurs and Beach Fill
10	No action needed	Sand with Groins
7	No action needed	Spur
2	No action needed	Spurs with Beach Fill
71	No action needed	Breakwater
333	No action needed	marsh with sill
17	No action needed	marsh with sill and beach nourishment
11	No action needed	revetment
223	No action needed	vegetation management only
2	Offshore breakwater	Spur
191	Offshore breakwaters	No action needed
54	Offshore breakwaters	Sill
17	Offshore breakwaters	Spur
5	Offshore breakwaters	Spurs with Beach Fill
1	Offshore breakwaters	beach nourishment
13	Offshore breakwaters	marsh with sill
3	Offshore breakwaters	revetment
12	Offshore breakwaters or revetment	No action needed
3	Offshore breakwaters or revetment	Spur
2	Offshore breakwaters or revetment	Spur with Low Sill
29	Offshore breakwaters or revetment	marsh with sill
1	Revetment	Breakwater, Spur and Beach Fill
3	Revetment	Low Sill; Spurs and Beach Fill
83	Revetment	No action needed
5	Revetment	Spurs with Beach Fill
8	Revetment	Breakwater
44	Revetment	marsh with sill
1	To be determined	Breakwater
1047	Vegetation management only	No action needed
1	Vegetation management only	Spur
1	Vegetation management only	Spurs with Beach Fill
2	Vegetation management only	beach nourishment
4	Vegetation management only	Breakwater
132	Vegetation management only	marsh with sill
2	Vegetation management only	marsh with sill and beach nourishment

MATHEWS COUNTY – Length of the shoreline assigned with a particular recommendation:

Recommendation	Miles of shoreline (SSP)	Miles of shoreline (CCRM)
No action needed	283.410	233.601
Vegetation management only	5.273	17.160
Marsh with Sill	9.584	7.865
Offshore breakwaters or revetment	0.000	0.293
Breakwaters	5.336	11.317
Revetment	0.248	1.682
Marsh with Biologs	0.000	1.173
Sand and Groins	0.197	0.000
Bank Grading	0.000	34.123
To be determined	0.000	0.006
Beach Nourishment	0.026	0.035
Sill	2.016	0.000
Spur	0.164	0.000
Spur with Low Sill	0.044	0.000
Breakwater, Spur and Beach Fill	0.230	0.000
Low Sill, Spurs and Beach Fill	0.131	0.000
Spurs with Beach Fill	0.144	0.000
Marsh with Sill and Beach Nourishment	0.451	0.000


Miles of shoreline (SSP)
No action needed
Vegetation management only
Marsh with Sill
Offshore breakwaters or revetment
Breakwaters
Revetment
Marsh with Biologs
Sand and Groins
Bank Grading
To be determined
Beach Nourishment


Miles of shoreline (CCRM)
No action needed
Vegetation management only
Marsh with Sill
Offshore breakwaters or revetment
Breakwaters
Revetment
Marsh with Biologs
Sand and Groins
Bank Grading
To be determined
Beach Nourishment

2.4 Comparison of Methods – Conclusions

The analytical review of data and methods has several highlights. First, both methods are reported with relatively comparable accuracies and scale. Results are reported within meters of the true location and resolution of data allows for recommendations to be made at the scale of individual property parcels.

In all three pilot areas reviewed, the SSP method covered fewer miles of shoreline than the CCRM method. This was largely attributed to the fact that the SSP shoreline does not address shoreline which has already been hardened; whereas the CCRM method does address hardened shoreline and assumes eventual structural failure will lead to replacement of shoreline protection structure.

Assessment of recommendations put forth along shoreline assessed in both methods suggests fair to good comparability in output. Comparability was significantly better in Mathews County (74% comparability) and Occahannock Creek (77% comparability). Lower Machooc used a classification system that was substantially different and this affected the comparability, which was still 57% comparable.

The review of time and effort is best accomplished first by examining monthly effort required to accomplish tasks since salaries differ between program staff. We used only the county of Mathews for this assessment since all the necessary budget information was available. Both methods required the development of the Shoreline Inventory, therefore the effort required for all field work, data processing and map generation for this task can be applied to both methods. The development of the Shoreline Inventory for Mathews County was completed in 6 months and required 9.75 months of staff effort. This effort was conducted completely by staff of the CCRM. CCRM required another 0.50 months of effort to run the Shoreline Management Model for erosion control recommendations for a total of 10.25 months of effort. A final product was not required, but maps were generated. The SSP effort required an additional 17.50 months of staff effort to complete the Shoreline Management Plan for Mathews County for a total of 27.25 months of effort. In addition SSP required nearly three times the travel costs which included additional vessel time for added field work. Final products were required but no estimate of time and effort to develop these products was available,

A review of materials and output associate with each method can be compared as well. The CCRM method delivers only the preferred management recommendations for erosion control treatments along the shoreline in map format. The SSP delivers these data, but also delivers other information for local government use. These data include a history of shoreline evolution, a review of wave climate conditions, background on county geology and geomorphology, etc . General cross sections are provided for sites that require construction involving stone. Compiling these elements can account for a significant amount of the effort.

At this time we can conclude that the CCRM Shoreline Management Model approach for generating erosion control recommendations is a more efficient method for delivering recommendations to local governments than the SSP. While CCRM uses an automated geo-spatial model, the output is consistent with recommendations that are recommended in the alternative SPP

approach. The CCRM method can also cover a greater geographic area and addresses already defended shoreline without additional effort. The SPP delivers additional content information and it is important not to discount this information as valuable for local governments engaged in shoreline management.

Therefore, to grasp the value of these other data to local governments, a survey was conducted to gain feedback from a targeted user audience. This audience includes local, state, and federal regulators, planners, and managers; as well as citizens, researchers, and private consultants.

3.0 Assessment of Content Value

On November 4, 2010 the CCRM hosted its semi-annual Tidal Wetlands Workshop. This workshop typically attracts members from localities, planning district commissions, the Virginia Marine Resources Commission (VMRC), local wetland boards, the Department of Conservation and Recreation (DCR), non-government organizations (NGOs), and commercial consultants. These individuals represent agency and program staff with responsibility or interest in regulating or managing activities along tidal shoreline. The venue, therefore, provided an excellent opportunity to solicit feedback on the development of Shoreline Management Plans (SMPs). Since only one locality within the coastal zone has a fully developed SMP (Mathews County) a number of tasks would be required to derive the full complement of needs expressed by the target audience needs. Workshop participants were asked to engage in 4 major tasks.

3.1 Task 1. Audience Response System

In Task 1 the participants were introduced to 14 different data themes or elements that could be included in a SMP. Organizers hoped to determine what information the target audience found useful. Using automated Audience Response Survey technology, they were asked to select from one of the following responses following a brief oral and visual description of each theme:

1.) I would use this information to make decisions
2) I am unsure if I would use this data to make decisions
3) I would not use this data to make decisions
4) I would not directly use this data but I like that it is provided as a reference

Task 1. Audience Response Survey Themes
Shoreline Inventory
Geology
Historic Shoreline Analysis
Wave Climate Analysis
Tidal Wetlands Inventory
Submerged Aquatic Vegetation
Impaired Waters
Shellfish Resources Data
Regulated Fish Area and Designated Sanctuaries
Bathymetry
Flood Zones
Priority Conservation Areas
Shoreline Management Recommendations

Task 1 - Audience Response System

		DATA SET SURVEYED													
PARTICIPANTS	ANSWERS	Shoreline Inventory	Geology	Historic Shoreline Analysis	Wave Climate Analysis	Tidal Wetlands Inventory	Submerged Aquatic Vegetation	Impaired Waters	Shellfish Resource Data	Regulated Fish Management Areas and Designated Sanctuaries	Bathymetry	Flood Zones	Priority Conservation Areas	Shoreline Management Recommendations	Structure Design/Cost Estimates
	A	6	5	7	6	8	5	4	4	3	2	7	6	8	8
Wetland board staff	B	2	1	1	2	1	2	2	0	0	0	2	1	0	1
	C	1	2	2	1	2	2	5	4	5	4	1	4	1	1
	D	4	5	3	3	2	4	1	4	3	6	2	1	3	1
	A	3	3	9	8	6	5	5	3	2	1	4	7	11	10
Wetland board member	B	3	3	0	1	0	3	0	0	0	4	0	0	0	0
	C	1	4	0	0	1	1	3	4	5	5	3	4	0	2
	D	3	3	2	2	3	3	2	4	5	2	5	1	0	0
	A	1	1	3	4	3	2	1	3	0	0	2	2	3	2
Local or regional planner	B	1	1	0	0	0	0	0	1	0	1	0	1	0	0
	C	0	0	0	0	1	1	1	0	3	3	2	1	0	2
	D	2	2	1	0	0	1	2	0	1	0	0	0	1	0
	A	0	3	5	3	2	4	2	1	1	1	1	0	5	3
Regulator (state or federal)	B	0	0	0	0	0	0	0	1	0	3	0	0	1	0
	C	0	0	0	0	1	1	1	1	4	2	4	3	0	0
	D	7	3	2	4	4	2	4	4	2	1	2	4	1	4
	A	3	3	4	5	3	4	2	3	1	4	3	2	4	4
Commercial/consulting	B	0	0	0	0	0	0	1	1	2	0	0	0	0	0
	C	0	1	0	0	1	0	3	1	2	2	2	3	1	1
	D	3	2	0	0	2	1	0	1	1	0	1	1	1	1
	A	6	5	8	7	9	6	7	5	3	5	9	6	10	9
Other	B	0	0	0	1	0	1	0	1	1	2	0	2	0	0
	C	0	0	1	0	0	0	0	0	2	0	0	0	0	0
	D	4	5	2	2	1	3	3	4	4	3	1	2	0	1

Answers:
A = I would use this information to make decisions
B = I am unsure if I would use this data to make decisions
C = I would not use this data to make decisions
D = I would not directly use this data, but I like that it is provided as a reference

The Task 1 table above reports the voting results. Since each parameter was evaluated independently in Task 1 there were certainly some parameters that were more important than others across the entire audience. Shoreline management recommendations received 82% response for " information necessary to make decisions". Whereas only 20% of the voters believed regulated fish areas was "information necessary to make decision".

3.2 Task 2. Prioritization

Task 2 gave respondents another opportunity to review the data in some more detail from maps and posters displayed in the meeting area. They were asked to designate their top four most important data sets. Within the top four results two parameters had the same percentage of votes and therefore the top five most important data sets are listed: Shoreline Management Recommendations (17.2%); Historic Shoreline Analysis (16.3%), Structure Design and Cost Estimates information (16.3%), Tidal Wetland Inventory (14.0%), and the Shoreline Inventory (13.6%).

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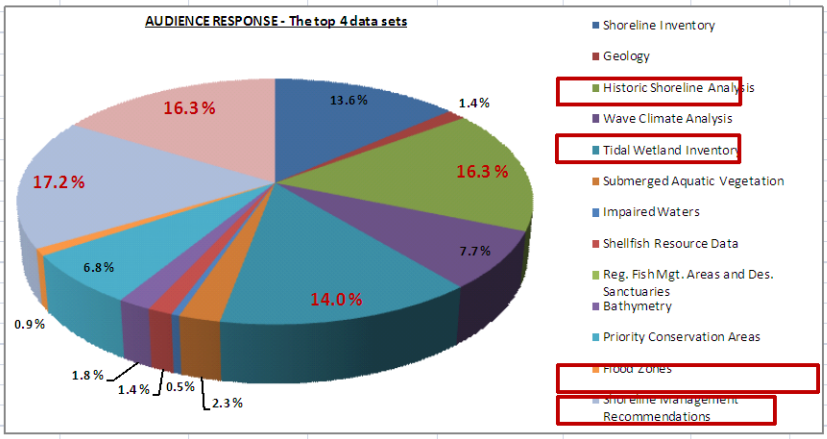
Task 2 - Top 4 most important data sets

DATA SET	PARTICIPANTS						TOTAL	PERCENTAGE
	Local Wetlands Boards	Agency(non-regulatory); Academics	Commercial (Consulting/Contractor)	Non-Government Organization	Regulatory	County Planner/Staff to LWB		
Shoreline Inventory	13	1	2	5	4	5	30	13.6
Geology	2	0	0	0	1	0	3	1.4
Historic Shoreline Analysis	10	1	7	6	6	6	36	16.3
Wave Climate Analysis	6	0	4	1	3	3	17	7.7
Tidal Wetland Inventory	10	0	1	5	3	12	31	14.0
Submerged Aquatic Vegetation	3	0	0	0	2	0	5	2.3
Impaired Waters	1	0	0	0	0	0	1	0.5
Shellfish Resource Data	2	0	0	1	0	0	3	1.4
Reg. Fish Mgt. Areas and Des. Sanctuaries	0	0	0	0	0	0	0	0.0
Bathymetry	3	0	0	0	0	1	4	1.8
Priority Conservation Areas	10	0	0	3	1	1	15	6.8
Flood Zones	0	0	0	1	0	1	2	0.9
Shoreline Management Recommendations	16	1	3	6	5	7	38	17.2
Structure Design/Coast Estimates	20	1	3	5	4	3	36	16.3
TOTAL DOTS	96	4	20	33	29	39	221	
TOTAL PERSONS (4 dots/person)	24	1	5	8	7	10	55	



Local Wetlands Board members comprise the highest percentage selecting Historic Shoreline Analysis; Shoreline Management Recommendations; and Structure Design and Cost Estimates information. Nevertheless, the highest percentages in the selection of the Tidal Wetland Inventory were shared by the Local Wetlands Boards and the County Planners/Staff to LWB groups.

3.3 Task 3. Voluntary Input

Task 3 gave the audience an opportunity to voluntarily identify other attributes or parameters not discussed that they consider important. Very low feedback was given, however, data such as shoreline slope, groundwater levels, invasive species, endangered species, and water levels were suggested.

3.4 Task 1. Data Output, Format, Costs

The afternoon session of the workshop focused on data output, format, cost/benefits, and deliverables. Task 4 was divided into 4 stations; each gathering data on a specific issue.

Station 1. Map Format

Station 2. Data Delivery

Station 3. SSP vs CCRM – Content and Output

Station 4. Cost Benefit of SSP vs. CCRM

3.4.a Station 1. Map Format – Shoreline Inventory

This task was specific to the **MAP** deliverables associated with the ***Virginia Shoreline Inventory***. The format being used includes multiple map compositions to illustrate the multitude of data that are collected. Workshop participants were presented with three different output alternatives that included the current 4 map format, a single map with all data displayed, and 1 page with two map panels. The alternatives used the same site location for all examples. Thirty eight respondents voted and 84 percent indicated a preference for a single map. The remaining voters preferred the current 4 map version. While this surprised the CCRM staff, feasibility for developing the inventory with only a single map frame is under consideration. However, there is great concern that large amounts of data will be lost in areas where development and altered shoreline exists. The preference for a single map has opened new discussion about moving the inventory to an online interactive site which will allow users to view all the layers at once across the entire county, and create and print maps as needed for selected locations. The results revealed at Station 2, discussed below, suggest a preference for data access online as well.

3.4.b Station 2. Data Delivery

This task gave respondents the opportunity to indicate a preference for data delivery. Four options were presented with examples: hardcopy maps, online access, interactive maps, digital GIS data. Difficulty in demonstrating distinctions between some of these products may have existed and influenced the voting. They were given two dots and asked to place their dots next to their top two choices. Fifty-three people participated. Online access received the highest percentage of possible votes (35.8%). Hardcopy maps received the lowest (13.2%). Interactive maps and digital GIS data received the same amount of vote (25.5%). The details of the voting are shown below.

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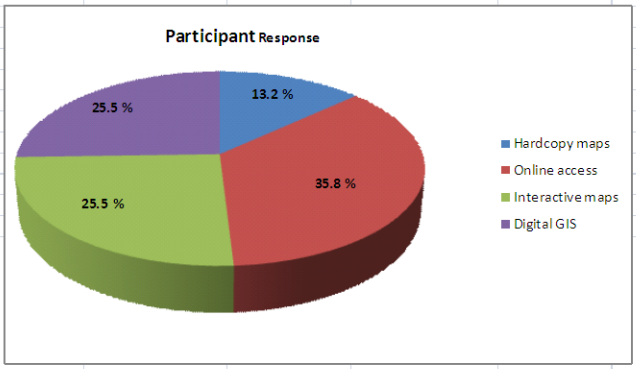
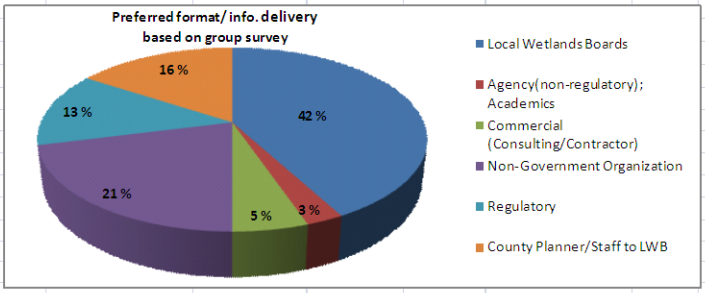
Task 4 - Map Format and Information Delivery - Station 2a, 2b, 2c, 2d

MAP FORMAT & INFORMATION DELIVERY	PARTICIPANT RESPONSE						TOTAL	PERCENTAGE
	Local Wetlands Boards	Agency(non-regulatory); Academics	Commercial (Consulting/Contractor)	Non-Government Organization	Regulatory	County Planner/Staff to LWB		
Hardcopy maps	8	0	2	3	0	1	14	13.2
Online access	**16**	**1**	**2**	**8**	**5**	**6**	**38**	35.8
Interactive maps	**16**	**1**	**2**	**3**	**3**	**2**	**27**	25.5
Digital GIS	**4**	**0**	**7**	**5**	**3**	**8**	**27**	25.5
TOTAL DOTS	44	2	13	19	11	17	106	100.0
TOTAL PERSONS (2 dots/person)	22	1	6.5	9.5	5.5	8.5	53	



Preferred map format and information delivery based on group survey

PARTICIPANTS	Online Access	
	Votes	Percentage
Local Wetlands Boards	**16**	**42**
Agency(non-regulatory); Academics	**1**	**3**
Commercial (Consulting/Contractor)	**2**	**5**
Non-Government Organization	**8**	**21**
Regulatory	**5**	**13**
County Planner/Staff to LWB	**6**	**16**



The results suggest the vast number of users rely heavily on the internet regardless of the products they preferentially download or view there. A shift toward an interactive based Shoreline Inventory may be desirable.

3.4.c Station 3. SSP vs CCRM – Content and Output

The audience was assigned in Task 4 Station 3 to review the map product output for the shoreline management plans generated by the SSP and the Geospatial Shoreline Management Model generated by CCRM. They were presented with maps that included the delineation of shoreline recommendations for each method, as well as tables, and cross-sections associated with the SSP approach. Only 14 voters were present. The majority of this audience (76 %) indicated a preference for the products associated with the SSP approach. These voting results suggest that the user audience

places value in the cross-sectional information provided and utilized tabular data as well as map information.

3.4.c Station 4. Cost Benefit of SSP vs. CCRM

Section 2.0 of this report summarized some of the cost and time differentials between developing the SSP and the CCRM products. Effort to generate the products associated with the SSP approached three times that required to generate the CCRM product. CCRM products were prepared for delivery in less than 11 months. It took more than 27 months to prepare the SSP for delivery. While remaining respondents were not presented with the budget details they were asked if they would change their preference given in Station 3 if they knew it would take four times longer and cost more than three times as much to develop the preferred product. Seventy six percent (76%) said they would change their preference. This suggests that while the content and deliverables associated with the SSP products may be more desirable, the local governments are not willing to wait or pay for the additional information. The majority of the responders were from the local wetland boards group.

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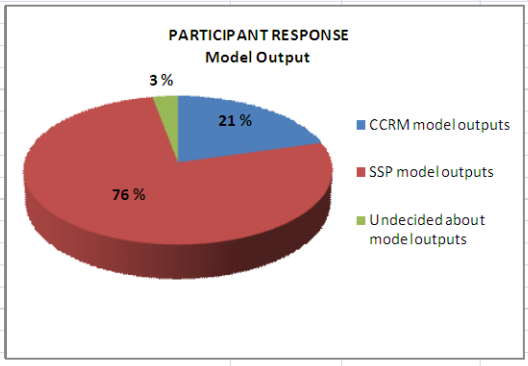
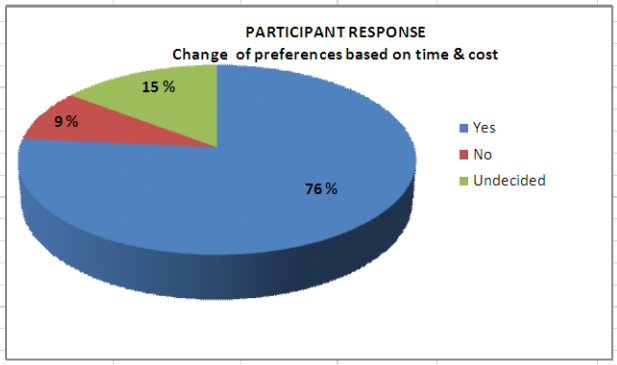
Task 4 - Recommendations for shoreline management options - Stations 3 and 4

	PARTICIPANTS							
MODEL OUTPUTS	Local Wetlands Boards	Agency(non-regulatory); Academics	Commercial (Consulting/Contractor)	Non-Government Organization	Regulatory	County Planner/Staff to LWB	TOTAL	PERCENTAGE
CCRM model outputs	1	0	1	2	1	2	7	**21**
SSP model outputs	**12**	**1**	**4**	**2**	**4**	**3**	**26**	**76**
Undecided about model outputs	**1**	**0**	**0**	**0**	**0**	**0**	1	**3**
Change of preferences based on time & cost								
Yes	**9**	**1**	**5**	**3**	**5**	**3**	**26**	**76**
No	2	0	0	0	0	1	3	**9**
Undecided	4	0	0	0	0	1	5	**15**
TOTAL DOTS	29	2	10	7	10	10	68	
TOTAL PERSONS (2 dots/person)	14.5	1	5	3.5	5	5	34	





4.0 Shoreline Management Plans – Conclusions and Recommendations

A detailed review of approaches to develop Shoreline Management Plans (SMPs) for local governments has been undertaken. The review has included a comparison of existing methods, and feedback from the stakeholder groups. Several highlights are worth summarizing.

1) Both methods capture the necessary accuracy associated with local level planning and review.

2) Within the limitations of the testing, both methods were relatively comparable.

3) Both methods capture the top ranking parameter designated by the surveyed audience (Shoreline Management Recommendations).

4) Only one of the top five parameters recommended by the stakeholders is not fully addressed in either approach (Tidal Marsh Inventory). However, marshes are considered in the recommendations.

5) The SSP approach contained more preferred elements with respect to content than the CCRM approach and therefore was voted initially as a product of choice by a small population of the original voting audience.

6) In their response to inquiries regarding time and cost benefits, the stakeholder response suggested the SSP could not be delivered within timeframes to meet the demands and the additional cost for the products returned may not be cost beneficial.

Based on all this information and the previous discussions, the following conclusions are drawn and recommendations put forth.

1) There is a demonstrated need for a Shoreline Management Plan for each coastal locality in Virginia.

2) At a minimum, the plans should provide guidance for local governments with respect to strategies for managing tidal shoreline. Specifically this includes products that determine the most effective approach for shoreline protection.

3) Virginia must begin production of SMPs to meet local government needs as soon as possible.

4) The automated Geospatial Shoreline Management Model (SMM) approach developed by CCRM returns the principal information need to local governments with acceptable accuracy and precision in a timely and cost effective manner. This method therefore should be adopted for generating the "Shoreline Management Recommendations", also referred to as strategies for shoreline protection.

5) The results of the surveys conducted indicate other data are also pertinent to local governments and relevant to any Shoreline Management Plan. Therefore, a hybrid format for a county-wide Shoreline Management Plan is recommended. This plan should include the SMM output developed by CCRM and discussed in #4 above to arrive at the recommended erosion control strategies. The Shoreline Management Plan should also include a historical shoreline analysis such as that developed by the SPP

to explain the evolution of shoreline development through time. This is essential for a full understanding of the wave climate environment as well as the impacts that management decisions have on the coastal landscape. The Shoreline Management Plan should also provide cost estimate and structural designs for guidance to local boards and staffers assessing the appropriateness of proposed structures. The information is also valuable to other community members including private property owners who may refer to this document for guidance. In addition we recommend that all SMP gather background information for some of the other leading parameters well received by the stakeholder audience. These include wave climate, and information on conservation planning. While a Tidal Wetlands Inventory would be desirable, the development of such a product, in itself, is an extensive undertaking ; requiring a commitment of significant additional funds. It therefore should remain an independent product and developed as funding opportunities present themselves. There is an argument; however, that the field work associated with developing a tidal marsh inventory could be done in tandem with the data collection for the Shoreline Inventory, which is required to generate shoreline protection strategies through the SMM.

6. Product delivery and availability should be provided through the internet. A general preference for using the internet was clear, while one specific type of product available through this medium was not strongly expressed. We know that there is now widespread use of GIS data so we recommend SMPs be posted online and that baseline GIS data developed under the plan be made available. This includes the Shoreline Inventory, recommended strategies for shoreline protection, and historic shoreline positions.