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Restoration Prioritization Toolset: Documentation and User's Guides 2007

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RESTORATION PRIORITIZATION TOOLBOX

Documentation and User's Guides 2007

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1. Overview

1.1 Background

With the growing population and pressure to develop coastal areas as well as coastal watersheds, conservation and restoration of coastal ecosystems is a high priority for the nation. Managers must make decisions on complex problems every day, and having a credible scientific basis for these decisions is critical. In addition, they need to plan and implement restoration in cost effective ways in order to maximize results for the money spent.

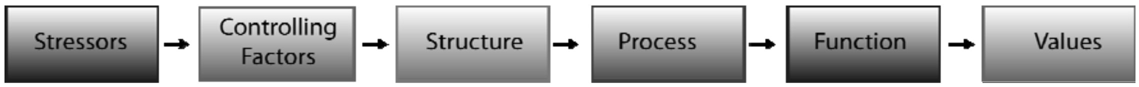
Among the most often sought after tool by managers is one that prioritizes restoration projects. A prioritization decision tool provides one of the bases for making investments in restoration projects. Ideally the tool contains the relevant scientific underpinnings, and facilitates the decision making process by providing an effective interactive mechanism.

The Restoration Prioritization Toolbox forms part of an integrated system within the Gulf of Mexico Regional Collaborative (GoMRC) framework to facilitate decisions related coastal ecosystem restoration, specifically the management of submerged aquatic vegetation. As a tool for on-the-ground natural resource managers, the factors which it examines will be purely environmental ones, making recommendations based on potential restoration success.

1.2 Development of a conceptual model

Conceptual models are one increasingly popular method that resource managers use to document their understanding of system dynamics, and can be used as a basis for ecosystem restoration. In this application, we created a conceptual model for seagrasses/SAV (http://www.gomrc.org/conceptual_model.html). The fundamental concept is that there are certain environmental parameters (Controlling Factors) such as sufficient light, correct temperature, correct substrate for growth, etc… that a species needs to flourish. Areas with these characteristics at least have the basic requirements for restoration of the species of interest. However, stressors (such as increased wave energy, contamination, or even disease) may make an area with adequate ranges of Controlling Factors unsuitable for restoration. Suitable conditions lead to suitable structure (SAV) and the wide range of processes, functions and values that the structure supports.

The main elements are below.



- **Controlling Factors** are those elements such as light, temperature, sediment type and desiccation which limit and determine habitat suitable for species growth.
- **Stressors** are elements which act on controlling factors (or directly on seagrasses) and may make an otherwise suitable site unsuitable. Examples of stressors include dredging, filling, boating activities, storm events, and shoreline armoring.
- **Structure** is the species itself. In this case, it is SAV or seagrasses
- **Processes** are environmental processes such as food web support or carbon sequestration which are a result of the structure
- **Functions** such as fish production result from the processes
- **Values** are social and economic values such as fishing, property protection or aesthetics which are a direct result from the functions.

1.3 Integration into GIS models

Based on the conceptual model, the Restoration Prioritization Toolbox uses local GIS datasets, bathymetric information and datasets derived from NASA products to represent elements of the conceptual model. This can assist the user in evaluating stressors, controlling factors and recommend a restoration management strategy based on current and past structure distribution. These GIS modeling techniques have involved weighting of system controlling factors and system stressors to score pre-defined ecological zones based on their suitability for restoration.

1.4 Restoration Toolbox Elements

The Restoration Toolbox is comprised of three fundamental elements (Figure 1-1):

(1) Model for Controlling Factors which uses NASA derived datasets with local datasets to predict areas which are suitable for a species growth.

(2) Benthic Change Tool examines species structure and distribution

(3) Prioritization are scripts which summarize and weight stress and produce final recommended management actions.

While each can be executed by itself, together they can be used for prioritization of restoration activities.

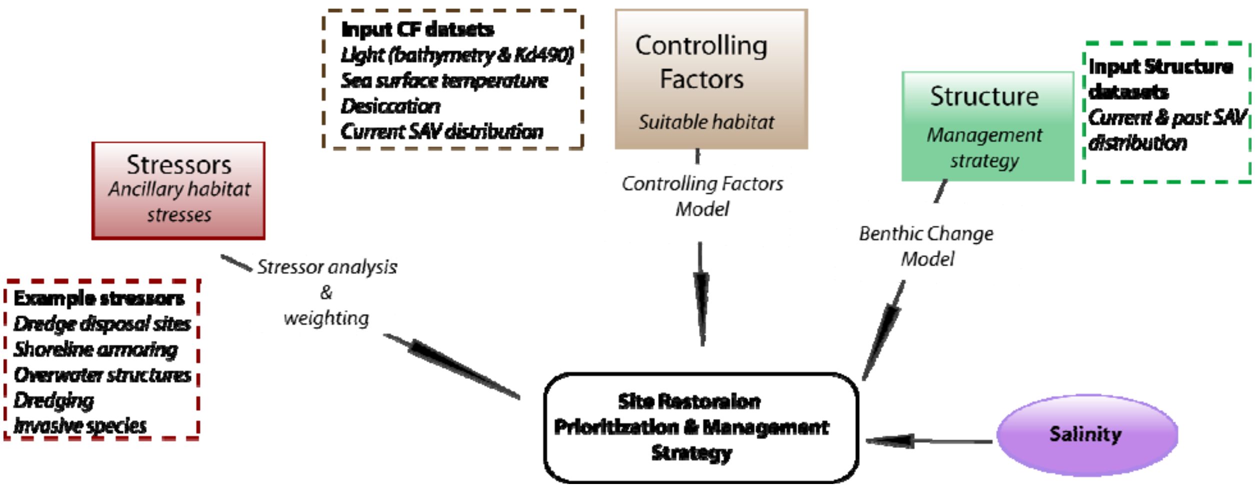


Figure 1-1. Restoration Toolbox Elements. Restoration Toolbox Models can be executed by themselves or sequentially for site prioritization and management. Each element analyzes one of the components of the conceptual model and provides feedback to the user based on that component. Finally, salinity for each site is examined to recommend a species appropriate for the site.

2. Controlling Factors Model

2.2 Background & Tool Overview

Predicting sites suitable for SAV habitat through models has been explored by several researches and applied in a variety of local bays and estuaries (Kelly et al. 2001, Lathrop et al. 2001, Short et al. 2002, Callahan et al. 2003), however all analyses have relied on previously collected in-situ data. New products derived from NASA's MODIS satellite provide a more cohesive spatial and temporal coverage in the Northern Gulf of Mexico on a 1km and a 250m scale for Sea Surface Temperature and the light attenuation coefficient Kd488. These new products can provide a potentially better input into a GIS model, capturing spatial and temporal variability.

The Controlling Factors Model (CF Model) is a spatially explicit GIS model based on the scientific conceptual model for seagrass / SAV in the Gulf of Mexico (http://www.gomrc.org/conceptual_model.html) which evaluates three of the most universally important factors (desiccation, temperature, and available light) that control distribution of seagrasses and other types of submerged aquatic vegetation (SAV). The output of the CF model is a scored grid with values of 0-9, corresponding with the suitability of habitat for SAV. This output can also be summarized based on sites of interest, or what we refer to as spatial decision units.

2.3 Scientific Basis for Scoring

<u>Desiccation</u>

Submerged aquatic vegetation found in the intertidal zone becomes stressed if it is exposed for extended amounts of time to the elements, and desiccation may well be the major limiting factor for upper intertidal eelgrass (Boese et al. 2005). By examining current SAV distribution and bathymetry values, areas which are too high are excluded from further analysis, areas which are somewhat high are given a lower score and areas which are deep are given the highest score.

<u>Sea Surface Temperature</u>

Water temperature also affects submerged aquatic vegetation distribution. While different species have adapted to different water temperature ranges, the ones looked at in the gulf: *Halodule wrightii, Ruppia maritima and Vallisneria americana* (Fonseca 1998, McFarland 2006) have similar optimal temperature requirements.

Available Light

Submerged aquatic vegetation must have sufficient light to carry out photosynthesis. The deeper the plant is, the less light is available, and in fact, the lower edge of vertical distribution is often determined by the amount of light available to plants. This can be described by the following adaptation of Lambert –Beer's Law where, for any given wavelength:

$$I_{\lambda,z} = I_{\lambda,0}\, e^{(-kz)} \quad (1)$$

z is depth
Io is irradiance for the wavelength λ at depth 0.
K is an attenuation coefficient
Iz is irradiance at depth z for wavelength λ.

Using the Kd488 (or the attenuation coefficient at 488nm) product and a separate bathymetry dataset, we can calculate the percent of light at the surface which exists at depth (z). The raster model then extracts values for % surface irradiance (SI) for areas where SAV is currently present and scores areas with suitable light more than those without.

Assumptions:

This light product assumes that the incoming radiance at the surface of the water is the same throughout the study area. The amount of light present at the water's surface varies day to day and hour to hour. Weather, time of day, season of year, and solar flares are among the variables that alter the amount of radiance hitting the water's surface. We assume that the variance of these factors over any particular bay/estuary is negligible for the purposes of this analysis.

2.4 Scoring

Description of the scoring can be found in Table 2-1. Figure 2-1 provides an illustration of how scores are obtained from distribution characteristics for desiccation and light attenuation.

Table 2-1. Scoring regime for Controlling Factors Model. Results for each element are added together, for potential scores ranging from 0-9 for each pixel. Scores 0-6 should be interpreted as unacceptable, 7 marginal, 8 & 9 acceptable for SAV growth.

Controlling Factor	Score	Score Range
Desiccation	2	Lowest elevation in bay to + 1σ for distribution
	1	+ 1σ to maximum elevation for distribution of SAV
	Excluded	Areas above maximum elevation for SAV
Sea Surface Temperature	0	Below 20°C; Above 37°C
	1	20-28°C; 32-37°C
	2	28-32°C
Light attenuation	0	Lowest (Iz/Io) in bay to min (Iz/Io) for distribution
	1	Minimum (Iz/Io) for distribution to - 1σ for distribution
	2	- 1σ for distribution to –1/2 σ for distribution
	4	–1/2 σ for distribution to +1/2 σ for distribution
	5	+1/2 σ for distribution to Mean Sea Level

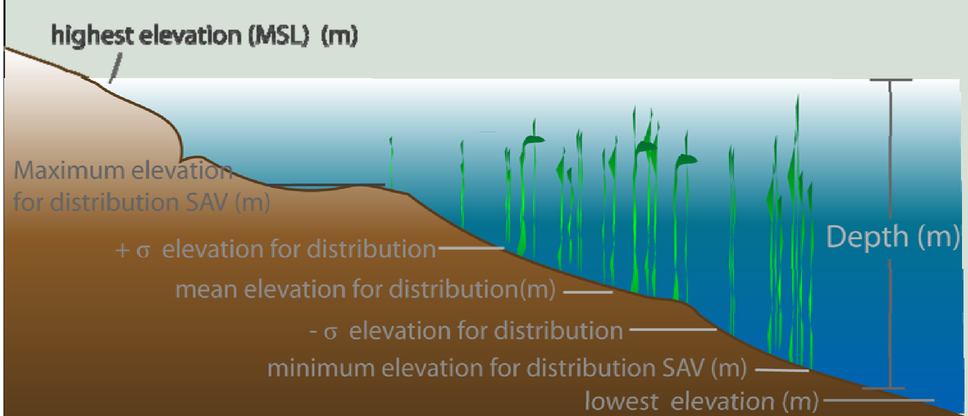


Figure 2-1. Scoring for desiccation. Based on current SAV distribution and bathymetry, we can derive the upper growth limit for SAV. We can then apply that limit to score the entire study area to score areas that are more like the current habitat higher than those that are not.

2.5 Technical requirements

Technical details for input datasets can be found in Table 2-2.

Table 2-2. Input dataset requirements

Input Dataset	Type	Description
Spatial Decision Unit (Potential Sites) *Optional*	Shapefile	Projected shapefile with a unique numeric code for each site. Includes attributes « AREA », which is the area of the site, and « LENGTH », which corresponds to the length of shoreline present in each site.
Bathymetry	Raster	Should be at a resolution sufficient to capture nearshore features. The vertical datum should be adjusted to Mean Sea Level and be in meters. Apply a mask to eliminate any values above sea level. Areas below sea level are positive.
Light Attenuation Coeffi-cient	Raster	Current input is MODIS K490 composite for a month, units should be m-1.
Temperature	Raster	Current input is MODIS SST composite over a month. Units should be in degrees C.
Current SAV Distribution	Shapefile	Projected shapefile which only represents species of inter-est. Mapping project should be complete for the area of interest

<u>Output</u>

The output of the CF model is a scored grid with values of 0-9, corresponding with the suitability of habitat for SAV. A user may also specify that results be summarized based on the spatial decision unit. In this case, the original shapefile is copied and two new attributes area added: GDAREA which is the total area per decision unit rated as good, and AVGSCR which is the average of scores 7-9 per decision area.

3. Benthic Change Analysis Tool

3.1 Background & Tool Overview

Over the last century, seagrasses have undergone a dramatic decrease in extent throughout the Gulf of Mexico (Handley et al. 2006). Though in recent years, the rate of decline has decreased and even reversed at some sites, monitoring how and where the extent of SAV changes in important for resource managers.

The Benthic Change Analysis Tool enables a user to quickly spatially evaluate presence/absence change for SAV and seagrasses between two time steps. The output of the Benthic Change Tool is a coded grid with four values.

If the evaluation is carried out as part of the Restoration prioritization assessment the user also has the option to summarize output raster based on an input shapefile, where each record is considered a separate 'Site' or spatial decision unit. Through this option, three new attributes are added to the input shapefile: RESTORE, ENHANCE, PRESERVE. The area in each site coded for each potential management strategy is recorded (see Table 3-1). At this point, these are just potential management strategies, to be evaluated with other factors.

Table 3-1. Codes for Benthic Change Analysis. Analysis helps select management strategy appropriate to site.

Code	Meaning	Potential Management Strategy
0	Currently present, historically absent	Preserve / Conserve
2	Currently absent, historically absent	Creation / Enhancement
4	Currently present, historically present	Preserve / Conserve
6	Currently absent, historically present	Restore

3.2 Technical Requirements

Required inputs are summarized in Table 3-2. Both SAV datasets should be projected in the same coordinate system and in a vector format and representative of only features which are submerged aquatic vegetation. This analysis only examines change in presence, not changes in density or biomass. Because this tool evaluates change in a raster format, some error will be introduced in translating vector features to raster features. A cell size should be selected which will capture the vector data nuances, this is particularly important to ensure that linear fringy SAV is captured. Though this tool was developed for SAV change analysis, it can be used to evaluate change with any feature between two time steps.

Table 3-2. Input datasets for Benthic Change Tool. A user may choose to summarize data based on a spatial decision unit, or may choose just to view the coded raster output.

Input Dataset	Type	Description
Spatial Decision Unit (Potential Sites) *Optional*	Shapefile	Projected shapefile with a unique numeric code for each site. Includes attributes « AREA », which is the area of the site, and « LENGTH », which corresponds to the length of shoreline present in each site.
Current SAV Distribution	Shapefile	Projected shapefile which only represents species of interest. Mapping project should be complete for the area of interest
Historical SAV Distribution	Shapefile	Projected shapefile which only depicts species of interest.

4. Prioritization Tool

4.1 Background & Tool Overview

The prioritization tool is comprised of 2 scripts which (1) Summarize and standardize stressor datasets, and (2) Weight and score these datasets and summarizes outputs from prior steps.

The decision unit shapefile is copied and new attributes are added. Final attributes of interest are: « Salinity », « R_PRIORITY », and « R_ACTION ».

- **R_Action** lists a potential management strategy per site: Restoration, Conservation, Enhancement or a combination of the above.
- **R_Priority**, lists the amount of stress and site suitability.
- **Salinity** suggests the types of species which would be more suited for the site based on the salinity level.

What is a spatial decision unit?

A spatial decision unit is the minimum unit at which a decision is made. It is at this level that the data is evaluated and summarized for the user. In this case, a spatial decision unit represents a potential restoration site (see figure to right), and is represented as polygons within a shapefile. Each unit has a unique code, and represents an area with contiguous benthic habitat and geomorphology. The goal is to define units so that a restoration action in the site will affect the function of the entire site.

(1) Summarize and standardize stressor datasets

Through the process of summarizing stressor datasets, a user can identify any shapefile which can be considered stressful to SAV. These stressors are standardized based on the length and area of the site and recorded in new fields in a Site polygon dataset (Table 4 -1). A summary will also be logged for the user's records.

Table 4-1. Summarizing stressor datasets per spatial decision unit. Datasets must have line, point, or polygon geometries to be used.

<table>
<tr><th>Input Stressor Dataset Type</th><th>Function</th><th>Output</th><th>Example of stressor</th></tr>
<tr><td>Line</td><td>For each decision unit polygon, % total shoreline covered by linear feature will be recorded</td><td rowspan="3">New attribute in decision unit shapefile with calculations. Attribute name will be the first seven characters of the file name with an extension of sd for a point dataset, and pc for a line or polygon dataset.</td><td>Shoreline armoring</td></tr>
<tr><td>Point</td><td>For each decision unit polygon, tool will record:
• Number of data points present
• Standardized to number of points per 1000 ft / m</td><td>Boat launches
Piers
Marinas
Outfalls</td></tr>
<tr><td>Polygon</td><td>• For each decision unit polygon, % of total area in unit covered by new polygon feature is recorded</td><td>Invasive species
Landslides</td></tr>
</table>

(2) Weight and score datasets

At this stage, the user selects identifies a relative weighting for each stressor.
First, each factor is scored between 1-5 based on the severity of the standardized stressor in the polygon. Scoring is by quintile and relative to other scores in the area. Decision units with no stressor present receive a score of zero. This relative ranking is then multiplied by the user defined weight. After calculating the relative stress, the stressor scores are totaled for each spatial decision unit.

Finally, each site with some type of stress is ranked 1-3 based on the amount of relative stress based on their scores. 1 - Low, 2 - Medium, and 3 - High.

Salinity

High and low seasonal averages for salinity are extracted for each site and compared against the salinity ranges for each species. The species which is most adequate for the site is recorded as in Table 4-2.

Table 4-2. SAV species category by salinity. Salinity category is recorded under new attribute "Salinity" for each potential site within decision unit shapefile.

Salinity Category	High value (psu)	Low value (psu)
Seagrass	>24	>14
Freshwater SAV	< 6	—
Oligohaline Ruppia	6-15	—
Ruppia & Halodule possible, outside optimal range	16-24	< 14

Restoration Management Strategy

The restoration management strategy uses results from the benthic change tool to evaluate what structure is present now and how it has changed over time to recommend a potential management strategy, under the new attribute **R_Action**. In addition, the tool evaluates the total area per site with suitable habitat to discern whether the conditions are adequate for restoration. Table 4-3 provides a summary.

Table 4-3. Potential Management Action. Management actions are based on the results of prior analysis and the attributes that they recorded in the decision unit file. RESTORE is the total area per site where SAV was present historically, but absent present day. PROTECT is the total area per site where SAV is currently present. GD_AREA is the total area per site with adequate controlling factors.

Potential Restoration Action	Attributes within decision unit shapefile		
	RESTORE	PROTECT	GD_AREA
Restore	> 5 ha	<1 ha	> 5ha
Protect & Restore	> 5ha	>1ha	> 5ha
Protect	<5 ha	>1ha	> 1ha
Enhance	<5ha	<1ha	—

Restoration Category

At this stage, the controlling factor scores are also ranked 1,2, or 3 depending on the average of acceptable scores (7-9) per site. Equal numbers of sites are placed in each group. Sites with no acceptable scores are ranked 0. These rankings are combined with the stressor score, for the final restoration category **R_Priority**. Table 4-4 summarizes how categories are defined.

Table 4-4. Restoration Priority Definitions. Restoration priorities summarizes the scores from the Controlling Factors and Stressors Analysis.

R_Priority Category	Controlling Factor Score	Stressor Score
Low Controlling Factors (CF)	0—1	Any
High Stress, Medium CF	2	3
Med Stress, Medium CF	2	2
Low Stress, Medium CF	2	1
High Stress, High CF	3	3
Med Stress, High CF	3	2
Low Stress, High CF	3	1

4.2 Interpreting Results

The three attributes: Salinity, R_Priority, and R_Action must be viewed together to evaluate potential management actions. A site with low controlling factors, for example, probably would not make a good site for restoration of SAV. Managers might be interested in changing the controlling factors, and in many cases this would be related to characteristics of the watershed. On the other hand, a site with High Controlling Factors and Low or Medium Stress with a restoration action of RESTORE, might be an ideal site to replant SAV. In a site with High Stress, High CF and a Protect action, managers may want to try to reduce stress to protect the current SAV population.

It is also important to keep in mind that the quality of results depend on the integrity and quality of the input datasets. If there are errors in the input datasets, there will be errors in the results as well.

This analysis should be viewed as a preliminary step in selecting a restoration management action appropriate for an area. It is equally important to visit the site in person for a better understanding of the ecological characteristics.

4.3 Technical Requirements

<u>Spatial decision unit dataset:</u>

- **Unique ID** The site dataset must be made up of polygons, with everything that is considered a site having a unique ID to identify it.
- **LENGTH** The site dataset must have an attribute LENGTH which represents the length of shoreline present
- **AREA** The site dataset must also have an attribute AREA which represents the total area of each site
- **Projection**—The dataset should be projected with a linear unit of meters. The projection should be the same for all input stressor datasets

<u>Stressor datasets</u>

- Only feature of interest should exit in dataset
- Dataset should be projected in the same projection as the site dataset
- Datasets should be shapefiles with only points, lines or polygons represented

5. Case Study - Mobile Bay, AL

5.1 Background on Mobile Bay

Mobile Bay is one of the many estuaries and bays located within the Gulf of Mexico, and it has a very dynamic system (Figure 5 – 1). On the north end of the bay, freshwater influx is high, and in the south, high salinity from the ocean dominates. The metropolitan area of Mobile, AL is located on the northwest edge, and smaller towns and community dot the shoreline.

Figure 5-1. Mobile Bay, AL.

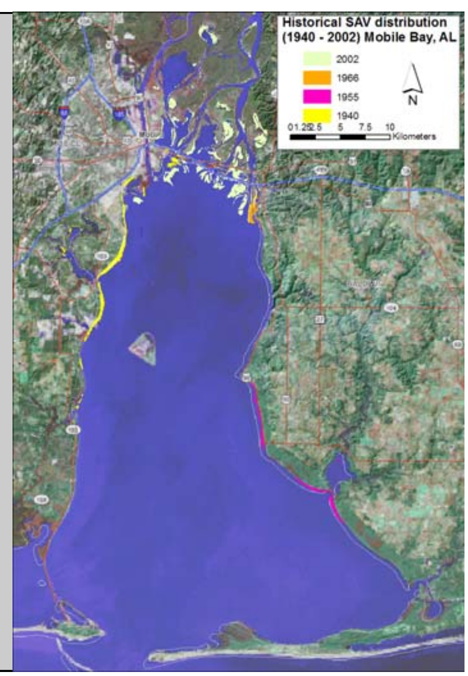
Conversion of forest to farmland and development of rural and coastal areas are common development activities. Within the bay itself, dredging, vessel activity, shoreline armoring and shoreline structures put additional stress on the nearshore habitat. Hurricanes and tropical storms add stress as well. Recently, invasive aquatic vegetation has been found in Mobile Bay.

Where have all the seagrasses gone?

Interpretation of early aerial photos from 1940-1966 allowed for SAV to be mapped in portions of Mobile Bay. Recent aerial photos show a diminished distribution of SAV. The figure to the right shows where the most recent mapping effort identified SAV compared with mapping from historical photos.

There are many suggested theories why this loss is seen. Some scientists point to altered salinity regimes within the bay, others to development and nearshore stresses, and others still to increased turbidity.

For further details about this study, please see:
Vittor & Associates. 2005. Historical SAV Distribution in the Mobile Bay National Estuary Program Area and Ranking Analysis of Potential SAV Restoration Sites. Prepared for Mobile Bay National Estuary Program, Mobile, AL. p 17.



Defining spatial decision unit

The spatial decision unit was defined by applying a buffer of 500m to the shoreline on the waterside and 200m on the land side. This buffer was extended in shallow areas near the Mobile—Tensaw Delta, to cover the entire zone where SAV are found currently or were found in the past. The newly formed polygon was divided into sites identified by changes in benthic type and geomorphology class. An attribute "CODE" was added and set equal to the FID +1, for a unique CODE for each site. This new shapefile was intersected with a shoreline polyline, and the length of the polyline recorded under a new attribute LENGTH. Total area for each unit was recorded under an attribute "AREA".

Controlling Factors Model

NASA satellite imagery products developed through the Naval Research Lab at Stennis under a NASA REASON project were used as data inputs for sea surface temperature and turbidity (K490). Datasets were a composite for May 2007. May was chosen as it is a month critical to growth of SAV, and a temporally significant scale. Current distribution of SAV is documented in a GIS layer (Vittor & Associates 2004) and a bathymetric layer from sonar (NOS, 1962) was used and corrected to Mean Sea Level.

Benthic Change

Spatial datasets for all past SAV distribution (National Wetlands Inventory (1992), Aerial photo interpretation 1950s -1970s)) were joined together for a consolidated coverage of areas where SAV have historically occurred. This was used as the data input for historical distribution. Shapefiles for current distribution was acquired from Mobile Bay's NEP (Vittor and Associates 2004).

Prioritization

In Mobile Bay, we chose to evaluate several stressors present in the system, including: shoreline armoring, presence of aquatic invasive species, dredge disposal sites, dredge channels and overwater structures. GIS datasets were acquired or developed to represent these stressors, and stressors were equally weighted.

Results

Results are summarized by decision unit (Figure 5-1). Together these results can help describe potential restoration sites, and provide user's with needed information, such as potential management strategy (A), level of stress and suitable level of controlling factors (B), and appropriate species (C).

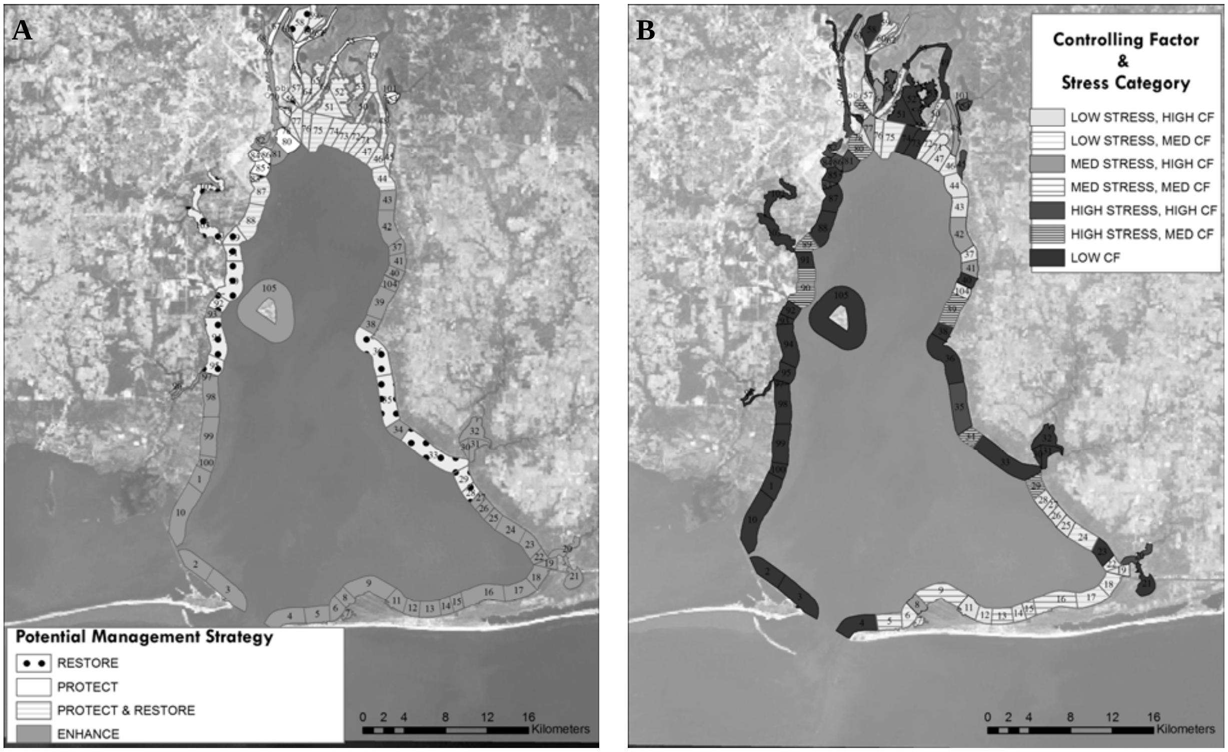


Figure 5-1. Results for prioritization in Mobile Bay. Areas to the north often are suitable for freshwater SAV and have SAV present currently. High and medium levels of stress could threaten the current SAV population. Areas towards the middle of the bay may have high controlling factors and low stress, but the salinity level is not ideal for SAV habitat.

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Appendix A– Overview of User's Tools and Guide

Which version of the tools should I use?

The restoration toolsets are available in two forms:

- Conceptual Model Explorer (CME) on the web
- ArcGIS Toolboxes (Controlling Factors and Benthic Change only)

Conceptual Model Explorer

The tool within the CME has more parameters hardwired than the ArcGIS toolbox but allows complete execution of the Restoration Toolbox elements. This may be ideal for users with limited experience with GIS, or no access to ArcGIS, or those interested specifically in Mobile Bay.

ArcGIS Toolbox

The Restoration Toolbox should be used for those with access to ArcGIS 9.2, with Spatial Analyst. The toolbox does not contain the prioritization tool, but does allows users to examine habitat suitability for SAV (Controlling Factors) and to evaluate change per polygon between two timesteps (Benthic Change). Complete instructions are housed within the tool itself.

How do I access and install these different versions?

Conceptual Model Explorer

This web based tool provides a simple user interface and requires no downloading of tools or data. However, at present time, it is configured for execution only for Mobile Bay, AL with limited substitution capability. To access the tool, go to
(http://persephone.bioe.orst.edu/cme/) and follow user's guide.

Instructions for installation of Restoration Toolbox

Requirements:

Toolboxes are formatted to be executed in ArcInfo 9.2 with a current Spatial Analyst extension.

Instructions:

1) Download zipped toolbox folder to your computer and extract contents to a folder
2) Open ArcMap
3) Right click on the top level "ArcToolbox" within your ArcToolbox window, and select "Add Toolbox"
4) Navigate to the place on your computer where you saved the folder and select the toolbox.
5) The toolbox should now appear within the ArcToolbox window.

To execute, simply follow directions within tool.

Appendix B:
User's Guide: Restoration Toolbox within the Conceptual Model Explorer

Background

The Restoration Prioritization Toolbox forms part of an integrated system within the Gulf of Mexico Regional Collaborative's (GOMRC) framework to help decision makers from a variety of agencies in their environmental restoration planning process, focusing in this case on submerged aquatic vegetation.

GOMRC's approach to prioritizing sites for restoration is based on a science- based representation of how the system functions, known as an ecological conceptual model. A conceptual model was developed for SAV habitat to help users understand how ecosystem stressors and certain coastal habitat conditions, referred to as controlling factors, can influence SAV distribution and abundance.

Geospatial data can provide insights on various elements of the conceptual model for SAV habitat. Analysis of this data enables use to predict where:

1) Controlling factor ranges are suitable for maintaining healthy SAV
2) SAV distribution has changed over time, and
3) Local stressors are influencing SAV habitat

GoMRC's Restoration Toolbox provides a means of collectively evaluating controlling factors, SAV distribution and local stresses, and recommending sites for SAV restoration in Mobile Bay.

Conceptual Model Explorer (CME) provides a simple user interface to execute complex spatial analyses and provide results. For those familiar with ArcGIS products, the restoration toolbox runs analyses on ESRI's ArcServer through the CME, and a user can execute with default datasets, provide new datasets, change weighting and choose to view or download results.

Restoration Toolbox Elements

The Restoration toolset contains three fundamental models that will run sequentially:

(1) Model for Controlling Factors which uses NASA derived datasets with local datasets to predict areas which are suitable for a species growth.

(2) Benthic Change Tool examines species structure and distribution

(3) Prioritization are scripts which summarize and weight stress and produce final recommended management actions.

Further details about each of these models is available on-line at www.gomrc.org.

Restoration Toolbox Execution - Four steps

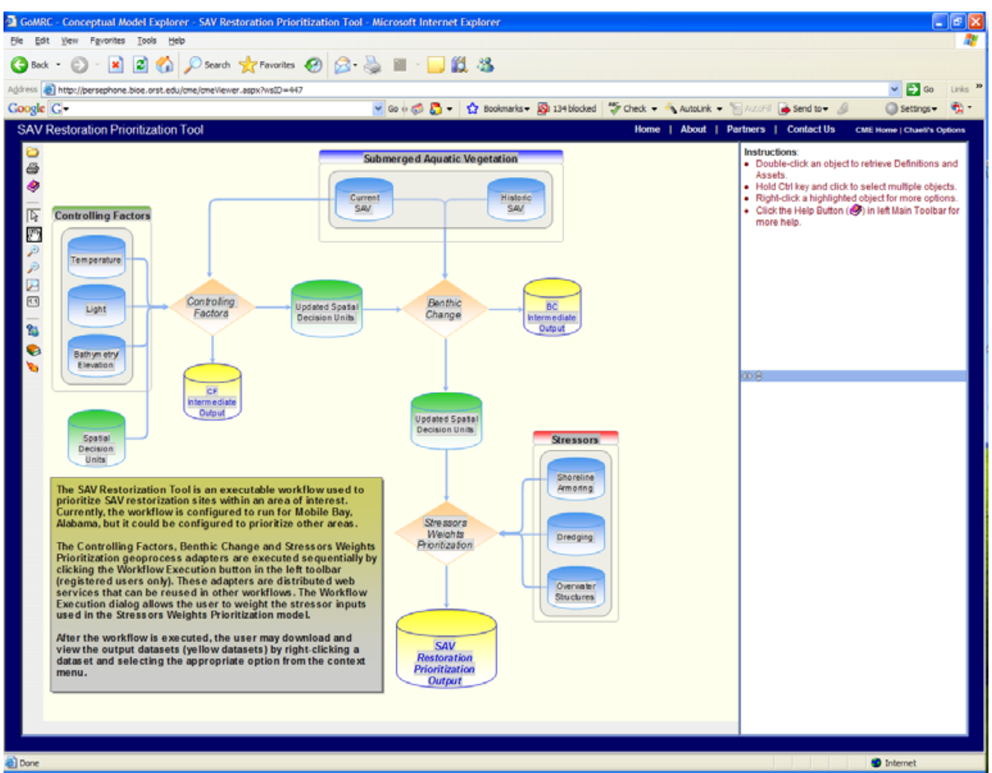
The restoration framework can be executed by following four simple steps:

1. **Log on to the conceptual model explorer**
2. **Select "Execute Workspace"**
3. **Configure set-up if desired**
4. **Download or map results**

1. Log on to the conceptual model explorer (http://persephone.bioe.orst.edu/cme/)

While a casual user may view conceptual models and tools without logging on, a log in is required to execute or change tools. Users can easily sign up for a free user account, by selecting **Create New User** from log in screen.

After logging on, the user will have a choice of different tools and models to view, edit or execute within the CME. In this case, we will **select the link "SAV Restoration Prioritization Tool".** The toolbox workspace (as shown below) will appear. This is a visual representation of analysis elements. The toolbox is comprised of three separate models that will run sequentially. Input datasets are grouped by the category of the scientific conceptual model they represent: Controlling Factors, Stressors or Structure.



Models are visually represented by orange diamonds, and in this case are referred to as “Adapters”.

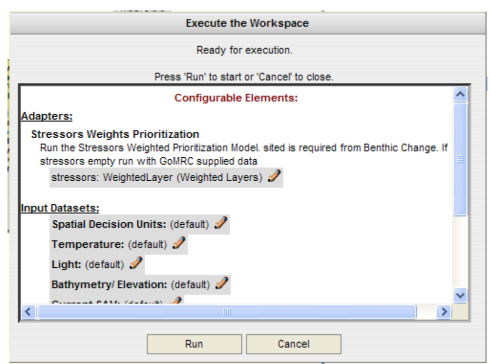
Input **datasets** are shown in blue, and outputs in yellow. In this case the shapefile for restoration sites is shown in green. After execution, newly derived datasets may either be visualized in our interactive map, or downloaded.

Relationships are represented by blue arrows. They can represent inputs to a model and outputs from a model.

Further details on these components and the CME itself are available through the CME help

2. Select “Execute the Workspace” 

To execute the spatial analysis, users should click on the **“Execute Workspace”** button on the left side toolbar. This will launch a user interface to change input datasets or weights. The window below will pop up.



3. Configure set-up if desired

The window allows access to change default inputs for (a) Scoring of stressors or (b) Input datasets (Experimental).

(a) Scoring of Stressors 

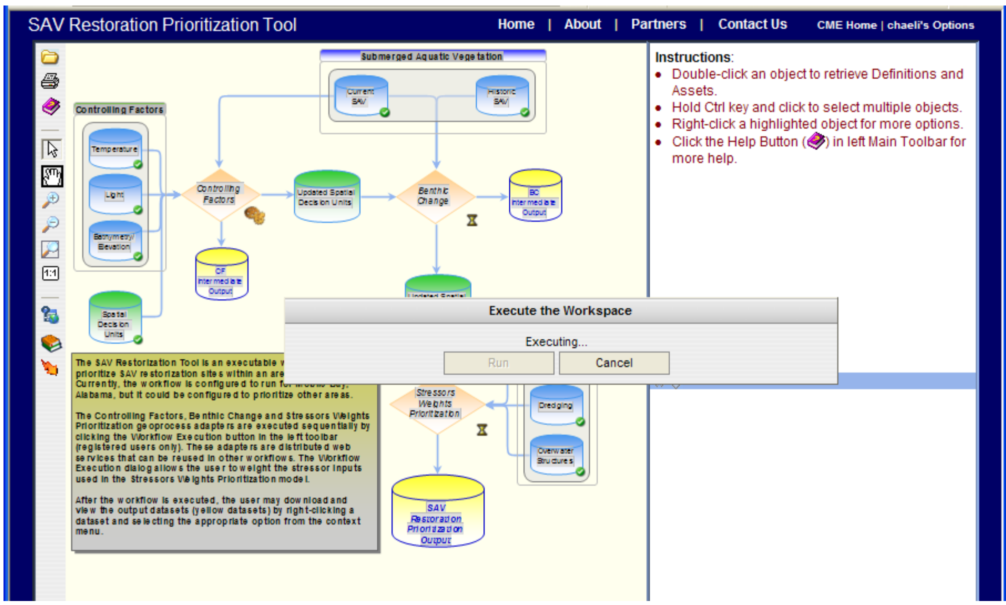
Click on the pencil. The “Edit Parameter” dialog box will appear. Users can change the relative importance of each unique stressor by entering a new number (integers) in the Weight box. After changes, user should select “Save”.

(b) Input datasets (Experimental) 

Input datasets can also be changed by clicking on the pencil. If access to the entire dataset is available online, the user can enter the URL. If the user has the dataset locally on their computer, they can upload the file (as long as it is under 10MB). Please see entire documentation for requirements for each dataset.

Click **RUN** for models to execute.

Users can track the progress of the model, by viewing the icons next to the adapters. The green check box indicates successful execution, gears indicate that particular model is running, and an hour glass shows that the model is waiting to be run.



4. Download or Map Results

After successful execution, **right click** on any of the yellow output datasets to either download or map results in our interactive map. Results will be available in the form of a shapefile. For those interested in accessing the results in a spreadsheet, choose to download the .dbf file. This file can be opened in Excel.

Appendix C. Technical documentation of Restoration Prioritization Toolbox

Background

With the growing population and pressure to develop coastal areas as well as coastal watersheds, conservation and restoration of coastal ecosystems is a high priority for the nation. Managers must make decisions on complex problems every day, and having a credible scientific basis for these decisions is critical. In addition, they need to plan and implement restoration in cost effective ways in order to maximize results for the money spent.

Among the most often sought after tool by managers is one that prioritizes restoration projects. A prioritization decision tool provides one of the bases for making investments in restoration projects. Ideally the tool contains the relevant scientific underpinnings, and facilitates the decision making process by providing an effective interactive mechanism.

The Restoration Prioritization Toolbox forms part of an integrated system within the Gulf of Mexico Regional Collaborative (GoMRC) framework to facilitate decisions related coastal ecosystem restoration, specifically the management of submerged aquatic vegetation. Based on the conceptual model, the Restoration Prioritization Toolbox uses local GIS datasets, bathymetric information and datasets derived from NASA products to represent elements of the conceptual model. This can assist the user in evaluating stressors, controlling factors and recommend a restoration management strategy based on current and past structure distribution. These GIS modeling techniques have involved weighting of system controlling factors and system stressors to score pre-defined ecological zones based on their suitability for restoration.

Application Description

The toolbox is comprised of three elements:

1. Model for Controlling Factors which uses NASA derived datasets with local datasets to predict areas which are suitable for a species growth.
2. Benthic Change Tool examines species structure and distribution
3. Prioritization are scripts which summarize and weight stress and produce final recommended management actions.

The Controlling Factors and Benthic Change tools are available both within the Conceptual Model Explorer (CME) and as stand alone ArcGIS toolboxes. The prioritization scripts are only executable through the CME.

Each tool was originally written in Python for execution in ArcInfo 9.2 with Spatial Analyst license and accessed by an ArcGIS toolbox. Scripts were recoded for execution within ArcServer.

Expected inputs for each model and outputs can be summarized in the tables below.

Input Dataset	Type	Description
Spatial Decision Unit (Potential Sites)	Shapefile	Projected shapefile with a unique numeric code for each site. Includes attributes « AREA », which is the area of the site, and « LENGTH », which corresponds to the length of shoreline present in each site.
Bathymetry	Raster	Should be at a resolution sufficient to capture nearshore (30m pixels). The vertical datum should be adjusted to Mean Sea Level and be in meters. Apply a mask to eliminate any values above sea level. Areas below sea level are positive.
Light Attenuation Coefficient	Raster	Current input is MODIS K490 composite for a month, units should be m-1.
Temperature	Raster	Current input is MODIS SST composite over a month. Units should be in C
Current SAV Distribution	Shapefile	Projected shapefile which only represents species of interest. Mapping project should be complete for the area of interest
Historical SAV Distribution	Shapefile	Projected shapefile which only depicts species of interest.
Salinity	Shapefile	Projected shapefile with High and Low salinity values recorded.
Stressor Datasets	Shapefiles	Projected shapefiles which represent environmental stressors of interest which occur within the spatial decision unit.

<table>
<tr><th>Model</th><th>Output</th><th>Description</th></tr>
<tr><td>Controlling Factors</td><td>Raster & New Decision Unit Shapefile</td><td>The output of the CF model is a scored grid with values of 0-9, corresponding with the suitability of habitat for SAV. A user may also specify that results be summarized based on the spatial decision unit. In this case, the original shapefile is copied and two new attributes area added: GDAREA which is the total area per decision unit rated as good, and AVGSCR which is the average of scores 7-9 per decision area.</td></tr>
<tr><td>Benthic Change</td><td>Raster & New Decision Unit Shapefile</td><td>The output of the Benthic Change Tool is a coded grid with 4 values, representing the type of change seen per cell.
<table>
<tr><th>Code</th><th>Meaning</th><th>Potential Management Strategy</th></tr>
<tr><td>0</td><td>Currently present, historically absent</td><td>Preserve / Conserve</td></tr>
<tr><td>2</td><td>Currently absent, historically absent</td><td>Creation / Enhancement</td></tr>
<tr><td>4</td><td>Currently present, historically present</td><td>Preserve / Conserve</td></tr>
<tr><td>6</td><td>Currently absent, historically present</td><td>Restore</td></tr>
</table>
The user also has the option to summarize output raster based on the spatial decision unit. Through this option, three new attributes are added to the input shapefile: RESTORE, ENHANCE, PRESERVE. The amount of area in each site for each potential management strategy is recorded.</td></tr>
<tr><td>Prioritization</td><td>New Decision Unit Shapefile</td><td>Decision Unit shapefile is copied and new attributes are added. Final attributes of interest are: « Salinity », « R_PRIORITY », and « R_ACTION ».
R_Action lists a potential management strategy per site: Restoration, Conservation, Enhancement or a combination of the above.
R_Priority, lists the amount of stress and site suitability.
Salinity suggests the types of species which would be more suited for the site based on the salinity level.</td></tr>
</table>

Processing

Detailed information on data processing and scoring is available Restoration Prioritization Toolbox : Documentation and User's Guides 2007

QA, Validation and Testing

The desktop toolbox went through a functional QA process as well as a critical scientific peer review of modeling and prioritization methods.

Relationship to other GoMRC Tools

The prioritization scheme is based on the Scientific Conceptual Model for SAV Restoration: http://www.gomrc.org/conceptual_model.html

The models are currently embedded in the Conceptual Model Explorer: