Coastal Wetlands Planning, Protection and Restoration Act

Wetland Value Assessment Methodology

Barrier Island Community Model

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Introduction

The Wetland Value Assessment (WVA) methodology is a quantitative habitat-based assessment methodology developed for use in determining wetland benefits of project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The WVA quantifies changes in fish and wildlife habitat quality and quantity that are expected to result from a proposed wetland restoration project. The WVA operates under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland habitat type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of community models developed specifically for each habitat type. The results of the WVA, measured in Average Annual Habitat Units (AAHUs), can be combined with cost data to provide a measure of the effectiveness of a proposed project in terms of annualized cost per AAHU gained. In addition, the WVA methodology provides an estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected/restored.

The WVA was developed by the CWPPRA Environmental Work Group (EnvWG) after the passage of CWPPRA in 1990. The EnvWG includes members from each agency represented on the CWPPRA Task Force and members of the Academic Advisory Group (AAG). The WVA is a modification of the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 1980). HEP has been widely used by the Fish and Wildlife Service (FWS) and other Federal and State agencies in evaluating the impacts of development projects on fish and wildlife resources. A notable difference exists between the two methodologies, however, in that HEP generally uses a species-oriented approach, whereas the WVA utilizes a community approach.

The WVA has been developed for application to several habitat types along the Louisiana coast and community models have been developed for fresh marsh, intermediate marsh, brackish marsh, saline marsh, swamp, barrier islands, and barrier headlands. Habitat assessment models for bottomland hardwoods and coastal chenier/ridge habitat were developed outside of CWPPRA and are periodically used by the EnvWG. The WVA models have been developed for determining the suitability of Louisiana coastal wetlands in providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. The models have been designed to function at a community level and therefore attempt to define an optimum combination of habitat conditions for <u>all</u> fish and wildlife species utilizing a given habitat type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index (SI) graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines the Suitability Index for each variable into a single value for habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI.

The output of each model (the HSI) is assumed to have a linear relationship with the suitability of a coastal wetland system in providing fish and wildlife habitat.

Historically, the EnvWG utilized the saline marsh community model to evaluate barrier island restoration projects. However, it was recognized that the saline marsh community model was inadequate in determining barrier island habitat quality and projecting barrier island restoration project benefits. Barrier islands provide many functions and values not provided by saline marsh and a unique assessment model was necessary to characterize those functions. This model has been designed to function at a community level and therefore attempts to define an optimal combination of habitat conditions for <u>all</u> fish and wildlife species utilizing barrier islands.

A draft barrier island community model was presented in May, 2001 and was reviewed and further developed by the EnvWG and Academic Advisory Group (AAG). Also participating in model development was an interagency group involved in the Barataria Barrier Shoreline Feasibility Study being conducted by the U.S. Army Corps of Engineers (USACE) and the Louisiana Department of Natural Resources (LDNR). The model was developed by an interagency/academic workgroup consisting of individuals with backgrounds in wildlife ecology, fisheries ecology, geomorphology, and plant ecology. As with all habitat assessment models, this model has undergone several revisions since development began in 2000. Model refinement will continue as the model is applied to various restoration projects in different environmental settings.

Note: This document has been primarily developed to guide the application of the barrier island community model for CWPPRA. However, the guidance it provides may be used by other restoration programs (e.g., Louisiana Coastal Area, U.S. Army Corps of Engineers Civil Works) recognizing the distinction between projects that result in net habitat gain (i.e., restoration), net loss (i.e., development), or no net loss (i.e., mitigation). It is unlikely that the barrier island community model would be utilized by the regulatory agencies to determine impacts or mitigation requirements for development projects. By definition, the model is applied to the entire island and it is therefore unlikely that the typical small-scale impacts resulting from development projects would be detected by an evaluation encompassing the entire island. Historically, the saline marsh community model has been applied in such instances as it is often utilized to determine the impacts of small-scale, non-restoration actions.

Geographic Scope

The barrier island community model bases its habitat assessment scheme on variables that are quite broadly applicable to barrier island habitats outside of Louisiana. The basic habitat categories- dune, supratidal, and intertidal, are all typical components of barrier islands throughout the Atlantic and Gulf Coasts of the USA, and into Mexico. The scientific literature used to justify the model parameters and coefficients comes from the Atlantic and Gulf of Mexico coastline from as far south as Mexico (Withers 2002) and as far north as New Brunswick, Canada (Craik and Titman 2008). The surf zone fish assemblages that appear in the northern Gulf of Mexico (Mississippi, Louisiana, and Texas) all appear to have a similar make up, consisting primarily of small juvenile planktivorous fish (Ellinwood 2008; Modde and Ross

1981; Modde and Ross 1983; Naughton and Saloman 1978; Springer and Woodburn 1960). Although a few species of birds might be gained or lost by moving from the western (Rio Grande River) to the eastern extreme of the northern Gulf of Mexico (Tampa Bay), they are typically ecologically similar to others already in the community- large waders that use the same intertidal shallows, shorebirds that use intertidal habitats, etc. (American Ornithologists Union 1998).

This model was developed for determining the suitability of Louisiana coastal barrier islands in providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. Specifically, this model should be applied to barrier islands which consist of emergent habitats and which are gulfward of bay or lake systems. This model was developed to evaluate restoration projects on barrier islands in the Terrebonne and Barataria Basins (e.g., Isles Dernieres, Timbalier, and Grand Terre). However, the basic model principles and valuation system allow its application to other barrier island systems, with some revision to model variables, SI curves, etc. For example, application to the Chandeleur Islands of Louisiana, which contain extensive seagrass beds, would require model revisions as the value of those seagrass beds is not specifically captured by this model. Application to other barrier islands along the Gulf coast would require some revision to model variables, SI curves, etc.

Minimum Area of Application

The area of application for the barrier island community model differs from the other community models in that the project boundary encompasses the entire island, regardless of the scope of the restoration action. Habitat restoration (i.e., dune and marsh creation) is considered to benefit the entire island and extend beyond the limits of dune and marsh creation. The addition of sediment can increase island longevity as those sediments are transported to other portions of the island via wind, waves, and currents along the shoreface (i.e., littoral drift). Also, created marsh provides a landward platform for island migration (i.e., “rollover”).

Based on the project boundary being defined as the entire island and that even the smallest barrier island has importance to some species of fish and wildlife, a minimum area of application was not determined. For those reasons, the minimum area to which this model should be applied should be based off of expert opinion.

Evaluation of Nominated Projects

Each year, projects are nominated at regional planning team meetings held at various locations along the coast. Each nominated project is assigned to one of the five Federal agencies which administer the CWPPRA program. Those agencies include the FWS, Environmental Protection Agency (EPA), National Marine Fisheries Service (NMFS), USACE, and Natural Resources Conservation Service (NRCS). The sponsoring agency is responsible for preparation of fact sheets which include a project description, preliminary costs, and an estimate of project benefits. The features, estimated benefits, and estimated costs for all nominated projects are reviewed by the EnvWG and the Engineering Work Group (EngWG). The benefits and cost estimates, and other pertinent information are provided to the Planning and Evaluation Subcommittee which prepares a matrix containing all project information. The Technical Committee utilizes that information in selecting which projects to further evaluate as candidate Priority Project List

(PPL) projects. Candidate projects remain assigned to one of the five Federal agencies. The Louisiana Office of Coastal Protection and Restoration (OCPR) usually serves in a supporting role to the Federal agencies although they may have the primary responsibility of preparing information for some candidate projects. The sponsoring agency serves as the point of contact for the project and is responsible for development of project features, preparation of cost estimates, and preparation of the draft WVA.

Field Investigation of Candidate Projects

The first step in evaluating candidate projects is to conduct a field investigation of the project area. This field investigation has several purposes: 1) familiarize the EnvWG and EngWG with the project area, 2) visit the locations of project features, 3) discuss a benefited area for the upcoming project boundary meeting, 4) determine habitat conditions in the project area, 5) compile a list of vegetative species and discuss habitat classification, and 6) collect data for the WVA (e.g., cover of submerged aquatics, water depths, salinities, etc.).

The sponsoring agency is responsible for field trip logistics and coordinating with landowners, local government, all CWPPRA agencies, the AAG, and other field trip attendees. Field trip attendees typically consist of each agency's EnvWG and EngWG representatives. The sponsoring agency should be familiar with the project area so that field time is spent efficiently.

The primary purpose of the field investigation is to allow members of the EnvWG and EngWG to familiarize themselves with the project area and project features in order to make informed decisions in the evaluation of the WVA. The sponsoring agency should not treat the interagency field investigation as the only opportunity to conduct surveys or take measurements to develop designs and/or cost estimates for the project. The sponsoring agency should have obtained that information during previous field trips or should plan a follow-up field trip. In cases where the project area is very large, it may be necessary to divide the group into small work parties to collect WVA information across the project area or to allow some areas to be investigated by at least a subset of the entire group. However, an effort should be made to keep the group together to facilitate discussion about wetland conditions in the project area, the causes of habitat loss, the project features, and the effectiveness of the project features.

Project Boundary Determination

The project boundary is the area where a measurable biological impact, in regard to the WVA variables, is expected to occur with project implementation. Project boundary meetings are attended by the EnvWG, EngWG, and sometimes other agency representatives. The U.S. Geological Survey (USGS)-Baton Rouge Field Station provides GIS support. Proposed project boundaries (i.e., shape files) should be provided to USGS prior to the boundary meeting. At the boundary meeting, the project sponsor presents the project features and rationale for the proposed benefited area. The boundary is discussed by the entire group and revisions to the boundary are made by consensus or, if necessary, by vote.

The boundary for barrier island projects extends from the Gulf shoreline at 0.0 ft NAVD88 to either the -1.5 ft NAVD88 elevation on the bayside, or 1,000 feet landward of the emergent

portion of the island, whichever is less. Barrier island projects only encompass emergent and bayside subtidal habitat (i.e., 0.0 to -1.5 ft NAVD88) while deep open water habitat around the island is omitted. In instances where a breach is filled or reconnecting islands across an inlet, water deeper than -1.5ft NAVD88 may be included. In addition, land located landward of the island can be included to capture benefits from reduced wave energy. Unlike marsh project areas, a barrier island project area changes throughout the evaluation period (i.e., 20 years) as the island erodes, migrates, shrinks in size, or enlarges under future with-project (FWP) conditions. As the island erodes, areas converting to deep open water (>-1.5 NAVD88) are removed from the project area.

Barrier island project areas must be divided into dune, supratidal, intertidal, and subtidal subareas as per model definitions. Elevation data should be utilized to divide the island area into the different habitat types. Habitat data or vegetative species composition data can be used as a substitute if survey data are unavailable, although less emphasis should be placed on this method as the intertidal area is not delineated by plant zonation. Project area size and habitat classification (i.e., dune, supratidal, etc.) are usually determined by the project sponsor from topographic, bathymetric and vegetation surveys, published literature, and GIS analyses. In the absence of bathymetric/topographic surveys, USGS habitat data can be beneficial to support the delineation of subareas.

Selection of Target Years

All CWPPRA project WVAs are conducted for a period of 20 years which corresponds to the authorized life of a CWPPRA project. Other programs (e.g., LCA) may require a longer period of analysis (e.g., 50 years or more to include the date of impact, construction duration, or date of mitigation). Each project evaluation must include target years (TY) 0, 1, and 20. Target year 0 (TY0) represents baseline or exiting conditions in the project area and TY20 (or TY50 for LCA projects) represents the projected conditions at the end of the project life. A linear fit (over the project life) is used to make the projection unless there are expected changes that may occur in the intervening years. Examples of these changes include (but are not limited to):

1. Storm events: Storm frequencies for the Louisiana coast vary depending on the period of record analyzed but are generally 8 to 10 years. For sites located along the gulf shoreline, it may be necessary to select a target year which corresponds to a storm event which is likely to occur within the project life in order to capture the effects of the storm. A storm event can impact a barrier island in several ways; (1) erosion rates could increase if the island is fragmented and/or if the shoreline is breached, (2) a decrease in vegetative cover as the island is overwashed, or (3) conversion of dune to supratidal, supratidal to intertidal, and intertidal to supratidal as island roll over and habitat zones erode or accrete. Selection of a storm impact target year should be based on the storm return frequency that would result in substantial impact (e.g., overtopping, breaching, etc.). Storm impact and return frequency (Stone et al. 1997), by barrier system, should be used as justification when selecting target years. If the FWOP loss rates are based on data which include the effects of storm events then care must be taken to ensure that effects of storm events are not double counted.

2. Changes in frequency and duration of flooding: As relative sea level (RSL) rise continues, flooding frequency and duration may increase which could result in marsh loss. Project features could also decrease flooding frequency and duration or increase flooding duration if drainage is retarded by structures.

3. Project implementation: Additional CWPPRA (or non-CWPPRA) projects may be built which could influence the conditions in the current project area.

4. Maintenance events: These would include items such as phased planting, a second lift on rocks used for shoreline protection, additional pumping of material for marsh creation or beach nourishment, replacement of structures, gapping containment dikes, construction of ponds or creeks, etc.

5. Increase or decrease in vegetative cover: These could be associated with project features (initial or phased) or environmental changes (see numbers 1, 2, and 4).

During the life span for which a project analysis is conducted, target years are selected which represent time intervals when changes are expected to occur. When habitat or environmental conditions change sufficient to result in a change to a variable's suitability index, additional target years may be added to the analysis. The new conditions are then projected forward to obtain the expected conditions until the next target year, or the end of the project life if there are no more intervening target years. In addition, target years should be selected for years in which any variable undergoes sufficient change to result in a large change in the overall HSI.

The EnvWG has adopted certain target year conventions for certain project types. Although these conventions are generally applied, exceptions are sometimes proposed and may be accepted by the group. It should be noted that these conventions are based on assumptions developed by the group and have not been validated. It is the responsibility of the project sponsor to provide justification for deviating from these conventions and this should be recorded in the Project Information Sheet. These conventions are summarized in Table 1. Maintenance events shall be included as additional target years as needed; other target years may be added to include other expected events (breaches, vegetation or salinity shifts, or changes in RSL rise). The information in Table 1 assumes that barrier island projects will be planted with some woody vegetation. However, that may not always be the case. The number of target years may be extended for programs which require consideration of a longer project life. Values for all variables must be determined for each target year selected. The variable values represent conditions at the end of the target year. For FWP, TY1 represents the conditions in the project area one year after project construction.

Table 1. Summary of Target Years used for CWPPRA barrier island restoration projects.

Project/Habitat Type	Target Year						
	0	1	3	5	10	20	>20
Barrier Island/Headland Restoration	Measured baseline		100% credit for marsh/dune plantings	100% credit for woody plantings	Storm Event (?)		Storm Event (?)

Use of the Community Habitat Models

Each community model contains a set of variables which is important in characterizing the habitat quality of several coastal wetland habitat types relative to the fish and wildlife communities dependent on those environments. Baseline (TY0) values are determined for each of those variables to describe existing conditions in the project area. Future values for those variables are projected to describe conditions in the area without the project and with the project. Projecting future values is the most complicated, and sometimes controversial, part of this process. It requires project sponsors to substantiate their claims with monitoring data, research findings, scientific literature, or examples of project success in other areas. Not all future projections can be substantiated by the results of monitoring or research, and, as with all wetland assessment methodologies, some projections are based on best professional judgment and can be subjective. It should be noted that future projections are not the sole responsibility of the project planner. It is the responsibility of the evaluation team (i.e., agency representatives, academics, and others) to use the best information available in developing those projections. Many times, the collective knowledge of the evaluation team is the only tool available to predict project benefits. The various workgroups are comprised of many individuals with diverse backgrounds and all project scenarios are discussed by the group and a final outcome is usually reached by consensus. Key assumptions made during the evaluation process, e.g., regarding the effects of climate change or storms, should be recorded on the Project Information Sheet. There are occasionally off-site conditions and human disturbances adjacent to a project area. These have an effect on the animals in the project area, however these disturbances are considered to be the same under FWOP and FWP conditions.

An important point to consider when projecting benefits is the effect of other constructed or authorized projects on the project area. Benefits attributed to those projects should be taken into consideration when projecting benefits for any candidate project. That procedure prevents a candidate project from being credited with benefits previously attributed to another project (i.e., double-counting). CWPPRA projects are not taken into consideration unless authorized for construction. Project planners should also consider the benefits of non-CWPPRA projects funded by other authorities (e.g., WRDA, State-only projects, and landowner-funded projects). An important aspect of the WVA, as it is used in restoration planning, is the comparison of the FWOP to the FWP condition. If another project influences the project area of the evaluated project, the other project must be considered as baseline and put into both FWOP and FWP. For instance, if a project being evaluated is in the area of a river diversion, the effect of the diversion must be considered in both the FWOP and FWP conditions.

Model Application

The barrier island community model should be applied to barrier island habitats found gulfward of bay or lake systems. This model was developed to evaluate restoration projects on barrier islands in the Terrebonne and Barataria Basins (e.g., Isles Dernieres, Timbalier, and Grand Terre). Application to the Chandeleur Islands, which contain extensive seagrass beds on the bayside, may require model revisions as the value of those seagrass beds is not specifically captured by this model.

Baseline Habitat Classification and Land/Water Data

One of the first steps in preparing a WVA for a barrier island restoration project is to determine the total project area size and the acreage of each of the habitat components (e.g., dune, supratidal, and intertidal). The total project area size and acreage of each habitat type should be determined using topographic or bathymetric surveys. Aerial photography and habitat classification data from USGS can be helpful to divide the island into the different habitat types. It is also helpful to use both elevation and habitat data to characterize the habitats across the island. If the project area acreage is not current, then the erosion rate should be applied to that acreage and adjusted to the current year. Adjustments to the project area acreage could also be obtained from process-based barrier island morphological modeling results and other supporting information.

Variable Selection

Barrier islands consist of many different habitat components including surf zone, beach, dune, supratidal marsh (i.e., swale), intertidal marsh, ponds, lagoons, tidal creeks, unvegetated flats, and subtidal habitat. A key assumption in model development was that for a barrier island to provide optimal conditions for fish and wildlife, all of the above habitat components should exist (See Appendix A for a review of the variables' role in providing fish and wildlife habitat). Therefore, model variables characterize those key habitat components to provide an index of habitat quality.

The barrier island model development group initially agreed that model variables should address barrier island habitat components (e.g., dune, supratidal, intertidal, vegetative cover, etc.), island integrity/longevity (e.g., island width), and back-barrier/wave shadow benefits. Published Habitat Suitability Index (HSI) models provided little help in developing a potential list of variables as very few HSI models address species-specific habitat needs on barrier islands.

The initial list of variables proposed for the barrier island model included;1) percent of the area classified as supratidal habitat, 2) percent of the supratidal habitat that is vegetated, 3) percent of the area classified as intertidal habitat, 4) percent of the intertidal habitat that is vegetated, 5) marsh edge and interspersion, 6) percent of the area classified as subtidal habitat (relative to subaerial), 7) percent of the subtidal habitat that is vegetated, 8) percent of the project area width that equals or exceeds the 20-year erosion rate, 9) dune height, and 10) percent of project length that protects interior marshes.

Variables which addressed island integrity (i.e., island width and dune height) were omitted from the model because they do not specifically address fish and wildlife habitat quality. However, those variables are important in determining island longevity and the loss of habitat over the project life. Therefore, they are necessary to determine the quantity of habitat at any given point during the analysis but are not needed to characterize habitat quality.

Woody habitat on barrier islands provides the important functions of nesting habitat for certain species such as the brown pelican and stopover habitat for neotropical migratory birds. Therefore, it was agreed to include a variable addressing that habitat component. In addition, the importance of beach and surf zone habitat was addressed by including a variable which describes the features, if any, located in the beach/surf zone. That zone is especially important as foraging habitat for shorebirds and wading birds and provides habitat for unique nekton assemblages.

The variables utilized for project evaluations in 2001 included: 1) percent of the subaerial area that is classified as dune habitat; 2) percent of the dune habitat that is vegetated; 3) percent of the subaerial area that is classified as supratidal habitat; 4) percent of the supratidal habitat that is vegetated; 5) percent of the subaerial area that is classified as intertidal habitat; 6) percent of the intertidal habitat that is vegetated; 7) percent of the area that is classified as subtidal habitat (relative to subaerial); 8) percent vegetative cover by woody species; 9) marsh edge and interspersion; and 10) beach/surf zone features.

Additional model revisions occurred during 2002. The EnvWG agreed that projecting individual vegetative cover values for the dune, supratidal and intertidal habitats is not necessary to capture the habitat functions provided by vegetative cover on a barrier island. It was agreed that the three individual vegetative cover variables would be combined into one variable which would address the entire island. The woody cover variable would remain as a stand-alone variable.

In addition, the EnvWG agreed that the subtidal habitat variable should be omitted from the model. Project evaluations conducted during 2001 indicated that the subtidal variable played an insignificant role in determining project benefits. Variable values were unchanged from FWOP conditions to FWP conditions for nearly all evaluations. It was agreed that most proposed projects would result in little or no change from baseline variable values. The variable was omitted from the model; however, subtidal habitat (i.e., open water habitat from 0.0 NAVD88 to –1.5 NAVD88) remains as part of the benefitted area and is included within the project boundary.

The final list of variables included in this model are: 1) percent of the subaerial area that is classified as dune habitat; 2) percent of the subaerial area that is classified as supratidal habitat; 3) percent of the subaerial area that is classified as intertidal habitat; 4) percent vegetative cover of dune, supratidal, and intertidal habitats; 5) percent vegetative cover by woody species; 6) marsh edge and interspersion; and 7) beach/surf zone features.

Suitability Index Graph Development

Each of the community models developed for CWPPRA include Suitability Index graphs for each variable. SI graphs are unique to each variable and define the relationship between that variable and habitat quality. A key assumption in developing the SI graphs was that existing, stable barrier islands which contain the three key habitat components (i.e., dune, supratidal, and intertidal habitats) should serve as the optimum to which all other islands should be compared. The model development group agreed that the model should not use, as its optimum, an island which would not have existed nor presently exists along the Louisiana coast. For example, the optimal barrier island (i.e., HSI = 1.0) should not be described as one 3 miles long, with dunes 20 feet high and 1,000 feet wide, and with extensive forested habitat. Islands of that type have never existed along the Louisiana coast and restoration efforts are not aimed at creating islands of that sort. Although, "super" barrier islands could be constructed and would provide the same functions as typical barrier islands, it was agreed that creation of such islands is not likely and a comparison of a typical barrier island to a super island would be unrealistic. In essence, the group agreed that optimal barrier island habitat once existed along the Louisiana coast and that a naturally-formed, stable barrier island should serve as the optimal condition in this model. Therefore, historical data and other information from existing barrier islands served as the primary basis for suitability index graph development. Suitability Index graph development was very similar to the process used for other habitat assessment models developed for CWPPRA (e.g., coastal marsh community models). A variety of resources were utilized to construct each SI graph, including personal knowledge of the barrier island model development group and EnvWG, consultation with other professionals and researchers outside the model development group, and published and unpublished data and studies. A review of contemporary, peer-reviewed scientific literature was also conducted for each of the variables, providing ecological support of the form of the SI graph for each of the variables (Appendix A). The process of SI graph development is one of constant evolution, feedback, and refinement; the form of each SI graph was decided upon through consensus among EnvWG members.

The Suitability Index graphs were developed according to the following assumptions.

Variables 1, 2, 3 - Percent Dune (V1), Percent Supratidal (V2), and Percent Intertidal (V3)

Dune habitat is defined as subaerial habitat $\geq$ 5 ft NAVD88 and encompasses foredune, dune, and reardune. Although dune habitat occurs at elevations below 5 ft NAVD88, lower-elevation dunes are more ephemeral and more frequently overwashed, which reduces their habitat value. Lower-elevation dunes often consist of vegetation more commonly associated with swale habitat and lack a high percentage of typical dune species. Supratidal habitat occurs from 2.0 ft NAVD88 to 4.9 ft NAVD88. This habitat type primarily encompasses swale and may include low-elevation dune and beach habitat. Intertidal habitat occurs from 0.0 ft NAVD88 to 1.9 ft NAVD88. This habitat type encompasses intertidal marsh, mudflats, beach, and any other habitats within that elevation range on the gulfside and bayside of the barrier island.

Suitability index graph relationships for these variables were determined by: 1) reviewing profiles and cross-sections of existing barrier islands along the Louisiana coast, 2) field investigations which provided ocular estimates of habitat distribution on the islands, and 3) field knowledge of those involved in development of the model.

Baseline (TY0) values for these variables should be determined from elevation surveys. If survey data are unavailable, then habitat classification data and/or vegetative species composition data can be used as a substitute. However, elevation data are preferable as the habitat types are defined by elevation.

Barrier islands are unique in that as they erode, the distribution of habitat types changes. Dune is converted to supratidal, supratidal to intertidal and intertidal to subtidal as the island erodes and elevation decreases. Therefore, future projections for these three variables must not only address the loss of habitat but also the conversion of one habitat type to another. Predicting barrier island habitat change under FWOP and FWP conditions is one of the more complex tasks facing coastal planners.

Fortunately, there are coastal engineering models and other analytical tools which can be utilized to assist in predicting future habitat conditions. Some models, such as the Storm Induced Beach Change Model (SBEACH) can be utilized to predict storm-induced changes in an island's profile (e.g., different dune heights, different marsh platform widths, etc.). Other models, such as the Generalized Model for Simulating Shoreline Change (GENESIS) and others, (e.g., DNRBS, NMLONG) predict shoreline position by modeling the movement of sand due to waves over several years.

The SBEACH model predicts cross-shore storm impacts and simulates beach profile changes that result from varying storm waves and water levels. Changes in island profile can be predicted for various target years, for different island cross sections, and for different types of storms. The GENESIS model calculates shoreline change produced by spatial and temporal differences in longshore sand transport produced by waves. The existing shoreline can be altered (i.e., FWP) by the addition of sand or hard structures and the shoreline response predicted over time. Literature available on barrier island modeling includes Coastal Planning and Engineering 2001, Dean 1997, Herbich 2000*a*, Herbich 2000*b*, List et al. 1997, and Tait 2000. Desktop PC versions of some of these models are available.

A third possible modeling approach is the use of a two- or three-dimensional process based morphological model to simulate most of the relevant physical processes that occur on barrier islands. One such example is the Delft3D system which bases predictions on detailed, process-based formulations that are resolved over a three-dimensional grid covering the project area. Processes solved include hydrodynamics, storm surge and profile inundation, waves, bottom shear stresses, sediment transport, and bottom changes (Moffatt and Nichol 2004).

Another commonly used engineering analysis is the development of a sediment budget, which considers both longshore and cross-shore transport. The sediment budget tracks the movement of sediment into, out of, and within a barrier island to predict shoreline change.

Several agencies including the NMFS, EPA, NRCS, and the OCPR have utilized many of the coastal engineering methods previously discussed. Their expertise should be utilized when assessing projects via the barrier island habitat model. In particular, the NMFS has worked extensively with private contractors utilizing many of these coastal engineering tools to evaluate barrier island project designs. In working with private contractors, the NMFS saw the need to develop a document which clearly defines the data requirements for the barrier island habitat model. That document, "*Data Requirements to Support Environmental Benefits of Barrier Island and Barrier Headland Projects Assessed with Community Based Models*" is attached as Appendix B.

Variable 4 - Percent Vegetative Cover of Dune, Supratidal, and Intertidal Habitats

Common dune species include beach tea (*Croton punctatus*), bitter panicum (*Panicum amarum*), morningglory (*Ipomoea sp.*), marshhay cordgrass (*Spartina patens*), and *Heterotheca subaxillaris*. Common foredune/high beach species include sea rocket (*Cakile fusiformis*), sea purslane (*Sesuvium portulacastrum*), and seaside heliotrope (*Heliotropium curassavicum*).

Common supratidal species include goldenrod (*Solidago sempervirens*), marshhay cordgrass (*Spartina patens*), saltgrass (*Distichlis spicata*), deerpea (*Vigna luteola*), eastern baccharis (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), sea ox-eye (*Borrichia frutescens*), glasswort (*Salicornia bigelovii, S. virginica*), saltwort (*Batis maritima*), black mangrove (*Avicennia germinans*), beach pea (*Strophostyles helvola*), seashore paspalum (*Paspalum vaginatum*), *Heterotheca subaxillaris*, *Fimbristylis castanea*, *Suaeda linearis*, smooth cordgrass (*Spartina alterniflora*), *Sabatia stellaris* and seaside gerardia (*Agalinis maritima*).

Common intertidal, back-barrier marsh species include smooth cordgrass (*Spartina alterniflora*) and black mangrove (*Avicennia germinans*). Intertidal habitat on the gulfside of an island is typically an unvegetated wash zone or low beach.

Suitability index graph relationships for this variable were determined by: 1) reviewing profiles and cross-sections of existing barrier islands along the Louisiana coast, 2) field investigations which provided ocular estimates of habitat distribution on the islands, and 3) field knowledge of those involved in development of the model.

The baseline (TY0) value for this variable is usually determined during field investigations of the project area. Previous WVAs for other projects can also be helpful. Future projections should consider island height and width which affect the frequency of overtopping and thus vegetative cover. Stable, unfragmented islands could be assumed to have greater vegetative cover, less frequent overtopping, and the ability to recover more quickly after storm events. The opposite would be true for fragmented, low-elevation islands which would experience more frequent overtopping.

Based on guidance from the AAG and scientific literature, the EnvWG has adopted some standard conventions for FWP. With an appropriate planting design, vegetative cover is assumed to be 25% in each habitat type at TY1 and would become optimal by TY3. A slight

reduction in vegetative cover is assumed at the target year when a storm event is expected to occur. However, vegetative cover can be assumed to return to optimal conditions the following year. However, as with all conventions, other scenarios can be presented and discussed by the group.

Variable 5 - Percent Cover by Woody Species

This variable is intended to capture the habitat value of areas vegetated by woody species. Common woody species include black mangrove (*Avicennia germinans*), eastern baccharis (*Baccharis halimifolia*), wax myrtle (*Myrica cerifera*), and marsh elder (*Iva frutescens*). This variable is defined as the percent of the subaerial vegetated area consisting of at least two woody species. The suitability index is divided by two for islands with only one woody species. The suitability index graph for this variable was primarily based on the best professional judgment and personal field knowledge of those involved in model development. It was agreed that cover by woody species should be a small percentage (10% to 20%) of the vegetative cover on an island.

The baseline (TY0) value for this variable is usually determined during field investigations of the project area. However, a field inspection may be necessary to determine the number of woody species present. Islands with two or more woody species are considered of higher habitat value than those with only one species. Previous WVAs for other projects can also be helpful.

Projections for this variable are similar to those for the vegetative cover variables for dune, supratidal, and intertidal habitats. However, this variable addresses cover by woody species for the entire island. Future projections should consider island elevation and width which affect the frequency of overtopping and thus vegetative cover by woody species. Stable, unfragmented islands could be assumed to have greater vegetative cover, less frequent overtopping, and the ability to recover more quickly after storm events. The opposite would be true for fragmented, low-elevation islands which would experience more frequent overtopping.

For FWP projections, the EnvWG has adopted some standard conventions. With an appropriate planting design, woody cover is assumed to be 5% at TY1 and optimal by TY5. A slight reduction in woody cover may be experienced at the target year when a storm event is expected to occur. However, cover could return to optimal conditions in subsequent years. Other scenarios can be presented and discussed by the group. Because the planting of woody species is a relatively new feature of CWPPRA restoration projects, more information on the growth and spread of various species is needed.

Variable 6 - Edge and Interspersion

This variable is intended to capture the relative juxtaposition of intertidal, subaerial habitat (vegetated and unvegetated) and intra-island aquatic habitats such as ponds, lagoons, and tidal creeks associated with barrier islands. The degree of interspersion is determined by comparing the project area to sample illustrations (pages 28-30) depicting different degrees of interspersion. Interspersion including ponds, lagoons, and tidal creeks is of specific importance in assessing the foraging and nursery habitat functions of barrier islands to marine and estuarine fish and shellfish

and associated avian predators. These habitats are characterized by specific physical attributes and thus unique fish and shellfish assemblages exhibit greater selection and utilization of these back barrier habitats as residents and transients over other barrier island, bay, and mainland aquatic habitats. However, interspersion can be indicative of degradation of back-barrier marsh from subsidence, a factor taken into secondary consideration in assigning suitability indices to the various interspersion classes.

A high degree of interspersion is assumed to be optimal (SI = 1.0), and the lowest expression of interspersion (e.g., all marsh/unvegetated flat, all open water, or all marsh/unvegetated flat clumped together) is assumed to be less desirable in terms of community-based function and quality. Class 1 is representative of unvegetated flats and healthy back-barrier marsh with a high degree of at least two of the following: tidal creeks, tidal channels, ponds, and/or lagoons. Numerous small ponds (Class 2) offer a high degree of interspersion, but are also usually indicative of the beginning of marsh break-up and degradation, and are therefore assigned a lower SI of 0.8. Class 3 represents the development of larger open water areas from coalescence of aquatic habitats, due to overwash, subsidence, or impacts from oil and gas exploration which provide less interspersion. Once these larger open water areas develop, they no longer have the physicochemical factors (e.g., area, edge, temperature, salinity, and hydroperiod) that make them functionally distinct and of high quality and would be assigned a SI = 0.6. Carpet marsh or projects designed to create intertidal marsh without construction of aquatic habitats would lack functionally distinct interspersion and provide basically one intertidal habitat type; therefore, natural and created carpet marsh should also be classified as Class 3. Class 4 represents extreme stages of subsidence or oil and gas induced loss of back barrier marshes or dominance of breaching with unstable overwash flats (SI = 0.4). Although habitats represented by this classification are predominantly subtidal, unvegetated flats still provide valuable habitat for many fish and shellfish and provide loafing areas targeted by waterbirds. The lowest expression of interspersion, Class 5, consists of no emergent, intertidal land and is assumed to be least optimal from a community basis (SI = 0.1). However, this class can represent the development of inlets which in themselves are important spawning and foraging habitat for economically important marine fishery species.

The suitability index graph for this variable was determined by reviewing aerial photographs of back-barrier habitats and determining which degree of interspersion provided optimal habitat conditions for fish and wildlife. It was determined that five classes of interspersion would best depict the range of interspersion on barrier islands. The suitability index value for each interspersion class was based on fisheries studies by the Louisiana State University, Coastal Fisheries Institute and the National Marine Fisheries Service; avian surveys by the Louisiana Department of Wildlife and Fisheries; wetland studies by LUMCON and the Louisiana State University, Wetland Biogeochemistry Institute; best professional judgment; and field knowledge of those involved in model development.

The baseline (TY0) value for this variable is usually determined by examining recent aerial photography of the project area and comparing it to the interspersion classes illustrated on pages 28-30. The project area may be divided into different interspersion classes as most project areas

contain more than one class. The baseline interspersion classes are discussed by the group and there is usually a group examination of the aerial photos.

Future projections for this variable can be difficult to develop. It requires the project planner to develop a mental picture of what the island will look like after 20 years (and for intermediate years) of deterioration. One technique which could assist with that process is reviewing historical aerial photos of the project area as well as photos of other islands which could provide a picture of what the project area will look like in the future. Also, modeling the platform response and the resulting acreage of each habitat type can be a means to justify the percentages and types of interspersion classes.

Variable 7 - Beach/Surf Zone Features

This variable is intended to capture the habitat value of the beach/surf zone. The suitability index graph for this variable is based on the assumption that a natural beach/surf zone slope or profile provides optimal habitat conditions for fish and wildlife. Man-made features such as breakwaters, containment dikes, and shoreline protection provide sub-optimal conditions. The suitability index value for each beach zone feature was based on the best professional judgment and field knowledge of those involved in model development.

The baseline (TY0) value for this variable is determined from field investigations or by reviewing aerial photography. The shoreline may encompass more than one beach zone feature. For example, a portion of the shoreline may contain rock breakwaters and the rest of the shoreline may have no structures. It is therefore necessary to determine which percent of the shoreline is in each class.

Future projections for this variable should consider such things as whether or not the hard structures will remain intact, migration of the island away from any hard structures, fill material placed over hard structures, and erosion of containment dikes during the equilibration process.

Habitat Suitability Index Formula

The EnvWG agreed that the primary habitat variables (i.e., those pertaining to dune, supratidal, and intertidal habitats) were the most important variables in characterizing the habitat quality of a barrier island. Therefore, those variables were given greater influence (Table 2) in the model than the remaining variables. Within the HSI formula, variable influence is determined only by the weight (i.e., multiplier) assigned to each variable.

$$HSI = 0.14(V_1) + 0.14(V_2) + 0.17(V_3) + 0.20(V_4) + 0.10\ (V_5) + 0.15(V_6) + 0.10(V_7)$$

Table 2. The relative contribution (%) of each of the variables to the HSI equation.

Variable	% Contribution
V1 – Dune Habitat	14%
V2 - Supratidal Habitat	14%
V3 - Intertidal Habitat	17%
V4 - Vegetative Cover	20%
V5 - Woody Species	10%
V6 - Interspersion	15%
V7 - Beach Zone Habitat	10%

Subsidence and Sea Level Rise

Subsidence and sea level rise (SLR) are assumed to affect FWOP and FWP scenarios. For most CWPPRA project evaluations (e.g., those within interior coastal areas), it is assumed that historical wetland loss rates calculated from a recent time period (e.g., 1985 to 2010) adequately capture the effects of subsidence and SLR for the relatively short analysis period of 20 years. However, for barrier island project evaluations, measures of subsidence and SLR are incorporated into many of the analytical modeling tools (e.g., SBEACH) used to determine project performance.

Model Revisions

As our knowledge of coastal ecology and coastal restoration benefits improves, the need may arise for model revision. Model revisions should be documented in an appendix to the model narratives to allow tracking between versions. In addition, the "Notes" tab of the Excel model spreadsheet should also reflect any revisions and the revision date.

Additional Notes

All project WVAs should be prepared in the Project Information Sheet (PIS) format (Appendix C) which was adopted by the EnvWG. At a minimum, the PIS should provide; 1) baseline habitat analysis, 2) marsh/wetland/island loss analysis, 3) calculations for each variable, 4) documentation of data sources and key assumptions and 5) a list of literature cited and/or reference material. Project evaluations are conducted much more efficiently when the project planner is well-prepared and all necessary information is presented in the PIS. The PIS should be revised after the WVA meeting to reflect all decisions made by the EnvWG. A copy of the final PIS should be provided to each member of the EnvWG.

The official calculation of project benefits is the responsibility of the EnvWG Chairman. However, project planners are encouraged to also calculate project benefits to serve as a check on the information provided to the CWPPRA Planning and Evaluation Subcommittee. Project benefits are calculated using Excel spreadsheets which have been developed specifically for each habitat model.

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WETLAND VALUE ASSESSMENT COMMUNITY MODEL

Barrier Island

Dune Habitat
Variable V_1 Percent of the total subaerial area that is classified as dune habitat.

Supratidal Habitat
Variable V_2 Percent of the total subaerial area that is classified as supratidal habitat.

Intertidal Habitat
Variable V_3 Percent of the total subaerial area that is classified as intertidal habitat.

Vegetative Cover
Variable V_4 Percent vegetative cover of dune, supratidal, and intertidal habitats.

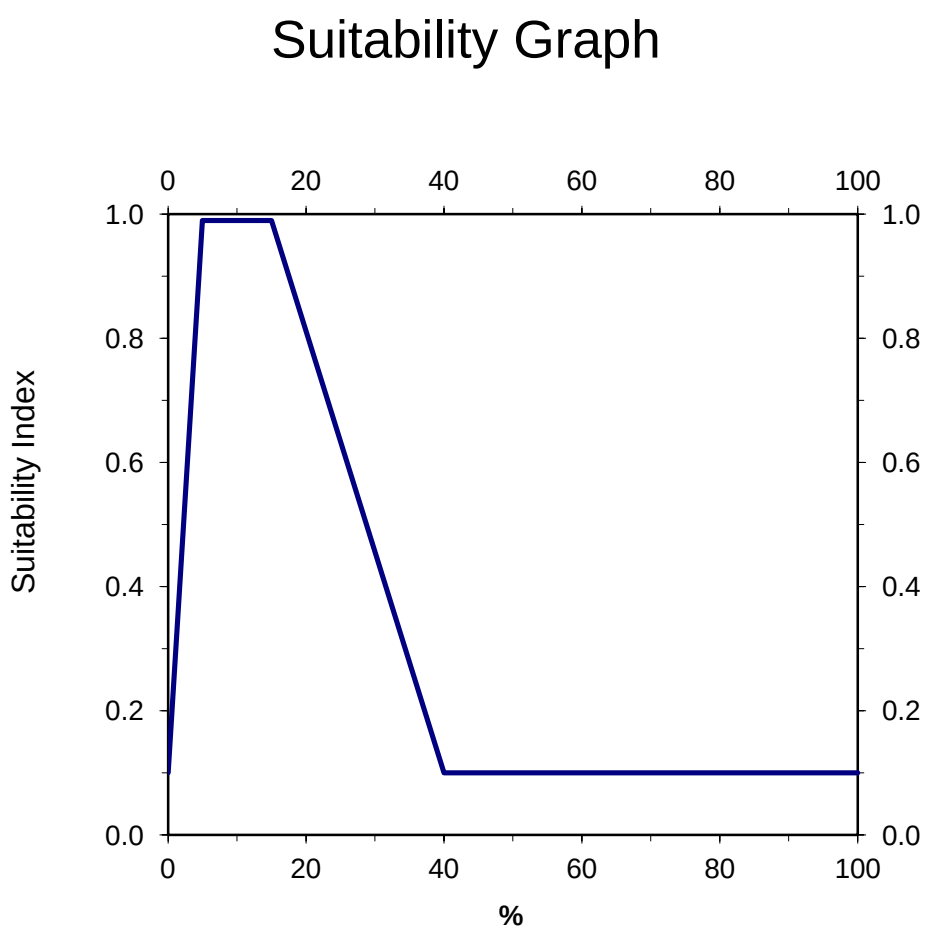
Woody Species
Variable V_5 Percent vegetative cover by woody species.

Interspersion
Variable V_6 Edge and Interspersion.

Beach Zone Habitat
Variable V_7 Beach/surf zone features.

BARRIER ISLAND

Variable V_1 Percent of the total subaerial area that is classified as dune habitat.

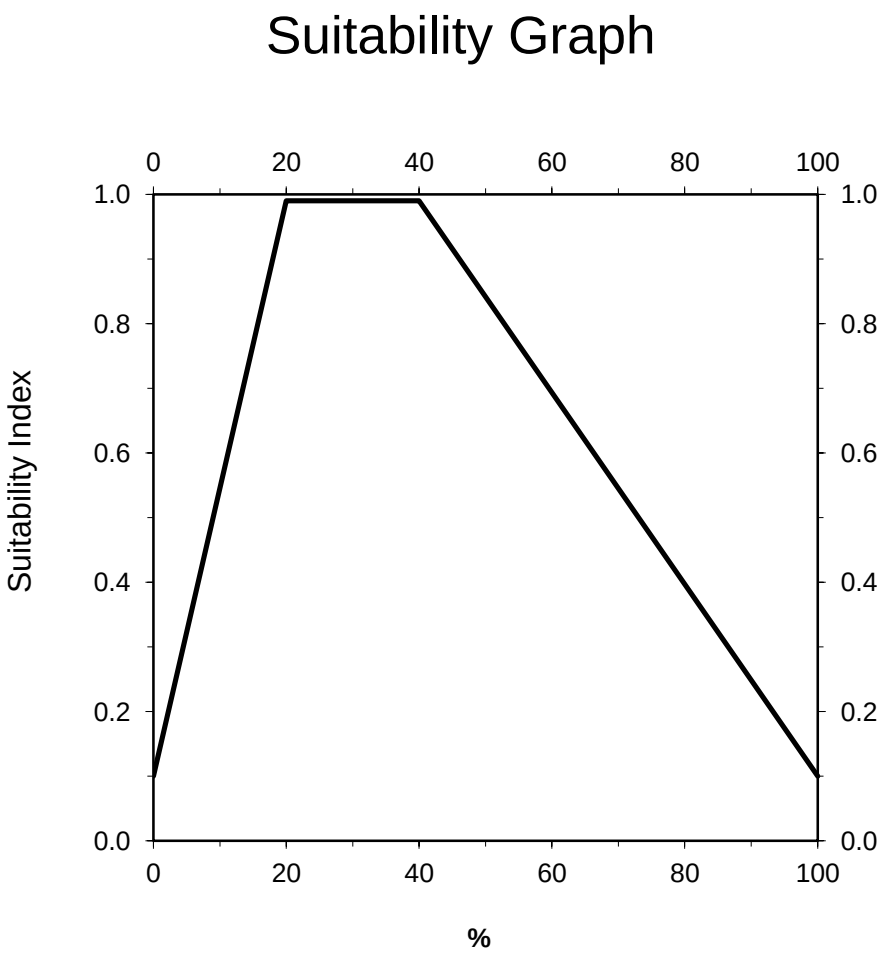


Line Formulas

If % < 5, then SI = (0.18*%) + 0.1
If 5 ≤ % ≤ 15, then SI = 1.0
If 15 < % ≤ 40, then SI = (-0.036*%) + 1.54
If % > 40, then SI = 0.1

BARRIER ISLAND

Variable V_2 Percent of the total subaerial area that is classified as supratidal habitat.

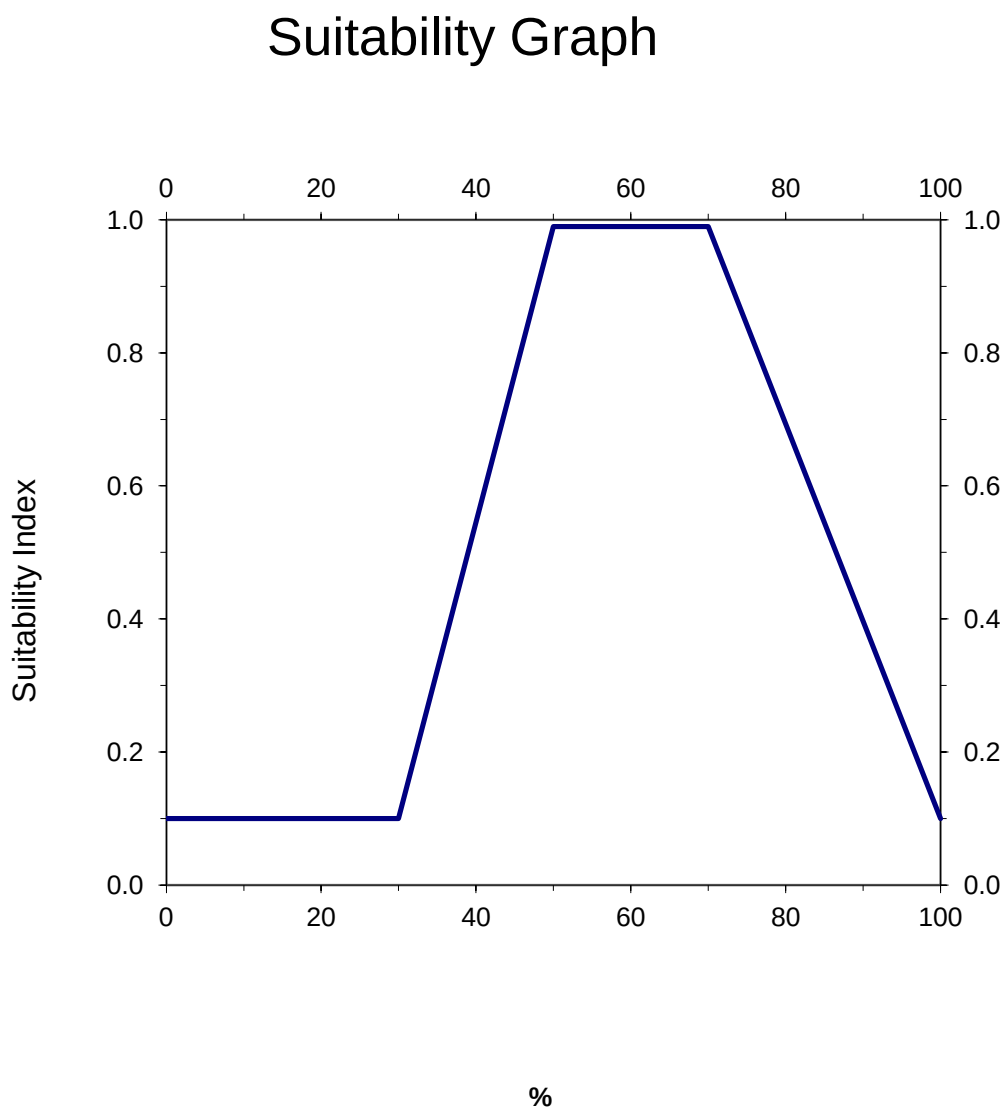


Line Formulas

If % < 20, then SI = (0.045*%) + 0.1
If 20 ≤ % ≤ 40, then SI = 1.0
If % > 40, then SI = (-0.015*%) + 1.6

BARRIER ISLAND

Variable V_3 Percent of the total subaerial area that is classified as intertidal habitat.

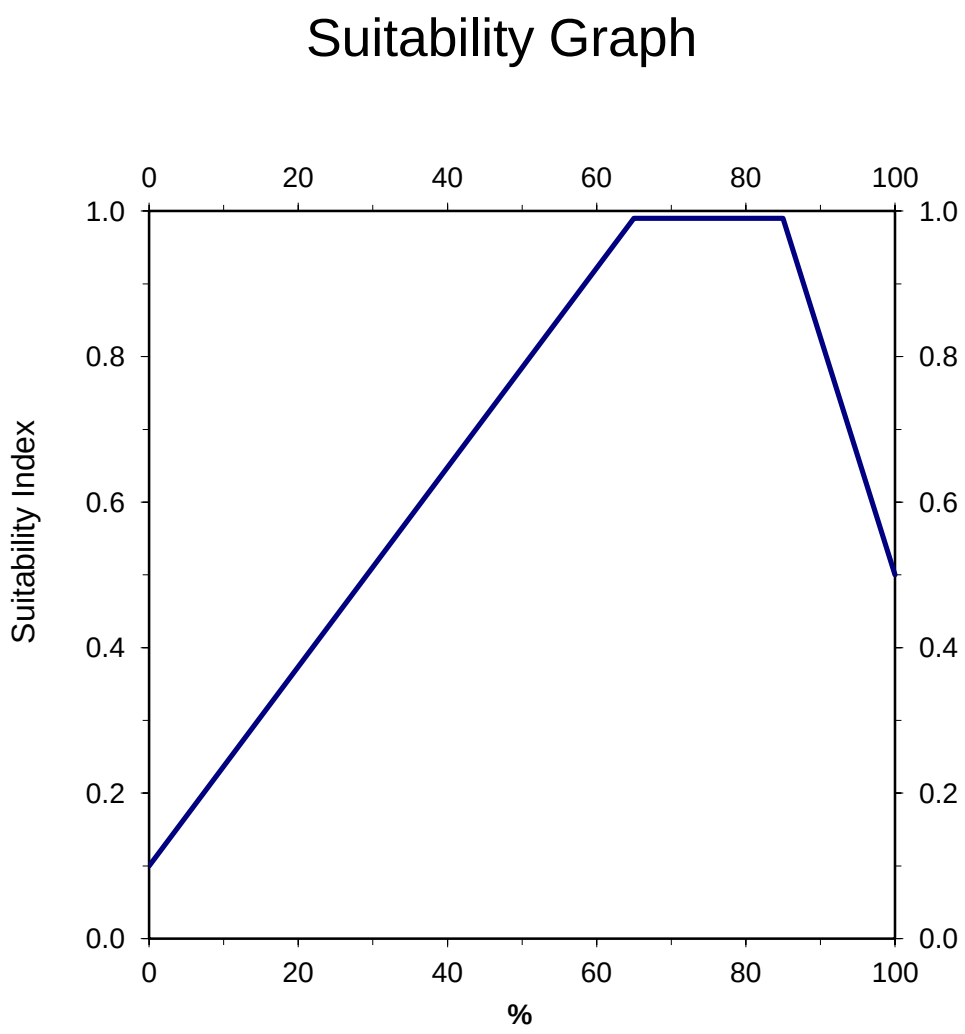


Line Formulas

If % < 30, then SI = 0.1
If 30 ≤ % < 50, then SI = (0.045*%) – 1.25
If 50 ≤ % ≤ 70, then SI = 1.0
If % > 70, then SI = (-0.03*%) + 3.1

BARRIER ISLAND

Variable V_4 Percent vegetative cover of dune, supratidal, and intertidal habitats.

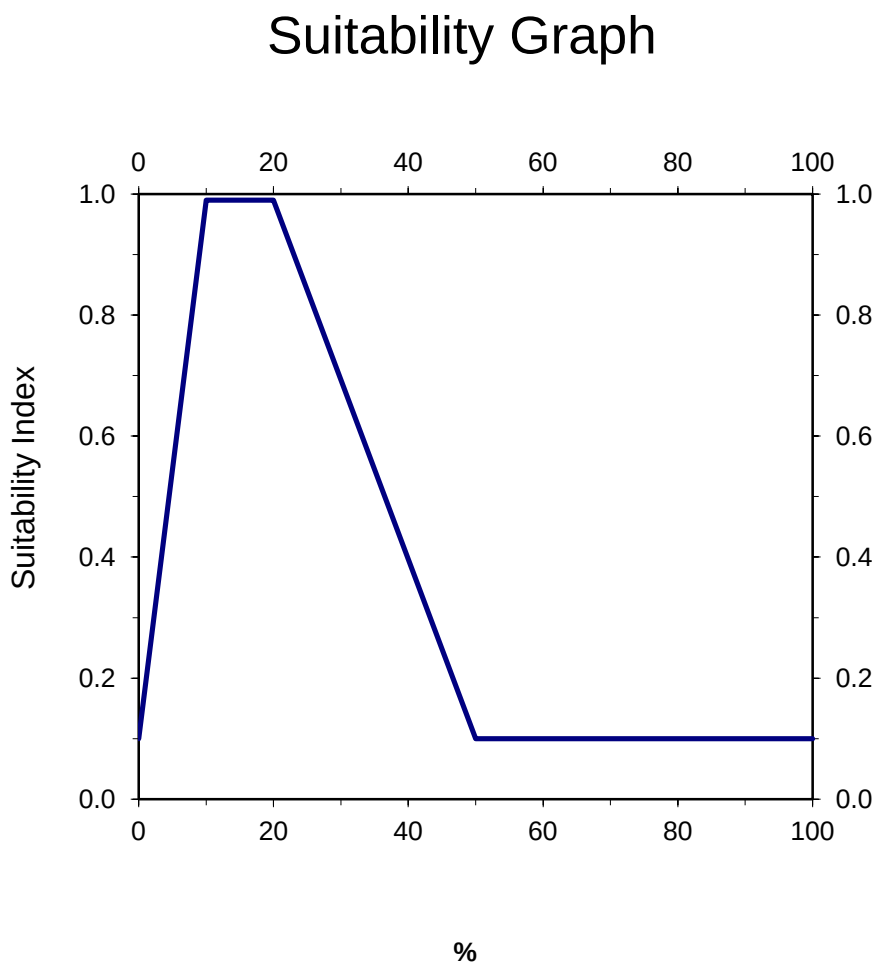


Line Formulas

If % < 65, then SI = (0.0138*%) + 0.1
If 65 ≤ % ≤ 85, then SI = 1.0
If % > 85, then SI = (-0.0333*%) + 3.83

BARRIER ISLAND

Variable V_5 Percent vegetative cover by woody species.



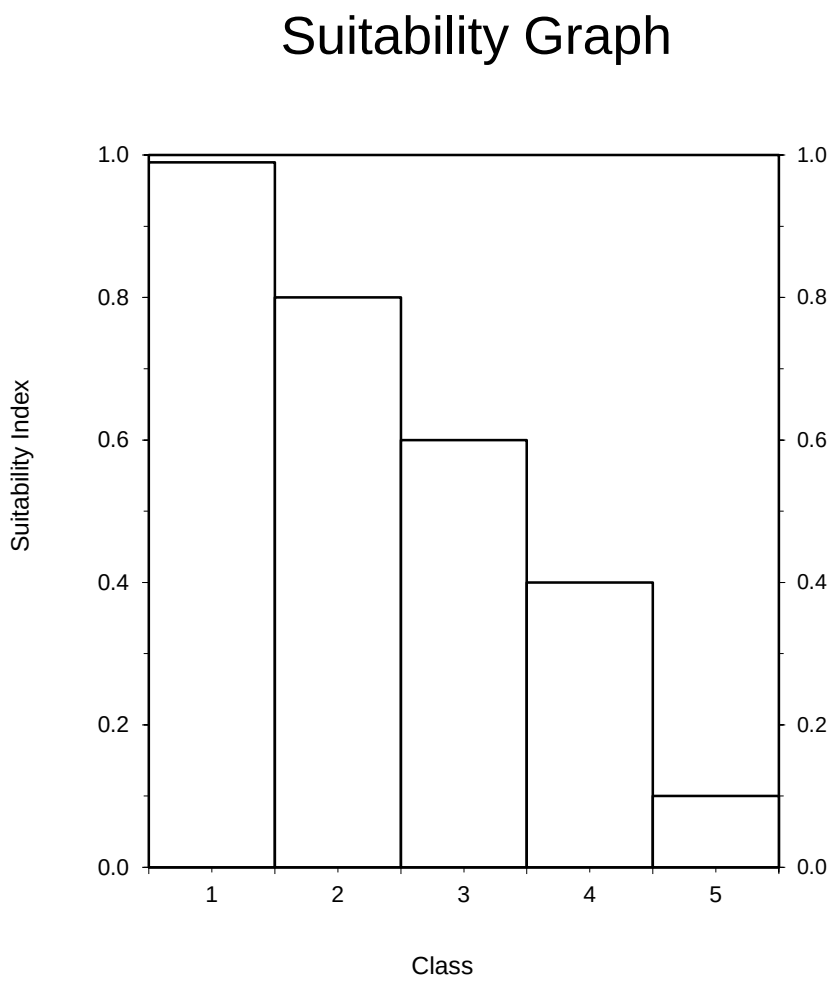
Line Formulas

If % < 10, then SI = (0.09*%) + 0.1
If 10 ≤ % ≤ 20, then SI = 1.0
If 20 < % ≤ 50, then SI = (-0.03*%) + 1.6
If % > 50, then SI = 0.1

The suitability index is divided by two for islands with only one woody species.

BARRIER ISLAND

Variable V_6 Edge and interspersion.



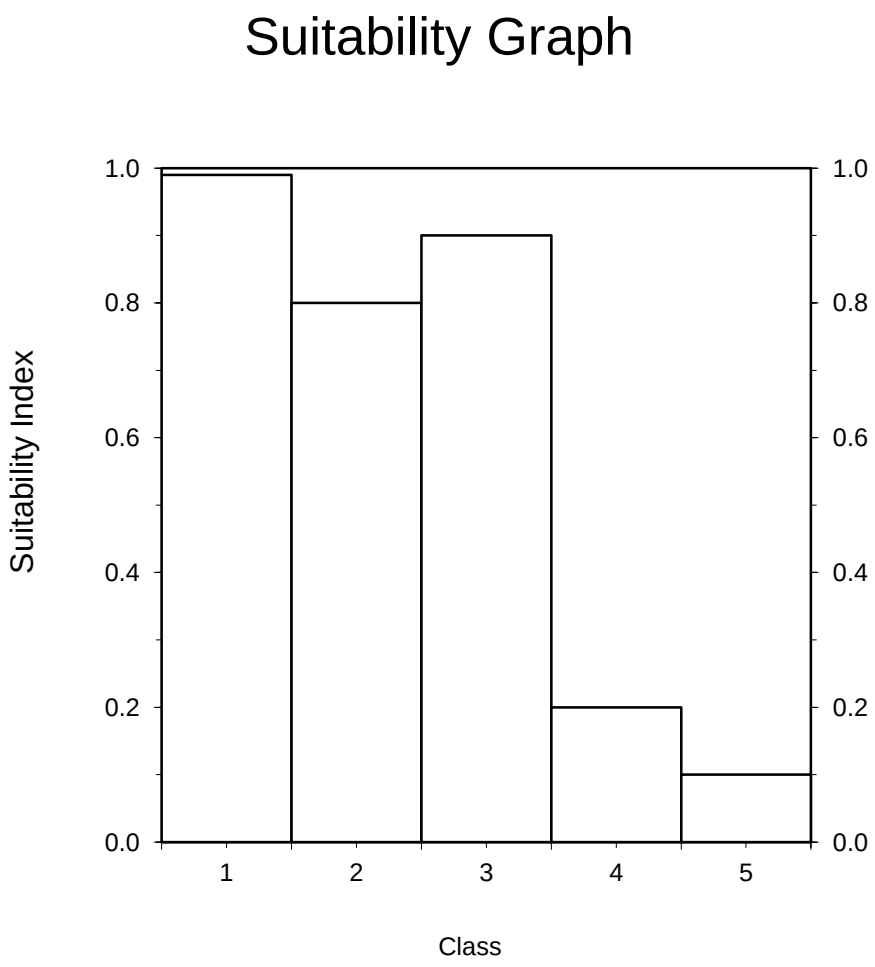
Instructions for Calculating SI for Variable V_6:

1. Refer to pages 28-30 for examples of the different interspersion classes.

2. Estimate the percent of project area in each class. If the entire project area is open water, assign interspersion Class 5.

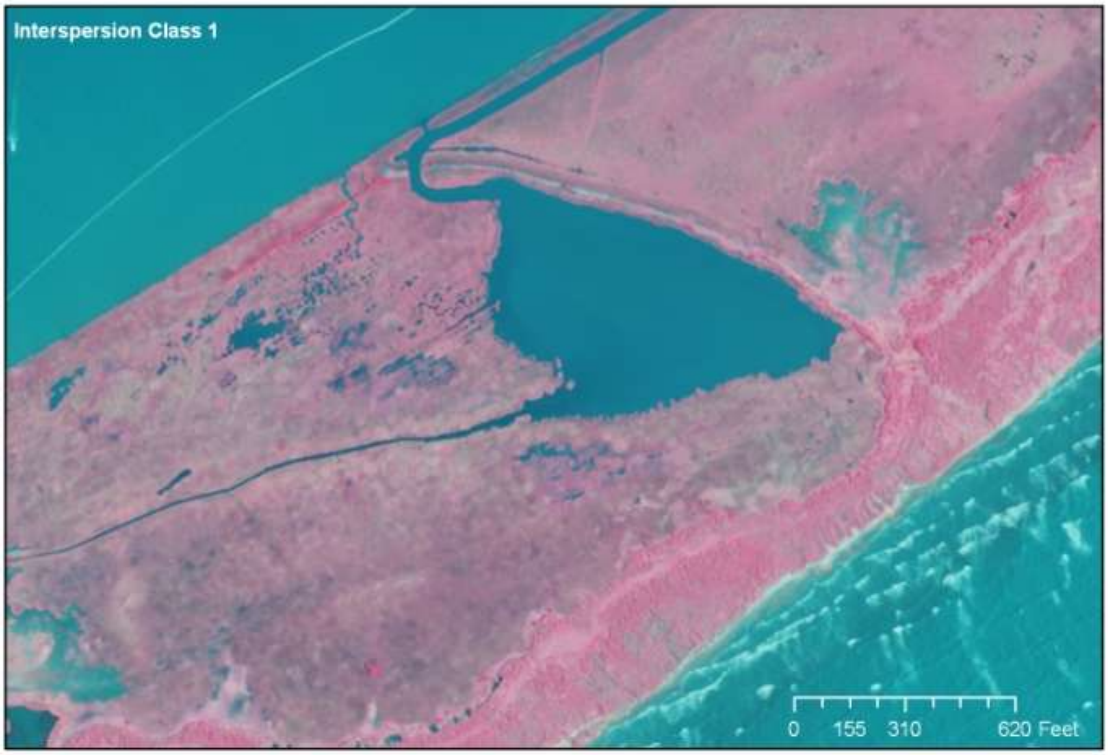
BARRIER ISLAND

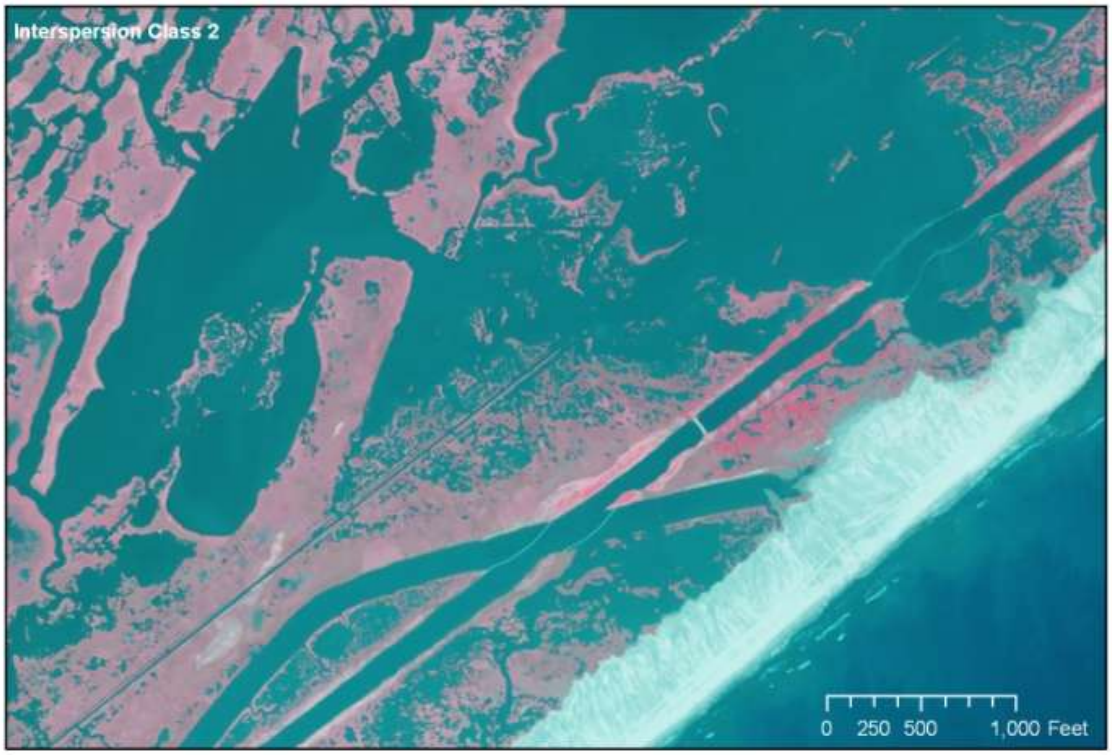
Variable V_7 Beach/surf zone features.



Class 1 = Natural Beach/Unconfined Disposal
Class 2 = Confined Disposal
Class 3 = Breakwaters
Class 4 = Rock on Beach
Class 5 = Seawall/No emergent habitat

Examples of Edge and Interspersion Classes





Interspersion Class 3
0 375 750 1,500 Feet

Interspersion Class 3
0 500 1,000 2,000 Feet

Interspersion Class 4
0 625 1,250 2,500 Feet

Appendix A

A description of the relative role of the model variables in providing habitat to the modeled community based on available, contemporary peer-reviewed scientific literature is provided below.

Variable V_1 - Percent of the total subaerial area that is classified as dune habitat

The primary significance of dune habitat for birds in this community is to serve as a refuge for avifauna during times of high water. The relatively high elevation used to define dune habitat in the model (≥ 5 ft above sea level) is important for providing substrate above the reach of high water; flooding is a major concern for nesting seabirds on barrier islands (Visser et al. 2005, Rounds et al. 2004, O'Connell and Beck 2003, Davis et al. 2001). In some circumstances high elevations may also be suitable for water bird nesting colonies. One potential nesting species is the Brown Pelican (*Pelecanus occidentalis*); based on surveys of pelican colony sites in Louisiana, Visser et al. (2005) recommended that artificial nesting islands include at least 2 ha of dunes ≥ 30 cm above MSL mixed with shrubby cover. Dunes may also harbor nesting colonies of large waders, twelve species of which nest on Louisiana barrier islands (Michot et al. 2001). While this may be very important at critical times of flooding risk, there is no evidence to suggest that such short-term refugia need to be large in size, as coastal water birds commonly aggregate in high densities even in normal circumstances (Lowery 1974; Michot et al. 2001). In addition to the limited benefit of having a large dune area, dunes may actually have some detrimental impact on colony nest success. Dunes have been reported to be sources of mammals that depredate seabird colonies on barrier islands on the Atlantic coast (Burger and Gochfield 1990). Presence of even a small number of predators can have a major impact on the success of waterbird colonies (e.g., Erwin and Beck 2007).

Variable V_2 - Percent of the total subaerial area that is classified as supratidal habitat

Supratidal habitat associated with barrier islands is important to birds for three primary reasons. First, this habitat serves as a nesting substrate for colonies of seabirds. Laughing Gulls (*Larus atricilla*), five species of terns (*Sterna spp.*), and the Black Skimmer (*Rynchops niger*) nest in supratidal habitat, sometimes in colonies of thousands of nests on Louisiana barrier islands (Michot et al. 2001; Pius and Leberg 2002). Rookeries of large wading birds also occur on some islands, and frequently include the Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), Tricolored Heron (*E. tricolor*), Black-crowned Night-Heron (*Nycticorax nycticorax*), White Ibis (*Eudocimus albus*), and in some cases Reddish Egret (*Egretta rufescens*), Cattle Egret (*Bubulcus ibis*), Little Blue Heron (*Egretta caerulea*), Yellow-crowned Night-Heron (*Nyctanassa violacea*), Glossy Ibis (*Plegadis falcinellus*), White-faced Ibis (*P. chihi*), and Roseate Spoonbill (*Platalea ajaja*) (Michot et al. 2001). Second, supratidal habitats are the nesting area for three shorebirds: American Oysercatcher (*Haematopus palliatus*), Wilson's Plover (*Charadrius wilsonia*), and (less commonly) Snowy Plover (*Charadrius alexandrinus*) (Lowery 1974). Third, the supratidal is sometimes a favored roosting habitat of shorebirds that feed in the intertidal (Placyk and Harrington 2004). The two aforementioned plover species also frequently forage above the wave zone in the supratidal, as does the Piping Plover (*Charadrius melodus*), a threatened species that winters on the outer Gulf Coast (Lowery 1974). The supratidal has been linked to the occurrence

of this species along the Gulf Coast (actually combined beach and intertidal area; LeDee et al. 2008) and the Atlantic Coast (Cohen et al. 2008).

Variable V_3 - Percent of the total subaerial area that is classified as intertidal habitat

The intertidal areas of barrier island habitats are important to the sustainability of the three largest commercial fisheries in Louisiana: Gulf Menhaden (*Brevoortia patronus*), shrimp spp., and Blue Crab (*Callinectes sapidus*) (Chesney *et al.*, 2000). These animals use this habitat as a nursery, a way to avoid larger potential predators that are unable to follow them into shallower water. Gulf Menhaden are an important fishery throughout the region; these fish commonly use intertidal zones early in their life history (Modde and Ross 1981). Commercially important invertebrate species such as Brown Shrimp (*Farfante penaeus aztecus*), White Shrimp (*Litppenaeus setiferus*), and Blue Crabs also use the intertidal zones heavily (Minello and Rozas 2002). Once these animals near reproductive size, they begin their migration offshore.

Intertidal habitat adjacent to barrier islands is also important for avifauna in barrier island ecosystems, providing foraging habitat for shorebirds of many species, and harboring several species of water and land birds that are salt marsh specialists. Intertidal habitat attracts the maximum numbers of foraging shorebirds in barrier island habitat systems in Connecticut (Placyk and Harrington 2004) and Texas (used by 38 species; Withers 2002). The intertidal area is the primary area used for foraging by most large wader species nesting on barrier islands (Custer and Osborne 1978). Marshes near barrier islands are used for nesting by Forster's Terns (*Sterna forsteri*) and Laughing Gulls (Erwin et al. 1981). In Louisiana, Caspian Terns (*Sterna caspia*) make heavier foraging use of coastal marshes than barrier islands, especially in winter (Lowery 1974). Additionally, marsh/shell pile islands have higher nest success for Gull-billed Terns (*Sterna nilotica*) than barrier islands themselves (Erwin et al. 1999). The importance of salt marshes to Louisiana's avifauna increases in winter with the arrival of the migratory Nelson's Sparrow (*Ammodramus nelsoni*), which winters exclusively in coastal marshes, and of three more rail species (King *Rallus elegans*, Sora *Porzana carolina*, and Virginia *R. limicola*); the latter is more numerous in coastal marshes than elsewhere in the state (Lowery 1974). Intertidal habitats in Louisiana appear to harbor the greatest wintering population of American White Pelicans (*Pelecanus erythrorhynchos*) east of the Rockies (King and Michot 2002), and southern Louisiana is a key wintering area for herons and egrets (Mikuska et al. 1998).

Variable V_4 - Percent vegetative cover of dune, supratidal, and intertidal habitats

Vegetative cover is especially important because it creates the distinction between open sediment and salt marsh habitat in the intertidal zone; hence total vegetation cover is given twice the weight of woody cover. In the supratidal area, shrubs are important for nesting Brown Pelicans (Hingtgen et al. 1985, Visser et al. 2005), and large waders frequently nest in woody vegetation. Studies have reported ducks selecting grasses as nesting cover on barrier islands in Atlantic Canada (Craik and Titman 2009), and the coastally nesting Mottled Duck (*Anas fulvigula*) has exhibited greater success in denser growth elsewhere in southern Louisiana (Durham and Afton 2003). Other studies have emphasized the benefit of reduced vegetation. Elsewhere in their ranges, scant vegetation has been favored by Snowy Plovers (*C. alexandrines;* Scarton and Valle 1997) and for nest sites of Royal (*Thalasseus maximus*) and Caspian Terns; Brasseur 2006).

Reduced vegetation has been reported to improve success of several ground-nesting seabirds (Spear et al. 2007, Mallach and Leberg 1999), and to be favored by nesting Least Terns (*Sterna antillarum*, Jackson and Jackson 1985). However, moderate vegetation density was used most by nesting Least Terns in another study (Burger and Gochfield 1990).

In the intertidal, vegetation is considered important for success of salt marsh nesting sparrows and ducks (Gabrey et al. 2002). Seaside Sparrows (*Ammodramus maritimus*) appear to increase use of vegetation tall enough to bend and form a nest canopy (Gabrey et al. 2001), and Clapper Rails (*Rallus longirostris*) build nests from salt marsh plants (Lowery 1974). Two salt-marsh sparrow species and Clapper Rails were less numerous in salt marshes that had been altered by ditching or impoundments (Burger et al. 1982), perhaps a response to reduced vegetative cover. Other studies have emphasized the value of reduced plant cover in the intertidal. Open intertidal habitat has been associated with occurrence of the Piping Plover (LeDee et al. 2008; Elias et al. 2000) and survival of its chicks on the Atlantic seaboard (Cohen et al. 2009). Thirty-seven shorebirds species used bayside intertidal habitats in one Texas study, while only 21 used vegetated marsh (Withers 2002). The type of vegetation present can be important: mixed seabird colonies on coastal Louisiana marsh islands were on sites with low shrub coverage, but high coverage of herbaceous growth and beach (Greer et al. 1988).

Variable V_5 - Percent vegetative cover by woody species.

Woody vegetation is relevant chiefly because it provides nesting substrates for pelicans and large waders, neither of which requires it strictly (Visser et al. 2005, Lowery 1974). Otherwise, density of vegetation on islands has trade-offs, being favored for concealed nesting by some species but shunned by others (Craik and Titman 2009, Spear et al. 2007, Mallach and Leberg 1999).

Common woody species on barrier islands include Black Mangrove (*Avicennia germinans*), Eastern Baccharis (*Baccharis halimifolia*), Wax Myrtle (*Myrica cerifera*), and Marsh Elder (*Iva frutescens*). The model places some value on plant species diversity, specifying that at least two woody species must be present; if only one is present then the suitability index is divided by two.

In the supratidal, shrubs are important for nesting Brown Pelicans. Visser et al. (2005) surveyed existing Brown Pelican colonies in Louisiana, and recommended that prospective nesting islands should have at least 2 ha of shrub vegetation (mixed with dune). The earlier recommendations of Hingtgen et al. (1985) had specified >50% woody vegetation coverage for this species. Woody vegetation is also commonly used by nesting large waders, which constitute nearly half of nesting water bird species in these systems. Nesting species on barrier islands include the Great Egret, Snowy Egret, Tricolored Heron, Black-crowned Night-Heron, White Ibis, and in some cases Reddish Egret, Cattle Egret, Little Blue Heron, Yellow-crowned Night-Heron, Glossy Ibis, White-faced Ibis, and Roseate Spoonbill (Michot et al. 2001).

Woody thickets are also significant to the habitat needs of migrating small land birds. Moore et al. (1990) compared the use of four habitats by spring migrants on Horn Island off the coast of Mississippi. Scrub/shrub habitat was characterized by the greatest number of species, the highest species diversity, and the largest number of individuals. More migrants recorded their maximum

abundance in scrub/shrub habitats than in the three other habitats combined (pine forest, marsh/meadow, and relict dune). The specification that woody cover includes at least two species is also relevant to use by passage migrants; greater plant diversity presumably gives migrants some variety to choose from in selecting cover and feeding substrates. Although the habitat needs of small migrant landbirds are most directly addressed by the Coastal Chenier/Ridge model, the ability of scrubby growth to provide valuable habitat for these species in the absence of forest cover should not be overlooked. The value of woody cover to nesting Brown Pelicans and large waders, and to small land bird migrants, does not mandate that these habitats cover large areas. Woody vegetation is incompatible with marshy or muddy intertidal habitats, and is unacceptable for nesting terns and skimmers.

Variable V_6 - Edge and interspersion

Salt marshes have been long considered to be a major nursery habitat for a large range of nekton from shrimp to commercially important fish. The marsh edge has been proven to be one of the most important areas within the wetland system of barrier islands. This is especially true because of the importance of the marshes to commercial fisheries. A study on the distribution of juvenile brown shrimp, white shrimp, and blue crabs discovered that their densities were highest 1m from the water's edge and declined quickly to 10m from the edge (Minello and Rozas, 2002). These animals stay near the edge to take advantage of the food and protection provided by these areas. A study completed in Louisiana found that 97.7% of nearly 17,000 fish specimens collected were between 0 and 1.25m from the marsh edge. Most of the animals collected during this study were juvenile or larvae further supporting the idea of the marsh edge as a nursery habitat for both fish and crustaceans (Baltz *et al.* 1993).

In respect to avifauna, this variable is included because the use of marsh habitats by a number of species is focused on water edges, so that salt marshes with more creeks and inlets have more suitable foraging area. For instance, creation of new water/vegetation edge in the form of artificial mosquito-control ponds is considered beneficial to large waders and shorebirds, creating foraging habitat (Mitchell et al. 2006). Piping Plovers benefit from the presence of pools within their coastal habitat (Elias et al. 2000). American White Pelicans, an open water forager of special interest because Louisiana appears to harbor their greatest wintering population east of the Rockies, use salt marsh here in winter but forage by swimming and therefore needs open water (King and Michot 2002). Herons and egrets also forage in shallow water due to the depth limitations imposed by their wading habits, and are therefore best suited to water edges; these taxa are especially important because they utilize southern Louisiana as a key wintering area (Mikuska et al. 1998). Other species have been linked to shallow water and therefore benefit from water edges; two species of *Calidris* sandpipers on the Atlantic Coast tended to use water 0-4 cm deep (Collazo et al. 2002), and two wintering *Anas* ducks in tidal habitats in Louisiana tended to forage near the mud-water interface (Johnson and Rohwer 2000), while a study of Mottled Duck habitat use resulted in a recommendation that water habitats < 15 cm deep be provided for the species (Paulus 1988). Green-winged Teal (*Anas crecca*) in coastal Louisiana favored marshes with a mosaic of water and vegetation for loafing (Rave and Baldassarre 1989). In general, extensive edge allows for greater area of moist sediment during falling tides; such substrates are crucial to shorebirds that probe in these substrates for invertebrates (Lowery 1974).

As marsh becomes replaced by open water, it becomes less suitable for birds dependent on moist substrates and shallow edges. Swimming species tend to either prefer to be near marshy cover, or are diving species with an affinity for even deeper water for foraging and resting (e.g., ducks in the genera *Aythya* and *Mergus*; Lowery 1974). Similarly, there may be some impact on resident nekton, as an increase in edge results in a decrease of inner habitat (Peterson and Turner, 1994). The fish and crustaceans that use that area do so for protection from resident species, as their pools and creeks become open to the outer marsh and the transient species, predation on the residents may increase. The implications of a lost habitat can be clearly seen in a study looking at White Shrimp densities at Elmgrove Point in Texas. Research found densities of 0.0 shrimp/m^2 in the open bay while marsh ponds showed populations of 5.6 shrimp/m^2 (Rozas and Zimmerman, 2000).

Variable V_7 - Beach/surf zone features

Surf zone areas within the northern Gulf of Mexico are important habitats for a number of fish (Modde and Ross, 1983). These areas are particularly important as nurseries for juvenile fishes and in some regions of the world have proven to be sites of accumulation for estuary dependent larva, accounting for up to 97% of the surf zone catch (Watt-Pringle and Strydom, 2003; Whitfield, 1989). It has been determined that fish assemblages around surf zones vary seasonally (Modde and Ross, 1981). In the northern Gulf of Mexico, a majority of young fish species occur during the spring and summer while others which spawn in the fall and winter [Pinfish (*Lagodon rhomboids*), Spot *(Leiostomus xanthurus),* Striped Mullet *(Mugil cephalus),* and/or Gulf menhaden] are present during the winter and spring (Modde and Ross 1981). It has also been determined that these fish show a diel pattern of usage for the surf zone with a majority of fish occurring during the early hours of dawn (Modde and Ross 1981). A diet study aimed at the most prominent fish around Horn Island Mississippi during spring/summer indicated that the majority of surf zone inhabitants were planktivores. Only two of the species studied (*Menticirruhus littoralis* <20mm and *Trachinotus caolinus*) showed any indication that they fed on benthic prey (Modde and Ross 1983). These results were confirmed in other areas of the Gulf as well. The most abundant fishes in the surf zone of Mustang Island, Texas were planktivores (McFarland, 1963) as were surf zone fish in northern and mid Florida (Naughton and Saloman, 1978; Springer and Woodburn 1960). This indicates that surf zone habitats around the Gulf of Mexico are primarily a home to small planktivorous fish that are using this harsh environment as a nursery ground, as it provides an abundance of food as well as protection from larger predators. The variability of the fish assemblages that occupy the surf-zone is minimal and remains relatively constant over large geographic areas (Modde and Ross, 1981). However, some areas may host larger species that are not found in nearby surf-zone habitats. Over the past decade, researchers have observed juvenile Lemon Sharks (*Negaprion brevostris*) around the Chandeleur Islands in Louisiana. The abundance of neonates and young of the year suggests that this large elasmobranch species is using these barrier islands as a nursery. A large number of these individuals are seen in the surf-zone in shallow water (Jon McKenzie, personal observation). While not heavily noted in scientific literature, the use of the surf-zone as a nursery for large species has been documented in other studies (Castro 1993a; Castro 1993b.)

Fish are not the only animals that use the benefits of a healthy beach zone habitat. A study completed along the waters of Galveston Island, Texas found that distribution of postlarval Brown Shrimp were significantly higher in areas of open beach than in areas near groins and jetties (Benfield and Downer, 2001). Other commercially important species are also prevalent within the surf zone. The Blue Crab had the second highest biomass of all species sampled in a surf-zone study in South Carolina (DeLancey, 1989). The most abundant crab in the previously mentioned study was the Speckled Crab (*Arenaeus cribrarius*); this crab is commonly used for bait and is a primary food source for larger commercially important fish such as red drum. Studies on the trophic relationship within surf zones indicate that there are a large range of other invertebrates that inhabit both the benthos and the open water areas. The Mole Crab (*Emerita talpoida*) accounted for the largest biomass in the South Carolina study (Delancey, 1989) while the Gulf of Mexico study showed a higher rate of predation on crustaceans such as copepod, mysids, and decapod larvae (Modde and Ross, 1983).

The surf-zone provides protection and food resources for a large range of nekton, from Blue Crabs to Lemon Sharks. This harsh environment may only provide habitat for a select group of species but its importance as a nursery must not be ignored. However, it has been suggested that not all surf zones are created equal; Suda *et al.* (2002) suggest that if there are no breakers or differences in turbidity between the inner and outer surf, then predators may have a better chance at locating prey.

In addition to nekton, the beach zone habitat is also important for birds. In one study in Texas, 15 species of shorebirds used ocean beach habitat (Withers 2002), and some shorebird species used ocean beaches more than more protected intertidal habitats in studies in New Jersey (Burger et al. 1977) and Connecticut (Placyck and Harrington 2004). Beaches on the Atlantic coast of Florida are important habitats for several taxa of waterbirds; one study found 35 species during the course of a year (Stolen 1999). Ocean beaches in Louisiana are used for foraging by shorebirds and for loafing by flocking gulls and terns. The latter include the barrier island and marsh nesting species (see list above), and also an array of winter visitors and passage migrants; these commonly include the Herring Gull (*Larus argentatus*), Ring-billed Gull (*Larus delawarensis*), Franklin's Gull (*Leucophaeus pipixcan*), Bonaparte's Gull (*Chroicocephalus philadelphia*), Black Tern (*Chlidonias niger*), and Common Tern (*Sterna hirundo*) (Lowery 1974). Among the beach inhabitants is the federally listed Piping Plover, which feeds both on ocean beaches and in the bayside intertidal (Cohen et al. 2008); its abundance is correlated with combined beach and intertidal flat area on the Gulf of Mexico coast in winter (LeDee et al. 2008). Despite this heavy use of beaches, many species use them merely for resting. Consequently, this is the least important variable in the WVA model and is primarily included to allow the discounting of sites that have been altered in ways that limit the attractiveness of the ocean beach for birds- namely covering the waterfront with rock, or construction of a seawall. These render the moist substrates at the water's edge inaccessible, lowering usefulness of the habitat to sandpipers and some other species that forage on moist sand.

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Appendix B

Data Requirements to Support Environmental Benefits of Barrier Island and Barrier Headland Projects Assessed with Community Based Models

Introduction

Proposed barrier shoreline projects are evaluated for projected environmental benefits at several stages during planning and design. During the project development process, changes in project design and site conditions often occur. Such changes necessitate updating CWPPRA assessments used to estimate a project's environmental benefits. This document provides a brief overview of the required information for updating environmental benefit assessments. Further clarification and information is contained in the *"Wetland Value Assessment Methodology: Coastal Marsh Community Models"*; "*Wetland Value Assessment Methodology: Barrier Island Community Model"*; and *"Wetland Value Assessment Methodology: Barrier Headland Community Model."*

A series of quantitative habitat based assessments are used to evaluate environmental benefits associated with barrier shoreline projects. The assessments use quantitative projections of planform performance over the project life (20 years) to predict environmental benefits associated with common barrier shoreline geomorphologic zones. The projections should be firmly based in survey data and engineering analyses best provided by the project design engineer, especially late in the project design phase (i.e., at 30% or 95% design completion). Quantitative projections of project performance (e.g., acres of habitat in each geomorphologic zone) should be provided in table format; figures should be provided depicting the limits of the project performance projections. All information should be in both electronic and hard copy formats. Each set of projections should be accompanied by a brief report, which describes the methods and analyses used and assumptions made. This information should be detailed enough to allow users to understand precisely how the acreage projections were derived.

Anticipated acreages within various elevation zones should be projected over the project life (20 years) using information about the existing conditions in a project area, and engineering predictions regarding performance with and without project implementation. Assessments must include both Future Without Project (FWOP) and Future With Project (FWP) projections. Assessments should reflect projected sediment losses over the project life (e.g., due to long and cross shore transport, subsidence and storms), profile adjustments (including post construction adjustment to equilibrium) due to those volumetric fluxes, and land change based on the defined habitat types. Sediment losses and planform changes should be included that result from processes, such as dune lowering due to storms, marsh platform lowering from the initial fill height (supratidal at +2.6' NAVD88) due to consolidation and dewatering, or affected erosion of marshes.

Three distinct community models are used to assess projects benefiting barrier shorelines. The information required to complete assessments for each community model is included in Tables 1 and 2. Prior to initiating project performance projections, the lead agency (in consultation with

the Environmental Workgroup as needed) will determine the appropriate model(s) for application to specific projects. The barrier island community model should be applied to barrier island projects consisting of island habitat not contiguous with the mainland or barrier headland (e.g., habitats found gulfward of bay or lake systems). This model includes all variables used to project benefits associated with barrier island restoration projects. By nature, barrier headlands are contiguous with the mainland marsh and have not yet detached and begun formation of a barrier island. Barrier headland projects include beach, dune, supratidal, and intertidal habitats. The barrier headland community model was developed to complement the barrier island model and should be applied to shoreline areas along the coast consisting of beach, dune, and supratidal habitat. The coastal marsh community model is used to evaluate intertidal habitats for barrier headland projects.

Project Boundary

Project boundaries must be established to determine the extent of project assessment. The project boundary varies by project type and model. The first step is to determine the project boundary (i.e., total project area). Generally, the total project boundary and acreage of each habitat type is determined using elevation/topographic/bathymetric data, recent aerial photography (e.g., 2004 DOQQs or more recent), and habitat analyses. Use of recent elevation data is preferred. The conditions (i.e., acres at various habitat elevations) should be "rolled forward" to the current year (i.e., Target Year 0) to establish baseline conditions by projecting losses predicted by engineering assessments. Survey data that are several years old could be updated based on cross shore/longshore modeling and/or shoreline retreat or wetland loss rates to project current planform conditions of the project area. If elevation data are not available, then habitat data can be used to divide the island/headland into the different habitat types. It is also helpful to use both elevation and habitat data to characterize the habitats across the island.

<u>Barrier Island Projects</u>

For barrier island projects, the entire island emergent and bayside subtidal habitat should be included in the boundary and not just the footprint of the proposed features. The boundary for the Barrier Island Community Model is defined to extend from the Gulf shoreline at 0.0 feet NAVD88 to either the -1.5 feet NAVD88 depth on the bayside, or 1,000 feet landward of the landward toe of fill, whichever is less. Barrier island projects only encompass emergent and bayside subtidal habitat (i.e., 0.0 to -1.5 NAVD88) while deep open water habitat around the island is omitted.

The project area changes throughout the evaluated 20-yr project life as the island erodes, migrates, and/or shrinks in size. As the island erodes, areas converting to deep open water (> -1.5 NAVD88) are removed from the project area. In determining project boundaries, consideration should be given to potential indirect effects of continued deterioration under FWOP conditions (will shoreline erosion result in increased loss outside of the project footprint?) and FWP conditions (will implementation of the project result in changes in erosion or loss rates of adjacent areas?).

The total area used for this analysis should include the planform area under both FWOP and FWP scenarios encompassed by the limits of both indirect and direct project effects as well as the bayside subtidal acreage. For example, if beach nourishment will result in changes outside of the project footprint, all affected areas should be included in the project area. Subtidal effects may or may not result, but that acreage should be provided under FWOP and FWP for each target year. Total acres will change throughout the Target Years (TY) (for example, the total acres will likely decrease over time in both the FWOP and FWP scenarios, but perhaps at different rates.)

Barrier Headland Projects

For Barrier Headland projects, the boundary includes two sub-areas. One sub-area extends from 0.0 ft NAVD 88 on the gulfside to the northern limits of the supratidal zone (+2.0 ft NAVD 88), equivalent to only the gulf intertidal, dune, and supratidal components of the Barrier Island model. This sub-area is used in the Barrier Headland Community Model. As in the Barrier Island model, this sub-area will vary over time as site conditions change.

The other sub-area includes any adjacent, back-barrier intertidal and open water areas, which are evaluated with the Coastal Marsh Community Model. The limits of the intertidal and open water areas are those affected (directly or indirectly) in the FWOP and FWP. Open water for barrier headland projects is not equivalent to barrier island projects, specifically the subtidal component in the barrier island model. For headland projects, the boundary for the open water components and subtidal components must remain constant over time when evaluated with the marsh model. If the performance projections result in loss of acreage within this area (i.e., by conversion to open water greater than 1.5 feet deep, or by conversion to supratidal due to overwash), those changes should be reported.

Habitat Components

The models are used to capture relative contributions of major “land form” or geomorphologic features to overall habitat value of barrier shorelines and its performance. The model components require inputs of total area for several elevation zones for targeted landforms. The required inputs for the Barrier Island and Barrier Headland models are slightly different. Tables 1 and 2 provide an overview of the model components which are discussed in more detail below.

Barrier Island Projects

Barrier Island Community Model

Acreage or planform area projections for subtidal (bayside), intertidal (bayside), intertidal (gulfside), supratidal, and dune acreages are required at various target years for FWOP and FWP. The island and project feature planform areas within these habitats should be provided separately. The planform area of the different habitat types will change throughout TYs. Additionally, as the island erodes, areas converting to deep open water (> - 1.5 NAVD88) are removed from the project area and the boundary shrinks as the island shrinks.

Dune acres may decrease over the TYs due to equilibrium losses, storm events, or shoreline retreat due to sea level rise. Dune may be converted to gulfside intertidal habitat through shoreline erosion or retreat; dune losses also may be the result of conversion of dune habitats to supratidal habitats through dune lowering. Supratidal habitats may be converted to intertidal habitats through overwash processes. Intertidal acres may change throughout the TYs (for example, the total intertidal acres will increase FWP between TY1 and TY3 as a +2.6 foot NAVD88 marsh platform settles from supratidal to intertidal elevations). The total and intertidal acres will show a decreasing trend after TY3 as subsidence and other losses reduce the marsh platform acres.

Intertidal acreage projections should be based on planform area between 0.0' and +1.9' feet NAVD88 and reported for the gulf side and bayside separately. The total area used for the intertidal component of the project shall include the extent of the effects of project features, and may include indirectly benefited areas and all other portions of the island. The total area used for the intertidal habitat shall include vegetated and unvegetated areas for the entire island.

The Subtidal zone encompasses the area located on the bayside only from 0.0 ft NAVD88 to either –1.5 ft NAVD88, or 1,000 feet landward, whichever is less. As with the other habitats, subtidal may decrease FWP as shoaling occurs with overwash, or it may increase as the marsh platform erodes and converts to open water.

Table 1. Barrier Island Model habitat components for use with barrier island projects.

Habitats	**Description**
The total acreage in the project boundary changes over the target years as project site conditions change. For any given TY, the total acreage will simply be the combined acreage of all habitat components.	
Dune	≥ +5 ft NAVD 88 - The portions of the dune platform anticipated to be within the elevation range
Supratidal	≥ +2.0 ft to ≤ +4.9 ft NAVD 88 - Beach berms and portions of fore and back-slope of dune within elevation range. Also should include primary retention/containment dikes for period anticipated to remain in elevation range. Will generally include major portion of marsh platform until the time dewatering and consolidation reduce the elevation to intertidal
Gulf Intertidal	≥ 0 ft to ≤ +1.9 ft NAVD 88 Gulf side beach slope/shallow open water
Bay Intertidal	≥ 0 ft to ≤ +1.9 ft NAVD 88 - Bayside elevations including vegetated wetlands, flats, and bayside open water areas
Subtidal	0.0 to –1.5 ft NAVD 88 or 1000 feet bayward of the 0.0 feet contour - Shallow open water bayside area only

Barrier Headland Projects

Habitats associated with Barrier Headland projects are evaluated with the Barrier Headland Community Model and the Emergent Marsh Community Model. The habitat zones defined by these models are very similar to barrier island projects, but they are not identical.

Barrier Headland Community Model

Dune (i.e., ≥ +5' NAVD88) and supratidal (i.e., ≥ +2.0' to +4.9' NAVD88) acres will change throughout the TYs (for example, the total headland acres will decrease under FWOP as the dune and supratidal acres are converted to either open water or marsh; dune acres may convert to supratidal acres due to storm events; or supratidal acres may be reduced due to shoreline erosion or profile equilibration).

Table 2. Barrier Headland Model habitat components for use with barrier headland projects.

Habitats	Description
The total acreage in the project boundary changes over the target years as project site conditions change. For any given TY, the total acreage will simply be the combined acreage of all habitat components.	
Dune	≥ +5 ft NAVD 88 - Portions of the dune platform anticipated to be within the elevation range.
Supratidal	≥ +2.0 ft to ≤ +4.9 ft NAVD 88 - Beach berms and portions of fore and back-slope of dune within elevation range. Also should include primary containment dikes for period anticipated to remain in elevation range. Will generally include major portion of marsh platform until the time dewatering and consolidation reduce the elevation to intertidal

Coastal Marsh Community Model

The intertidal and landward open water areas influenced by the project features as determined by analysis of coastal and wetland processes should be included in the marsh model for Barrier Headland projects. Mainland or northern marsh shorelines along ponds or bays may be benefited from maintained hydrology or wave climate. These marshes also may benefit from reduced wind-induced erosion if projected with infilling or restoring portions of bays. Generally, this model could include the intertidal and subtidal areas defined for the Barrier Island model. Intertidal areas are used to determine marsh areas under the marsh model. Intertidal for this application is defined again as 0.0 ft NAVD 88 to +1.9 ft NAVD 88. However, elevations within this range are only included from areas located on the north or landward side only and NOT on the gulfside. Open water used for the marsh model is similar to the barrier island model in that it includes the subtidal area. However, it may also include deeper open water that currently exists or may develop during the project life within the landward transgression path.

Table 3. Coastal Marsh Community Model habitat components for use with barrier headland projects.

Habitats	Description
The following two components should include acreage enclosed in a fixed boundary that does not change with time. The fixed boundary should encompass the maximum area between +1.9 and –1.5 feet NAVD expected to be benefited by the project (including footprint and any indirectly affected areas). The combined acreage of the two habitat components likely will be equal to the total acreage encompassed by the boundary in any given TY. The boundary includes those areas defined below and any projected measurable benefits to adjacent or mainland areas.	

Marsh	≥ 0 ft to ≤ +1.9 ft NAVD 88 landward vegetated wetlands and landward open water areas
Open water	landward subtidal plus deeper water within affected area (i.e., 0.0 to –1.5 ft NAVD or 1000 ft landward *plus deeper water within the FWOP and FWP migration*

Target Years (TYs)

The TYs for which the planform projections are needed is dependent on when processes such as equilibration, storm events, overwash, subsidence, etc., will result in an overall change in planform area, or in the conversion of one habitat type to another. For example, TY 1 FWP scenario is used to represent "as-built" conditions, and TY 3 is usually used to capture the changes due to initial equilibration of beach fill, and the conversion of supratidal elevations (greater than 2.0') in the marsh platform to intertidal elevation through compaction and dewatering. TY 5 is often used to enable the Environmental Workgroup to pro-rate benefits based on vegetative characteristics. TY10 and TY20 are often used to capture long-term and synoptic losses (e.g., 10-year storms). At a minimum, these data generally are needed for FWOP TY1, TY10, and TY20 and FWP at TY1, TY3, TY5, TY10, and TY20.

See Tables 4 and 5 for information typically evaluated by project type under FWOP and FWP.

Table 4. Information required in table (e.g., Excel) and figure format (electronic and hard copies) for Barrier Island projects (Barrier Island Community Model)

FUTURE WITHOUT PROJECT				
Planform Performance projections (acres)				
	TY0	TY1	TY10	TY20
Subtidal (bayside) 0.0 to -1.5 ft NAVD				
Intertidal (bayside) 0 to +1.9 ft NAVD				
Supratidal +2.0 to + 4.9 ft NAVD				
Dune => + 5.0 ft NAVD				
Intertidal (Gulfside) 0 to +1.9 ft NAVD				
TOTAL				

FUTURE WITH PROJECT						
Planform Performance projections (acres)						
	TY0	TY1	TY3	TY5	TY10	TY20
Subtidal (bayside) 0.0 to -1.5 ft NAVD						
Intertidal (bayside) 0 to +1.9 ft NAVD						
Supratidal +2.0 to + 4.9 ft NAVD						
Dune => + 5.0 ft NAVD						
Intertidal (Gulfside) 0 to +1.9 ft NAVD						
TOTAL						

Table 5. Information required in table (e.g., Excel) and figure format (electronic and hard copies) for Barrier Headland projects (Barrier Headland and Coastal Marsh Community Models)

FUTURE WITHOUT PROJECT					
Planform Performance projections (acres)					
		TY0	TY1	TY10	TY20
Emergent Marsh Model	Subtidal (landward) 0.0 to -1.5 ft NAVD				
	Intertidal (landward) 0 to +1.9 ft NAVD				
Headland Model	Supratidal +2.0 to + 4.9 ft NAVD				
	Dune => + 5.0 ft NAVD				
TOTAL					

FUTURE WITH PROJECT							
Planform Performance projections (acres)							
		TY0	TY1	TY3	TY5	TY10	TY20
Emergent Marsh Model	Subtidal (landward) 0.0 to -1.5 ft NAVD						
	Intertidal (landward) 0 to +1.9 ft NAVD						
Headland Model	Supratidal +2.0 to + 4.9 ft NAVD						
	Dune => + 5.0 ft NAVD						
TOTAL							

Appendix C

Project Information Sheet Format

Project Name:

Sponsoring Agency: List Environmental and Engineering Work Group Contacts

Project Location and Description: Describe project location (Coast 2050 region, basin, parish, nearby cities, important bodies of water, total acres, wetland type, etc.). Include a project map.

Problem: Discuss the major causes (historical and current) of marsh loss in the project area.

Objectives: How will the project address the major causes of land loss in the project area? What are the specific objectives of the project?

Project Features: List all project features including their locations, dimensions, etc. The project map should include the locations of all project features.

Monitoring and Modeling Results for Similar Projects: Relevant monitoring reports and modeling studies should be discussed.

Miscellaneous: As necessary, discuss how the following subjects as they relate to the project.
Climate change
Off site disturbances – these are generally the same FWOP and FWP.
Any project risks or uncertainties

V1 – Percent of the total subaerial area that is classified as dune habitat

1) Discuss the vegetative community
2) Discuss methods (e.g., SBEACH) used to predict changes in dune habitat under FWOP and FWP conditions. Discuss how storms, subsidence, etc. were considered in land loss projections.

TY 0 – acres of dune (% of subaerial area); total subaerial acres

FWOP – include assumptions for FWOP condition. Use as many TYs as necessary and provide justification.
TY 1 – acres of dune (% of subaerial area); total subaerial acres
TY X – acres of dune (% of subaerial area); total subaerial acres
TY Y – acres of dune (% of subaerial area); total subaerial acres
TY 20 – acres of dune (% of subaerial area); total subaerial acres

FWP – include assumptions for FWP condition. Use as many TYs as necessary and provide justification.
TY 1 – acres of dune (% of subaerial area); total subaerial acres
TY X – acres of dune (% of subaerial area); total subaerial acres

TY 20 – acres of dune (% of subaerial area); total subaerial acres

V2 – Percent of the total subaerial area that is classified as supratidal habitat

1) Discuss the vegetative community
2) Discuss methods (e.g., SBEACH) used to predict changes in supratidal habitat under FWOP and FWP conditions. Discuss how storms, subsidence, etc. were considered in land loss projections.

TY 0 – acres of supratidal habitat (% of subaerial area); total subaerial acres

FWOP – include assumptions for FWOP condition. Use as many TYs as necessary and provide justification.
TY 1 – acres of supratidal habitat (% of subaerial area); total subaerial acres
TY X – acres of supratidal habitat (% of subaerial area); total subaerial acres
TY Y – acres of supratidal habitat (% of subaerial area); total subaerial acres
TY 20 – acres of supratidal habitat (% of subaerial area); total subaerial acres

FWP – include assumptions for FWP condition. Use as many TYs as necessary and provide justification.
TY 1 – acres of supratidal habitat (% of subaerial area); total subaerial acres
TY X – acres of supratidal habitat (% of subaerial area); total subaerial acres
TY 20 – acres of supratidal habitat (% of subaerial area); total subaerial acres

V3 – Percent of the total subaerial area that is classified as intertidal habitat

1) Discuss the vegetative community
2) Discuss methods (e.g., SBEACH) used to predict changes in dune habitat under FWOP and FWP conditions. Discuss how storms, subsidence, etc. were considered in land loss projections.

TY 0 – acres of intertidal habitat (% of subaerial area); total subaerial acres

FWOP – include assumptions for FWOP condition. Use as many TYs as necessary and provide justification.
TY 1 – acres of intertidal habitat (% of subaerial area); total subaerial acres
TY X – acres of intertidal habitat (% of subaerial area); total subaerial acres
TY Y – acres of intertidal habitat (% of subaerial area); total subaerial acres
TY 20 – acres of intertidal habitat (% of subaerial area); total subaerial acres

FWP – include assumptions for FWP condition. Use as many TYs as necessary and provide justification.
TY 1 – acres of intertidal habitat (% of subaerial area); total subaerial acres
TY X – acres of intertidal habitat (% of subaerial area); total subaerial acres
TY 20 – acres of intertidal habitat (% of subaerial area); total subaerial acres

V4 – Percent vegetative cover of dune, supratidal, and intertidal habitats
Discuss methods used to determine baseline conditions and to predict future values. Discuss

species planted and planting design for FWP.

TY0 – baseline value; percent vegetative cover of all subaerial habitats

FWOP
TY 1 - % cover value
TY X - % cover value
TY 20 - % cover value

FWP
TY 1 - % cover value
TY X - % cover value
TY 20 - % cover value

V5 – Percent vegetative cover by woody species
Discuss current woody vegetative community. Discuss methods used to determine baseline conditions and to predict future values. Discuss species planted and planting design for FWP.

TY0 – baseline value; percent vegetative cover by woody species in all subaerial habitats

FWOP
TY 1 - % cover value
TY X - % cover value
TY 20 - % cover value

FWP
TY 1 - % cover value
TY X - % cover value
TY 20 - % cover value

V6 – Edge and interspersion
Show all calculations to determine baseline value.

TY 0 – % within each class

FWOP – include rationale for percent in each class
TY 1 – % in each class
TY X – % in each class
TY20 – % in each class

FWP – include rationale for percent in each class
TY 1 – % in each class
TY X – % in each class
TY20 - % in each class

V6 – Beach/surf zone features
Show all calculations to determine baseline value.

TY 0 – % within each class

FWOP – include rationale for percent in each class
TY 1 – % in each class
TY X – % in each class
TY20 – % in each class

FWP – include rationale for percent in each class
TY 1 – % in each class
TY X – % in each class
TY20 - % in each class

Literature Cited

Other Supporting Information

Document Revisions

Version 1.0 – March 2010 document developed via the Corps' WVA certification process

Version 1.1 – January 2012

1) Pertinent sections from Procedural Manual incorporated
2) Revised interspersion figures incorporated